Muswellbrook Solar Farm

Environmental Impact Statement

Prepared for ESCO

July 2023

Certification and declaration

For submission of an environmental impact statement (EIS) under Part 4, Division 4.1 of the NSW Environmental Planning and Assessment Act 1979.

Details of person who prepared the statement	
Jennifer Summersby BSc, BEng (Env) (Hons 1) Senior Environmental Engineer 7 July 2023 EMM Consulting Pty Limited Level 3, 175 Scott Street Newcastle NSW 2300	David Snashall BEc, MEnvPl, FPIA Associate Director 7 July 2023 EMM Consulting Pty Limited Ground floor, 20 Chandos Street St Leonards NSW 2065

Project details

Project name: Muswellbrook Solar Farm

Application number: SSD-46543209

Address of the land in respect of which the development application is made: The legal property description of the land to be developed is (refer to Table 3.2 of the EIS): Lot 61 DP1113302, Lot 101 DP1148216, Lot 19 DP16352, Lot 1 DP184481, Lot 6 DP26760, Lot 2 DP26760, Lot 5 DP26760, Lot 3 DP571355, Lot 1 DP571355, Lot 682 DP611756, Lot 1 DP614842, Lot 2 DP614842, Lot 71 DP629631, Lot 1 DP723294, Lot 57 DP752484, Lot 58 DP752484, Lot 59 DP752484, Lot 60 DP752484, Lot 97 DP752484, Lot 39 DP793463, and Lot 40 DP793463.

Applicant details

Applicant name: ESCO Solar Farm 9 Pty Ltd as trustee for the ESCO Solar Farm 9 Trust (ABN 88 366 226 320)

Applicant address: Level 4, 13 Cremorne Street, Richmond, Victoria 3121

Declaration by registered environmental assessment practitioner

The undersigned declares that this EIS:

- has been prepared in accordance with Part 4 of the *Environmental Planning and Assessment Act 1979*
- has been prepared in accordance with Schedule 3 of the Environmental Planning and Assessment Regulation 2001
- 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 Development 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.

Name: David Snashall

Registration number: R80026

Organisation registered with: CEnvP Program

Date: 7 July 2023

Executive Summary

ES1 Introduction

ESCO Solar Farm 9 Pty Ltd as trustee for the ESCO Solar Farm 9 Trust (ESCO) proposes to develop a large-scale solar photovoltaic (PV) generation facility and associated infrastructure to be known as the Muswellbrook Solar Farm (the project). The proposed solar farm will have generation capacity of approximately 135 megawatts alternating current (MWac) and would produce around 347 gigawatt hours (GWh) of energy annually which is enough to power approximately 79,000 homes. The proposed battery energy storage system (BESS) will also have a capacity of approximately 135 MWac and up to two hours of storage.

The project is State significant development (SSD) pursuant to Schedule 1 of the State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP). Accordingly, approval for the project is required under part 4 of the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act).

ES2 Strategic context

The National Electricity Market (NEM) is undergoing rapid and significant transformation from a centralised system of large fossil fuel (coal and gas) generation towards an array of smaller scale and widely dispersed wind, solar and other renewable energy generators. This change is being driven by an evolving power supply mix, weather, consumer preferences, ageing infrastructure and changing technologies. It is expected that all existing NSW coal fired generation infrastructure (capacity of approximately 8,000 MW) will be retired by 2040.

The project will contribute to the security of renewable energy supply in NSW, while reducing greenhouse gas emissions by approximately 7.6 million tonnes (Mt) (CO2e) over its operational life.

The project is consistent with the infrastructure investment objectives set out in the *Electricity Infrastructure Investment Act 2020*, being the construction of generation infrastructure that is necessary to minimise electricity costs for NSW electricity customers, and the construction of long duration storage infrastructure that is necessary to meet the reliability standard.

Importantly, the project will also contribute to the continued growth of renewable energy generation and storage capacity in the Hunter-Central Coast REZ.

ES3 The project

ESCO proposes to develop the project at Muscle Creek Road, Muswellbrook NSW, approximately 2.5 kilometres (km) east of Muswellbrook within the Muswellbrook Shire local government area (LGA) in the Hunter Region of NSW. The site encompasses approximately 482 hectares (ha) and is located adjacent to the Muswellbrook Coal Mine on land primarily owned by Idemitsu who is the mine operator. The project area has been selected to optimise the future land use of the Muswellbrook Coal Mine site for the generation of renewable energy. The project location is shown in Figure 1.1.

The project comprises the following key components:

- development of a large-scale solar farm with a generation capacity of approximately 135 MWac
- development of a utility scale BESS with a capacity of approximately 135 MWac and up to two hours of storage
- grid connection and electricity transmission line infrastructure.

The project is consistent with NSW government policy for development of electricity infrastructure. It will contribute to the development of Renewable Energy Zones in NSW and the Hunter Central Coast region and assist in meeting NSW's energy generation and storage requirements, as well as the NSW and Australian Government emissions reduction targets.

ES4 Engagement

As part of the project refinement process and preparation of the EIS, consultation has been, and will continue to be, undertaken with a range of stakeholders including various local and NSW government agencies, the local community and neighbouring landholders.

ESCO has been working closely with relevant stakeholders to gain an understanding of the interests that stakeholders have in the project, the potential impacts to stakeholders, and using these insights to inform project design and refinement. Mitigation measures have been incorporated into the project design where applicable to appropriately manage and mitigate these impacts for the local community.

ESCO will continue stakeholder engagement activities to ensure matters raised by the community and other stakeholders are understood and addressed. Future engagement and consultation activities for the project will include public exhibition of this EIS, responding to the submissions received during the public exhibition, ongoing engagement with landholders and further community information sessions.

ES5 Assessment of impacts

ES5.1 Biodiversity

A biodiversity development assessment report BDAR (provided in Appendix D) has been prepared for the project by Eco Logical in accordance with the Biodiversity Assessment Method (BAM) and the biodiversity related Secretary's Environmental Assessment Requirements (SEARs).

Measures to avoid and minimise impacts to vegetation were a key input to the project refinement process, resulting in the avoidance of the following plant community types (PCTs) from the development footprint:

- 155.3 ha of PCT 1691 – Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter
- 9.6 ha of PCT 1603 – Narrow-leaved Ironbark – Bull Oak – Grey Box shrub – grass open forest of the central and lower Hunter
- 9.6 ha of PCT 281 – Rough-Barked Apple – red gum – Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion.

Residual biodiversity impacts include:

- 125.2 ha of PCT 1691, of which 10.7 ha is of high enough condition for it, and its associated habitat for flora and fauna species, to require offsets under the NSW Biodiversity Offset Scheme (BOS)
- 118 ha of PCT 281, of which 61 ha is of a condition to require offsets
- 71.4 ha of PCT 1603, of which 24.4 ha is of a condition to require offsets
- 1.1 ha of PCT 1607 – Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter, all of which will require offsets
- direct impacts to 23.2 ha of Pine Donkey Orchid population in the Muswellbrook local government area

- direct impacts to one individual of the *Cymbidium canaliculatum* population in the Hunter Catchment
- direct impacts to 3.2 ha of foraging habitat associated with buffers for the Large-eared pied bat
- direct impacts to 0.4 ha of foraging habitat associated with the Southern Myotis
- direct impacts to 19.8 ha of habitat of the Brush-tailed Phascogale
- direct impacts to 42.8 ha of habitat of the Squirrel glider.

These residual impacts will be compensated for through the implementation of a biodiversity offset strategy.

One Threatened Ecological Community (TEC) listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) at risk of serious and irreversible impacts (SAII) occurs within the project area:

- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions.

The TEC and fauna species have been assessed in accordance with Section 9.1 of the BAM (DPIE 2020) and the assessment is presented in Section 7.1 of the BDAR.

ES5.2 Aboriginal heritage

An Aboriginal Cultural Heritage Assessment (ACHA) (provided in Appendix E) has been prepared for the project by EMM. The ACHA was prepared in general accordance with the *Code of Practice for Archaeological Investigation in NSW* (DECCW 2010a), guided by the *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in New South Wales* (OEH 2011) and the relevant SEARs.

A search of the Aboriginal Heritage Information Management System (AHIMS) database found six Aboriginal heritage sites located within the project area. Field survey and test excavations were completed with representatives from Registered Aboriginal Parties (RAPs). Based on the findings of the desktop assessment, survey and test excavations, the project area can be considered to encompass four Aboriginal sites, places and/or objects, consisting of three artefact scatters (MSF-FA1, MSF-FA-2, MSF-BS1) and a culturally modified tree (tentative status) (MSF-CMT1). The project would result in the total or partial loss of all sites, however, portions of MSF-FA1 and MSF-FA2 would be preserved and there would be opportunities for heritage interpretation and public outreach.

An Aboriginal cultural heritage management plan will be developed for the project in consultation with the Department of Planning and Environment (DPE), Registered Aboriginal Parties for the project and Heritage NSW, and will include details regarding the management and mitigation of known Aboriginal sites, along with unanticipated finds procedures and training and reporting protocols.

ES5.3 Landscape and visual

A landscape and visual impact assessment (LVIA) (provided in Appendix F) was undertaken by EMM to determine the potential impact of the project on the existing landscape character and visual amenity.

Four landscape character zones (LCZ) were identified based on the dominant landform and landscape features. These are:

- Agricultural plains – characterised by level or gently sloping land that rises from a river or creek that has been cleared for agricultural uses:
  - views are open along the valleys with trees lining the rivers and creeks. Views are contained by the hillsides along the valley sides
  - this LCZ has a **Low** landscape character impact.
- Ridges – characterised by Bells Mountain and associated low ridges running south and westward:
  - views are limited due to tree canopies and access is limited
  - this LCZ has a **Moderate-Low** landscape character impact.
- Vegetated valleys – characterised by gentle slopes and undulating topography:
  - views are limited by undulating topography and vegetation growth
  - this LCZ has a **Moderate** landscape character impact.
- Urban slopes – characterised by hillsides that are covered with residential and commercial developments:
  - the hillsides are entirely covered by urban development. Views tend to be contained within the urban fabric with some views over the adjacent valleys
  - this LCZ has a **Low** landscape character impact.

Visual assessments were undertaken from a number of representative viewpoints selected based on the locations of residences, public areas, and roads/rail and zone of visual influence (ZVI) mapping to determine which locations had the potential for visual impacts from the project.

The visual assessment determined that, of the viewpoints assessed, infrastructure may be visible to varying degrees from eight of the nine viewpoints. Based on variable elevation and undulation in the landscape, the presence of vegetation, and the size of the power generation infrastructure, the impact assessment predicts:

- a very low visual impact from Viewpoints 1,2, 5 and 9
- a low visual impact from Viewpoints 3, 4, 6, 7 and 8
- there were no viewpoint locations with a moderate impact rating
- there were no viewpoint locations with a high impact rating.

In addition to the viewpoint assessments, each resident within 4 km of the project area is listed with the potential visual impacts. The assessment for residences predicts:

- no impact to low visual impact for all residences
- no residences with a moderate or high impact rating.

A glint and glare analysis was performed to measure the possibility of glare from the solar arrays and the project infrastructure. The results indicate the risk of glint and glare related impacts experienced at residences and along roads and rail as a result of the project are within acceptable limits, with screening provided by existing trees, and no mitigation is required.

ES5.4 Social

A social impact assessment (SIA) (provided in Appendix G) was prepared by EMM in accordance with relevant SEARs and the Social Impact Assessment Guideline (DPE 2023a). The SIA assessed both negative and positive aspects of the project on different groups of people and local communities and documented the benefits to the broader region.

The local community acknowledges the transition to renewable energy and is generally supportive of the project.

Potential social impacts were assessed using a social risk framework based on a combination of consequence and likelihood. The outcomes of the SIA indicate that the social impacts are largely associated with amenity impacts during construction and permanent changes to the visual landscape, as well as potential impacts of workforce accommodation demands on rental accommodation and short-term accommodation. Mitigation measures are recommended including ongoing monitoring and periodic review of mitigation strategies to adapt to changing circumstances.

An Accommodation and Employment Strategy (Appendix P) has been prepared by ESCO (2023) outlining the strategies that may be used by the project to ensure that sufficient accommodation can be sourced, and to maximise local business and workforce opportunities. A monitoring and evaluation framework has been included to ensure the strategy remains effective.

ES5.5 Land and soils

A land use, soils and erosion (LUSEA) (provided in Appendix H) has been prepared by EMM to identify and assess potential land capability, soil erosion, sedimentation and rehabilitation impacts associated with the project. In addition, an agricultural impact assessment (AIA) (provided in Appendix I) has been prepared by Minesoils (2023) to assess the impacts of the project on agricultural land.

The project area is primarily on land zoned as RU1 Primary Production, as well as land zoned as SP2 Infrastructure and C3 Environmental Management under the Muswellbrook LEP. The southern area of the project area is primarily used for cattle grazing and is characterised by degraded native grasslands and modified pastures with widely scattered remnant paddock trees. The northern area predominantly comprises regenerating even-aged regrowth Ironbark with occasional mature trees, sparsely scattered shrubs and degraded native grasslands. The Muswellbrook Coal mine is located adjacent to the project area.

There is no biophysical strategic agricultural land (BSAL) mapped within the project area. Soils in the project area are of moderate capability with portions of moderate to low capability, and low capability land. The project area is dominated by soils with moderately low fertility, and there are some very small areas of moderate and moderately high fertility soils. The land and soil capability of agricultural lands in the project area are unlikely to change as a result of the project from their current capability and will be managed through the implementation of appropriate mitigation measures.

Erosion hazard ranges from low to high throughout the project area. Most of the project area has a very low to moderate erosion hazard, with small areas of high to extreme erosion hazard. This hazard can be minimised to an acceptable level via adoption of appropriate drainage, erosion and sediment control practices, management measures for which will be incorporated in the construction environmental management plan (CEMP) for the project.

ES5.6 Water resources

A water resources impact assessment (provided in Appendix J) has been prepared by EMM. A flood assessment was also completed as part of this assessment by BMT (2023).

The project is located in the Hunter River catchment within the Muscle Creek and Sandy Creek sub catchments. There are multiple stream and drainage lines across the project area ranging from first order to fourth order streams. The most significant is a fourth order tributary of Muscle Creek in the southern project area. Non-minor streams have been offset through the project to protect the vegetated riparian zone.

The groundwater environment has also been modified due to the historical open cut and underground mining operations within and surrounding the project area. This has led to an alteration of the groundwater environment. Existing underground dewatering infrastructure at the surface remains active and will be utilised by the project as a primary non-potable water source.

Flood modelling was undertaken to provide planning guidance for placement of internal infrastructure and assess potential flood risks. Depths of flooding and flood hazard across the project area are highly variable depending on the local hydraulic conditions but are generally less than 1.5 m depth in the southern project area, and 0.2 m depth in the northern project area in the 1% Average Exceedance Probability (AEP) event.

The project facility area will include an upslope open channel and diversion bund to create flood free areas up to the 1% AEP event. The open channel and diversion bund will be implemented to divert drainage and flooding towards the tributary of Muscle Creek reinstating the existing mapped watercourse.

Overall, potential surface water and groundwater impacts during both construction and operation are considered minor and manageable with proposed water management and mitigations measures in place.

Water demands (non-potable) during construction and operation will utilise existing water access licences currently held by Muswellbrook Coal Company. No additional water licences will be required for the project. Potable water will be trucked in. The project will not impact adjacent licensed water users or basic landholder rights during construction and operations.

ES5.7 Traffic and transport

A traffic impact assessment (TIA) (provided in Appendix K) has been prepared by EMM in accordance with the NSW Government's (RTA) *Guide to Traffic Generating Developments* and the SEARs.

The project will be serviced by a network of roads including the New England Highway, Muscle Creek Road and Sandy Creek Road. Construction of the solar farm would generate a maximum of 200 light vehicle movements per day, and a maximum of 90 heavy vehicle movements per day, with up to 180 movements (light and heavy) during peak hours. Peak hours are expected to be between 8:00 am and 9:00 am ad between 3:30 pm and 4:30 pm. Operating traffic volumes would be approximately seven vehicle movements per day.

The existing level of service (LOS) for key intersections for the projects is LOS A (good operation) or LOS B (good with acceptable delays and spare capacity), with no change to the LOS rating under the cumulative traffic scenario. The mid-block capacity of Muscle Creek Road is expected to operate at LOS C, and Sandy Creek Road is expected to operate at LOS B in the cumulative traffic scenario. The LOS C is considered to be a satisfactory condition for traffic flow and is only expected to be experienced in the AM and PM peak hours during the construction period.

To accommodate the construction traffic movements associated with the project, an upgrade to the intersection of Sandy Creek Road and the northern site access will be required for a basic right turn treatment from Sandy Creek Roads to the northern site access.

School bus services operate on Muscle Creek Road and Sandy Creek Road. Impacts to these services will be mitigated through implementation of a construction traffic management plan, incorporating a driver code of conduct, which informs drivers about the school bus routes along Muscle Creek Road and Sandy Creek Road.

ES5.8 Noise and vibration

A noise and vibration impact assessment (NVIA) (provided in Appendix L) was prepared by EMM in response to the SEARs and in general accordance with the relevant government guidelines.

Construction works are proposed to occur during standard hours Monday to Friday (7:00 am–6:00 pm) and on Saturdays from 8:00 am–1:00 pm. Significant impacts in relation to noise at non-associated residents are not anticipated as a result of the project during construction or operation. One residence may experience moderately intrusive noise (NML+10dB) and the project may be clearly audible at 33 other residences during site preparation works. No exceedance of the 'Highly Noise Affected' level is expected.

Operational noise is predicted to satisfy the NSW *Noise Policy for Industry* (NPfI) (EPA 2017) project noise trigger levels for all assessment locations.

During peak construction, increases in road traffic noise will occur along the New England Highway, Sandy Creek Road and Muscle Creek Road. Assessed road traffic noise levels indicate that the relative increases for each assessed road will remain below the thresholds provided in the *Road Noise Policy* (RNP) (DECCW 2011).

Assuming the proposed mitigation measures outlined are applied, the project is not anticipated to generate significant noise or vibration impacts.

ES5.9 Hazards and risk

A preliminary hazard analysis (PHA) was prepared by Sherpa Consulting (provided in Appendix M). The PHA summarises potential hazards and risks associated with the project and details management measures to reduce these hazards and risks to acceptable levels. The PHA considered all hazards and risks associated with the project including the BESS, the on-site substation, electrical collection and conversion systems and ancillary infrastructure.

The PHA determined that the project is not classed as a potentially hazardous development. For all identified events associated with the project, the resulting consequences are not expected to have significant offsite impacts. The assessment identified numerous scenarios/events with potential for off-site impacts, which were subject to qualitative risk analysis in accordance with the Multi-level Risk Assessment Guideline (DoP 2011b). Of the 16 events identified, all were rated as "Very Low" risk except for one "Medium" risk event. This event is related to an unauthorised person accessing the proposed BESS/development footprint, resulting in vandalism/asset damage to the infrastructure with the potential for self-injury during the act. To adequately manage this risk, security fencing, cameras, and warning signs will be installed, and onsite security protocols implemented to deter trespassers and minimise unauthorised person access.

Based on the study risk acceptance criteria, the risk profile for the project is considered to be tolerable. The analysis found that the project is compliant with the Hazardous Industry Planning Advisory Paper (HIPAP) 4 (DoP 2011c) qualitative risk criteria.

ES5.10 Bushfire

A Bushfire Strategic Study has been prepared for the project by Cool Burn Fire and Ecology (provided in Appendix N). The project area is in the Muswellbrook LGA in the Upper Hunter which has an accepted fire danger rating of Fire Danger Index (FDI) 100. The project area is mapped as Vegetation Category 1 and Vegetation Category 2 bushfire prone vegetation and associated buffers. Vegetation across the project area is classified as a mix of grassy woodland and grassland, with a large portion of the project area classified as cleared, partially cleared, and managed. The project area is considered as moderate to potentially high risk for bushfire.

The project would result in a reduction of unmanaged bushfire prone vegetation and connectivity in the locality, such that adjoining land uses would benefit from an overall reduced bushfire risk. No additional bushfire management actions would be required on adjoining land.

The mitigation measures outlined would ensure that the project complies with the aims, objectives and specific performance criteria of *Planning for Bushfire Protection* (RFS 2019).

ES5.11 Historic heritage

A historic heritage assessment was undertaken by OzArk to investigate any archaeological potential, including built heritage items of historical heritage significance related to European occupation (refer to Appendix O).

There are no items listed on the National Heritage List, Commonwealth Heritage List of State Heritage Register within or near the project area. No items listed on the Muswellbrook LEP are located within the project area. No historic sites or areas of significance were recorded during the surveys.

A historic heritage management plan including an unanticipated finds protocol will be implemented for the project in the instance that any previously unrecorded or unanticipated historic objects are encountered during construction.

ES5.12 Air quality

Emissions to the atmosphere from the project during construction will be temporary in nature and will be restricted to dust caused by land disturbance and vehicle, plant and equipment exhaust emissions.

Ongoing maintenance of project infrastructure and the land within the development footprint will be required during operation. Maintenance activities will result in very minor, localised vehicle emissions and generation of dust from vehicles travelling along internal, unsealed access roads.

The implementation of mitigation measures such as dust suppression and local road maintenance will reduce air quality impacts during construction and operations.

ES5.13 Waste

The project will produce a number of waste streams during the construction period. Minor quantities of waste will also continue to be generated during operations. Potential impacts from poor management of waste include contamination of land and water and human and animal health impacts.

All wastes produced by the project will be classified, stored and handled in accordance with the *Waste Classification Guidelines – Part 1: Classifying Waste* (EPA 2014). A waste management plan (WMP) is being prepared and will be implemented in consultation with Muswellbrook Council and DPE to effectively manage waste during construction, operation and decommissioning of the project.

ES5.14 Economics

The project is expected to result in a temporary loss of agricultural land and production over the project life, however ESCO are investigating the use of Agrisolar which may offset some of these impacts. The project will bring economic benefits and stimulus to the local region in the form of local employment, use of local services and additional retail expenditure during construction. Up to nine full time equivalent jobs would be created by the project with an estimated local economic stimulus of up to $45.5 million in additional wages over the operational life of the project.

ES5.15 Cumulative impacts

The project will contribute to the overall growth of the Hunter-Central Coast REZ. Other proposed, approved, under construction and operational developments known at the time of finalisation of this EIS have been considered.

Development in the vicinity of the project has the potential to generate cumulative impacts with the project during both construction and operation and may include impacts relating to workforce demand and supply, housing and short-term accommodation, traffic and transport, and amenity (including noise and visual impacts). Mitigation measures relating to these impacts are included in this EIS.

ES6 Justification and conclusion

The project involves the development and operation of a large-scale solar PV generation facility along with battery storage and associated infrastructure. The project will be within the NSW Government declared Hunter-Central Coast REZ and will play an important part in achieving the objectives of the Hunter-Central Coast REZ by contributing to the continued growth of renewable energy generation and storage capacity. It will support the Commonwealth and State governments in achieving their respective renewable energy and greenhouse gas emission reduction targets.

The project is justified economically due to the economic benefits and stimulus it will provide to the local region. The project will generate up to 200 jobs during construction and up to nine full time equivalent jobs throughout operations and will provide ongoing economic benefits for both the local economy and broader region. ESCO will work in partnership with Muswellbrook Shire Council and the local community to ensure that, as far as possible, the benefits of the projected economic growth in the region are maximised and impacts minimised.

The site is suitable for the project due to several factors, notably its location within the Hunter-Central Coast REZ. In addition, the study area is favourable for the construction and operation of a solar and battery project due to the available solar resource, physical conditions (flat to gently undulating topography and predominantly cleared land), absence of biophysical strategic agricultural land and relatively few neighbours living within close proximity. Further, the project's proximity to existing electricity and transmission infrastructure in the Hunter Valley means that there is infrastructure within the immediate area with the capacity to export the electricity generated by the project to the grid.

A suite of design, mitigation and management measures are proposed in this EIS to avoid, minimise and manage impacts of the project. There will be economic investment and employment benefits for the local region and a realised opportunity for renewable energy generation, while minimising potential environmental and social impacts. The overall benefits of the project are considered to be in the public interest.

TABLE OF CONTENTS

Appendices

Tables

Figures

Photographs

1 Introduction

1.1 Project background

ESCO Solar Farm 9 Pty Ltd as trustee for the ESCO Solar Farm 9 Trust (ESCO) proposes to develop a large-scale photovoltaic (PV) generation facility and associated infrastructure, known as Muswellbrook Solar Farm (the project), comprising the following key elements:

- development of a large-scale solar farm with a generation capacity of approximately 135 megawatts alternating current (MWac)
- development of a utility scale battery energy storage system (BESS) with a capacity of approximately 135 MWac and up to two hours of storage
- grid connection and electricity transmission line infrastructure.

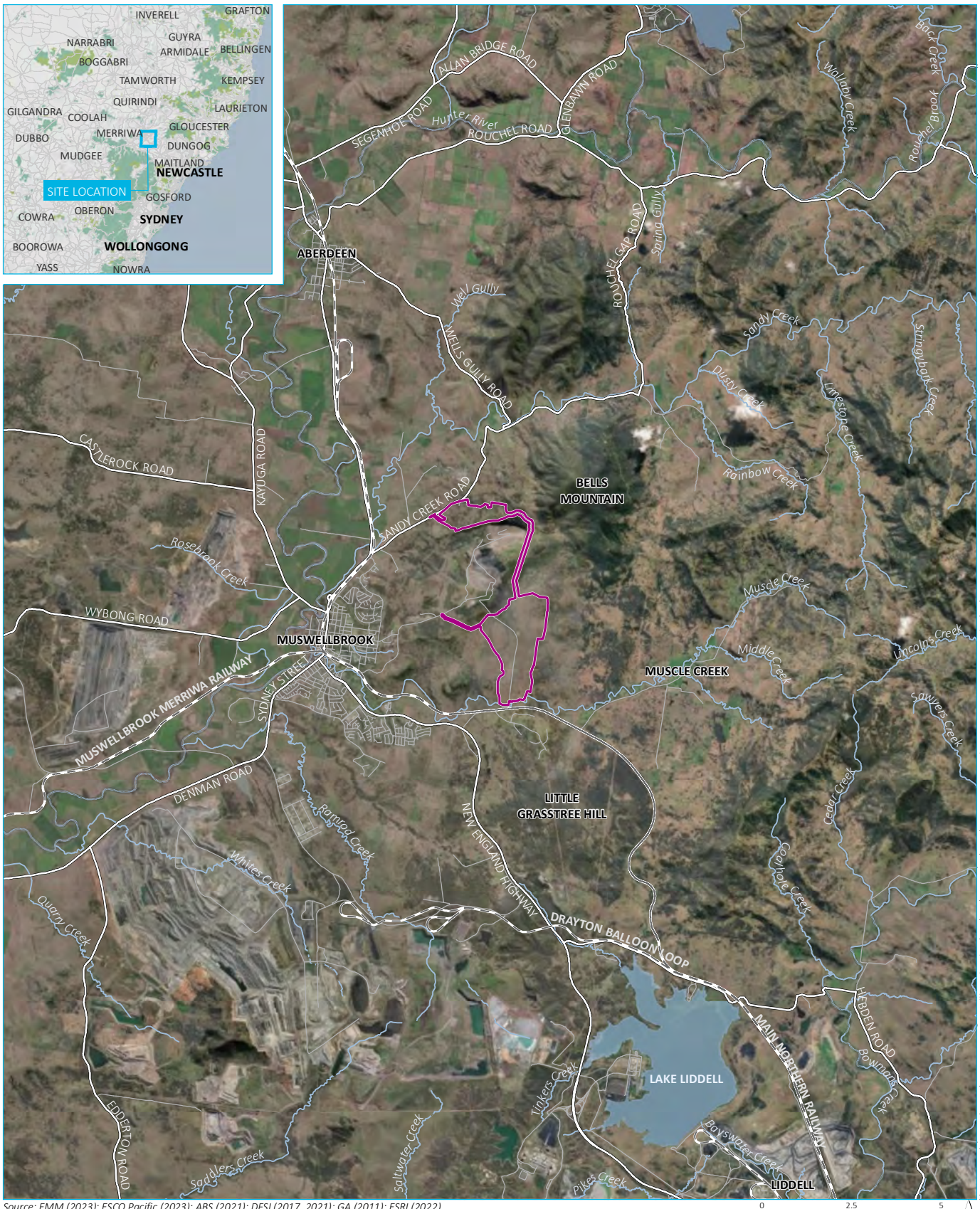
The project is situated adjacent to the Muswellbrook Coal Mine on land primarily owned by Idemitsu, the mine operator. Coal mining at Idemitsu's Muswellbrook Coal Company (MCC) site ceased in November 2022, after 115 years of operations. Idemitsu has developed a Draft Master Plan to redevelop the site and generate post-mining investment and employment in the region.

The Draft Master Plan outlines the vision for the site which has been named the Muswellbrook Clean Industries Precinct (MCIP). This precinct includes a range of renewable energy and other projects at the site including the Muswellbrook pumped hydro energy storage, solar, battery storage and green hydrogen projects, along with training facilities.

The project area has been selected to optimise the future land use of the Muswellbrook Coal Mine site for the generation of renewable energy and is ideally located adjacent to existing transmission infrastructure. The project area is traversed by existing 132 kilovolt (kV) and 330 kV transmission lines. It is an ideal site for increasing generation capacity to the NSW electricity grid with minimal requirements for additional transmission infrastructure.

As part of the project's early stages of development, ESCO performed a preliminary assessment of available land informed by a review of topography, preliminary ecological assessment, and significant surface water features. Disturbance areas of the operating mine footprint were avoided. The project investigation area was the subject of a planning and environmental constraints analysis, which identified key risks and constraints to the project based on preliminary design considerations, State and Commonwealth panning and assessment frameworks and the environment both within and surrounding the site. Further details regarding site selection and project development are provided in Section 2.2.

The project is on Wonnarua Country, within the localities of Muswellbrook and Muscle Creek in the Muswellbrook Shire Council Local Government Area (LGA), in the Hunter Region of NSW. The nearest population centre to the project is the township of Muswellbrook, approximately 2.5 km west of the project. The project location is shown in Figure 1.1.



Source: EMM (2023); ESCO Pacific (2023); ABS (2021); DFSI (2017, 2021); GA (2011); ESRI (2022)

0 2.5 5 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS001_RegionalSetting_20230705_03.mxd 5/07/2023

KEY

- Project area
- Rail line
- Major road
- Minor road
- Named watercourse
- Named waterbody

INSET KEY

- Major road
- NPWS reserve
- State forest

Regional setting

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 1.1

EMM
creating opportunities

1.2 Project overview

The project will comprise the following key components:

- a network of approximately 300,000 solar PV panels and associated mounting infrastructure
- a BESS with a capacity of up to 135 MWac and a storage duration of up to 2 hours
- electrical collection systems (BESS collection station and solar farm collection station), transformer substation, and switchyard
- an operations and maintenance facility, including demountable offices, amenities, equipment sheds, storage and parking areas
- internal access roads
- a temporary construction compound/laydowns (during construction and decommissioning only)
- electricity transmission line infrastructure connecting to the grid and connecting the north and south areas of the solar farm.

The project will be developed within a project area of approximately 482 hectares (ha) (described further in Section 3.2). The land area to be covered by the project components (the development footprint) has been refined through an iterative design process throughout the preparation of this Environmental Impact Statement (EIS) and has been informed by the outcomes of community and stakeholder engagement and the findings of the environmental, social and economic assessments. This is described further in Section 2.5.4.

The project aligns with the NSW and Commonwealth government's objectives for energy security and reliability, and emissions reductions, and will contribute to the continued growth of renewable energy generation and storage capacity in NSW and the Hunter Central Coast region.

The project will help to achieve this through the following objectives:

- Support and contribute to Commonwealth and State climate change commitments such as the *Paris Agreement 2015*, *Renewable Energy Target (RET) Scheme* (DCCEEW 2022a), 2022 ISP (AEMO 2022) and *NSW Net Zero Plan Stage 1: 2020–2030* (DPIE 2020b).
- Contribute to the development of the Hunter-Central Coast Renewable Energy Zone (REZ), supplying approximately 135 MWac of electricity generating capacity and 135 MWac/270 MWh of energy storage to the National Electricity Market (NEM).
- Contribute to capacity gaps in the electricity market following the closure of more than 8,000 megawatt (MW) worth of coal-fired power generators within NSW by 2035 (DPIE 2019). The project will provide a total annual generation capacity of around 347 gigawatt hours (GWh) which is equivalent to powering the needs of approximately 79,000 homes, thereby enhancing reliability and security of electricity supply in NSW.
- Support the realisation of the Hunter Regional Plan's goal to be the leading regional economy in Australia by helping to diversify and grow the energy sector.

1.3 The applicant

The applicant details are outlined in Table 1.1.

Table 1.1 Applicant details

Item	Details
Name	ESCO Solar Farm 9 Pty Ltd as trustee for the ESCO Solar Farm 9 Trust (ESCO)
Contact	Carla Evans
Address	Level 4, 13 Cremorne Street, Richmond, Victoria 3121
ABN	88 366 226 320
Summary	The Muswellbrook Solar Farm is being developed by ESCO Solar Farm 9 Pty Ltd as trustee for the ESCO Solar Farm 9 Trust I (ESCO). Muswellbrook Solar Farm is a joint venture between ESCO Pacific Holdings Pty Ltd (ESCO Pacific) and Idemitsu Renewable Developments Australia (Idemitsu). ESCO Pacific is a leading Australian developer and asset manager of utility scale solar farms with a proven track record of developing projects from early-stage feasibility through to financial close and ultimately project commissioning. ESCO Pacific is also the long term asset manager of a 360 MWdc portfolio of operational solar farms. ESCO Pacific's team comprises highly qualified infrastructure, development and corporate finance professionals with experience delivering utility scale renewable energy projects to market. ESCO Pacific has a proven track record, delivering to market over 603 megawatts direct current (MWdc) of operational solar generation (Ross River Solar Farm, Childers Solar Farm, Susan River Solar Farm and Moura Solar Farm in QLD and Finley Solar Farm in NSW) with a further 200 MWdc currently under construction (Wyalong Solar Farm (NSW) and Glenrowan Solar Farm (VIC)). ESCO Pacific has a pipeline of projects approaching 2GW in advanced stages of development in VIC, NSW, QLD and SA. Idemitsu Australia has been operating in Australia for more than 40 years. Idemitsu Australia is a subsidiary of Japanese company Idemitsu Kosan, which has a long history of with renewable energy projects in Japan. In 2021, Idemitsu Renewable Developments Australia was formed, to focus on innovation, including new solar, hydro, wind and battery hybrid energy development projects and export opportunities. Both ESCO Pacific and Idemitsu have a record of responsible environmental management. The development, construction and operation of ESCO Pacific and Idemitsu Australia projects is undertaken line with best practice environmental management. There are no past or present proceedings against the person undertaking the action

1.4 Related development

The majority of the site is owned by Idemitsu Australia, the owner of MCC which operates the Muswellbrook mine site. The mine is operated under development approval DA 2002/205, determined by Muswellbrook Shire Council. The DA boundary, and associated mining leases and coal tenements are shown on Figure 2.4. The project area assessed in this EIS overlaps a small area of the mine's DA consisting of a small section of the northern project area, and the internal connection route between the northern and southern project areas. The project assessed in this EIS will not interfere with the rehabilitation obligations of the existing DA.

The connecting transmission line from the solar farm and BESS to the grid are included in the project's operational infrastructure and is included in the project area (Figure 3.1). ESCO has consulted with Ausgrid regarding a suitable connection point to the 95M transmission line. Impacts associated with the connection have been assessed in this EIS.

The NSW Government has identified a number of REZs across the state, which are areas where solar and wind power generation projects will be grouped together to efficiently store and transmit electricity from these projects across NSW. Five zones have been identified so far, and the Hunter-Central Coast REZ is in the early stages of planning. The project is within the Hunter-Central Coast REZ.

The Hunter-Central Coast REZ was formally declared by the Minister for Energy under Section 19(1) of the NSW *Electricity Infrastructure Investment Act 2020* (EII Act) on 9 December 2022. The project aligns with the NSW and Commonwealth Government's objective for energy security and reliability and emissions reductions and will contribute to the continued growth of renewable energy generation and storage capacity in the Hunter-Central Coast REZ.

EnergyCo is leading the planning and development of the REZ, including community and stakeholder consultation (NSW Treasury 2022). Registrations of Interest were open between December 2021 and February 2022 for the Hunter-Central Coast REZ and attracted a significant response (NSW Treasury 2022). Commercial parties registered interest in almost 40 gigawatts and more than $100 billion of potential investment comprising (NSW Treasury 2022):

- 24 solar energy projects
- 13 onshore and seven offshore wind energy projects
- 35 large-scale batteries
- eight pumped hydro projects.

Source: NSW Treasury 2022

Figure 1.2 Hunter-Central Coast REZ

1.5 Restrictions or covenants of the site

There are several Crown roads within the project footprint. One of the roads, Limestone Road, is a formed dirt road. The other Crown roads are not developed roads (paper roads). Idemitsu are engaging with NSW Crown Lands to formally close the paper roads. If this is not possible by the commencement of construction, above ground infrastructure would not be constructed on these roads. avoided.

The existing powerline easements for the 132 kV and 330 kV transmission lines across the project area will be maintained.

The compulsory acquisition and lease areas associated with the Muswellbrook Bypass have largely been avoided. The 132 kV transmission line connection to the grid and 45 m wide easement crosses the Muswellbrook Bypass at one location. Transport for NSW (TfNSW) has advised that this is acceptable (refer Chapter 5).

The above restrictions/easements do not inhibit the carrying out of the proposed development. These easements would not be impacted by the project and all permissions would be maintained.

1.6 Purpose of this document

The project is State significant development (SSD) pursuant to Schedule 1 of the State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP), as discussed further in Section 4.3. Accordingly, approval for the project is required under part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

This EIS accompanies an SSD application for the project. ESCO submitted a request for the Secretary's environmental assessment requirements (SEARs) to the Department of Planning and Environment (DPE) in July 2022. DPE issued the SEARs (SSD-46543209) on 21 September 2022. Supplementary SEARs were issued on 21 April 2023 in relation to matters of national environmental significance (MNES) (EPBC 2022/09303).

This EIS has been prepared in accordance with the *State significant development guidelines – preparing an environmental impact statement* (DPE 2022) and describes the project, the existing environment, planning considerations and the statutory context for the project, potential impacts, mitigation measures, residual impacts and a description of the community engagement undertaken and outcomes. It is informed by the technical assessments contained in the appendices and provides an overview of these assessments. It addresses the requirements of the SEARs issued by DPE and the appended agency requirements. A summary of how the SEARs have been addressed is provided in Appendix A.

1.7 EIS terminology

The following terms are used throughout this EIS:

- **Project area**: the area of assessment (approximately 482 ha) for baseline surveys and studies conducted for the EIS. The project area comprises the maximum area considered for the project based on the extent of land owned by Idemitsu adjacent to the Muswellbrook Coal Mine, and a third party landholder that has a landholder agreement with the project (refer to Figure 2.2).
    - **Southern project area**: the area to the south of the MCC mine pit, connected to the northern project area by an internal overhead line.
    - **Northern project area**: the area to the north of the MCC mine pit
- **Development footprint**: the maximum extent of ground disturbing work, comprising approximately 324 ha of land, associated with construction and operation of the project (refer to Figure 3.1). All operational components of the project will be within the development footprint. The development footprint is the outcome of the iterative process outlined in this EIS which led to excluding certain areas of environmental or social constraint, as discussed further in Section 2.5.3. The development footprint includes:
    - **Solar array footprint**: the area within the project area used for solar arrays (approximately 300 ha).

- **Transmission line easements**: the buffers and easements associated with the overhead transmission line connections between the north and south sections of the solar farm (33 kV internal connection) (6.4 ha), and from the internal project switchyard to the connection point with the grid (132 kV connection to 95M transmission line) (11.2 ha).

- **Facilities area**: an area comprising the BESS (2.1 ha), switchyard (0.2 ha), transformer substation (0.1 ha), solar array collection station (0.04 ha), BESS collection station (0.03 ha), operations and maintenance (O&M) facility (0.08 ha), storage and car park (0.12 ha).

- **Diversion channel**: a channel and berm designed to mitigate flood impacts to the BESS by diverting flood water away from the BESS to a tributary of Muscle Creek (0.2 ha).

- Internal access track and cable crossing locations.

- **Restricted development area**: land within the project area where disturbance will be avoided including:

  - **Biodiversity exclusion area**: approximately 14.16 ha of land excluded based on areas of high value biodiversity.

- **Access points to the project**: the locations where all construction and operation traffic will access the development footprint after using the access route. The existing mine access road will be used for the project.

- **Proposed connection point**: the indicative location of the point at which the facility will connect to the transmission network as determined in consultation with Ausgrid.

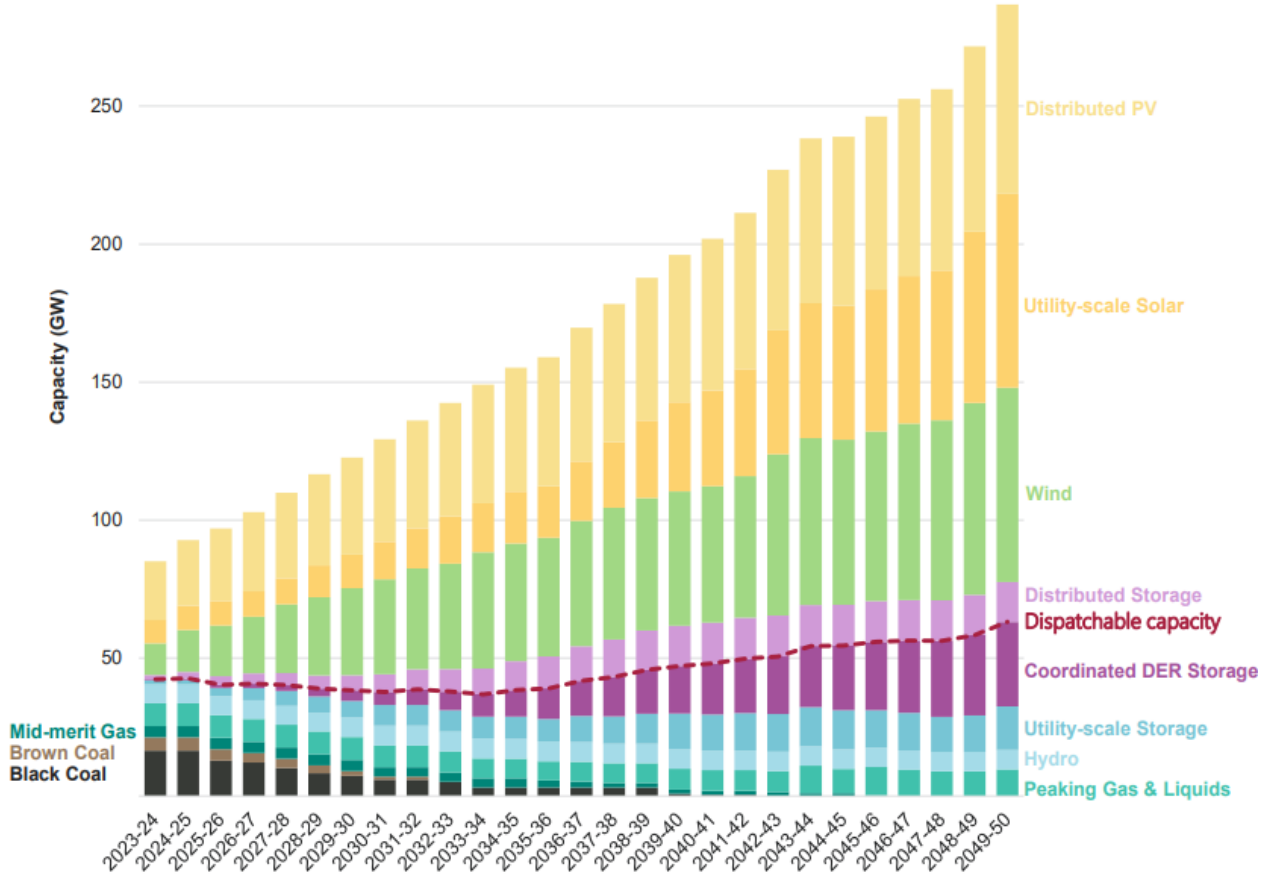
2 Strategic context

2.1 Project need and objectives

2.1.1 Security of supply

The project will deliver 135 MWac of renewable energy to the grid. According to its base case (step change) scenario in the 2022 Integrated System Plan (2022 ISP) (AEMO 2022), the Australian Energy Market Operator (AEMO) expects all of NSW's coal fired generation capacity (approximately 8,000 MW) to retire by 2040 (AEMO 2022).

AEMO notes that coal fired generation capacity is withdrawing faster than announced with 60% of capacity likely to be withdrawn by 2030. Coal-fired generators are continuing to bring forward their withdrawal from the market – potentially by up to seven years to 2025 in the case of the Eraring Power Station (AEMO 2022). Without coal fired power, a nine-fold increase in utility-scale variable renewable capacity will be required to meet demand. Much of this resource will be built in REZs that coordinate network and renewable investment. These zones have the potential to foster a more holistic approach to regional employment, economic opportunity and community participation that may lead to greater local fulfilment of the NEM's supply chain needs (AEMO 2022).



Source: AEMO 2022

Figure 2.1 Forecast NEM capacity to 2050

2.1.2 Climate change policy

The project will support the Commonwealth and NSW governments in achieving renewable energy and greenhouse gas reduction targets. The Commonwealth and all NEM state governments have committed to a net zero emission economy by 2050 or sooner (AEMO 2022). In particular, the project will help achieve the objectives of the Commonwealth Government's Large Scale Renewable Energy Target (LRET) (DCCEEW 2022a), Paris Agreement 2015 targets and the NSW Government's Net Zero Plan (DPIE 2020b) and Energy Roadmap (DPIE 2020a) legislation.

ESCO has estimated that the project is estimated to offset 7.6 million tonnes (Mt) of carbon dioxide equivalent (CO_2e) over 35 years of operation[1]. This is the equivalent of 104,000 cars off the road, or over 23 million trees planted.

2.1.3 Other project objectives

In addition to the energy security and climate change objectives of the project, it will also:

- provide ongoing economic benefits for both the local economy within the Muswellbrook LGA and more broadly, the regional economy within the Hunter region
- provide employment opportunities during the 28-month construction period and during operations.

The project has also been designed to avoid wherever possible, and minimise, environmental, community and landholder impacts, as discussed further in Section 2.5.4.

An outline of how the project will contribute to achieving the objectives of international, national, state, regional and local government policies, plans and strategies is summarised in Table 2.1.

Table 2.1 Alignment with key strategic planning frameworks

Plan, policy or strategy	Description	Project alignment with strategic framework
International context		
The Paris Agreement 2015	*The Paris Agreement* is a legally binding international treaty on climate change adopted by 196 parties in 2015. As a signatory to the agreement, the Australian Government has committed to reduce greenhouse gas emissions by 26%–28% on 2005 levels by 2030.	The project will contribute to meeting Australia's commitments under the Paris Agreement by providing an alternative energy source to energy sourced from fossil fuels, thereby reducing the NEM's annual greenhouse gas emissions.

[1] For annual generation of 247,679 in year 1 with 0.4% degradation from years 2-35. NSW emissions intensity of 0.6727 kg CO2e / kWh (AEMO data for NSW for 2022). Assumes NSW emissions intensity does not change over 35 years.

Table 2.1 Alignment with key strategic planning frameworks

Plan, policy or strategy	Description	Project alignment with strategic framework
National context		
Large-scale Renewable Energy Target (DCCEEW 2022a)	The Australian Government Clean Energy Regulator administers the *Large-scale Renewable Energy Target* which incentivises investment in renewable energy power such as wind and solar farms. The target is designed to reduce emissions in the electricity sector and encourage additional generation from sustainable and renewable sources. The *Large-scale Renewable Energy Target* of 33,000 gigawatt hours of additional renewable electricity generation was met in 2020-2021 on a 12 month rolling basis (Clean Energy Regulator 2021). The annual target will remain at 33,000 gigawatt hours until the scheme ends in 2030. Notwithstanding, the Clean Energy Regulator expects that large-scale renewable generation is on track to reach up to 44,000 gigawatt hours in 2022 (Clean Energy Regulator 2022).	The solar farm will have an indicative capacity of around 135 MWac and include a BESS of up to 135 MWac for a 2 hour duration, which will make significant contributions towards meeting the Large-scale Renewable Energy Target in future years. In addition, the BESS will be able to store renewable energy to increase market efficiency and enable greater penetration of renewables in the electricity grid.
Integrated System Plan 2022 (AEMO 2022)	The *Integrated Systems Plan 2022* (ISP 2022) prepared by the AEMO provides an optimal development path to support Australia's complex and rapid energy transformation towards net zero emissions "When successful, the transformation of the NEM will deliver low-cost renewable electricity with reliability and security, help meet regional and national climate targets, and contribute significantly to regional jobs and economic growth" (AEMO 2022). REZs are identified as areas that coordinate network and renewable investment and foster a holistic approach to regional employment, economic opportunity and community participation.	The ISP 2022 identifies that EnergyCo is in the early stages of planning for the Hunter-Central Coast REZ. The project is within the declared Hunter-Central Coast REZ and would contribute to the continued growth of renewable energy generation and storage capacity in the Hunter-Central Coast REZ.
Net Zero 2050 (DISER 2021)	In October 2021 the Australian government released its Long-Term Emissions Reduction Plan to achieve net zero emissions by 2050. The Plan aims at reaching a net zero economy through a technology-based approach, whilst protecting relevant industries, regions and jobs. It is part of an overarching strategy for emission reduction, based on a technology-led approach which includes a Technology Investment Roadmap and its Low Emissions Technology Statements.	The project will reduce greenhouse gas emissions by approximately 7.6 Mt (CO2e) over its operational life.
State context		
NSW Electricity Infrastructure Investment Roadmap (DPIE 2020a)	The *NSW Electricity Infrastructure Roadmap* and its implementing legislation the EII Act, coordinates investment in transmission, generation, storage and firming infrastructure as ageing coal-fired generation plants retire. The roadmap includes actions that will deliver "whole-of system" benefits. The roadmap sets out a plan to deliver the state's first five REZs in the Central-West Orana, New England, South-West, Hunter-Central Coast, and Illawarra regions.	The project is within the declared Hunter-Central Coast REZ and is ideally placed to contribute to the success of the roadmap.
Large-Scale Solar Energy Guideline (DPE 2022a)	The *Large-Scale Solar Energy Guideline* (DPE 2022a) provides the community, industry, applicants, and regulators with guidance on the planning framework for the assessment of large-scale solar projects and identifies the key planning considerations relevant to solar energy development in NSW.	Site selection and impact assessment considerations detailed in the guideline have been and will continue to be used to inform the project (Section 2.2).

Table 2.1 Alignment with key strategic planning frameworks

Plan, policy or strategy	Description	Project alignment with strategic framework
Net Zero Plan Stage 1: 2020–2030 (DPIE 2020b) and Implementation Update (DPIE 2021a)	The *Net Zero Plan Stage 1 2020–2030* (DPIE 2020) outlines the NSW Government's plan to grow the economy and create jobs while helping the state to deliver a 35% cut in emissions compared to 2005 levels. The *Net Zero Plan Stage 1 2020–2030 Implementation Update* (DPIE 2021a) outlines the implementation of the Electricity Infrastructure Roadmap and REZs.	The project contributes to Priority 1 of the Plan: "drive uptake of proven emissions reduction technologies that grow the economy, create new jobs or reduce the cost of living." The Hunter-Central Coast REZ is identified in the Implementation Update as an area where multiple sources of renewable generation can be connected along with storage and network infrastructure to boost investment in regional NSW.
Local and regional context		
Hunter Regional Plan 2036 (DPE 2016a) and draft *Hunter Regional Plan 2041* (DPIE 2021b)	The *Hunter Regional Plan 2036* (DPE 2016a) outlines the NSW Government's land use planning priorities and decisions over the next 20 years for the Hunter region. One of the goals of the plan is to create a strong and dynamic regional economy. The draft *Hunter Regional Plan 2041* is the 5 year review of the Plan.	The project will contribute to Goal 1 of the Plan 2036 "the leading regional economy in Australia" through Direction 5 "transform the productivity of the Upper Hunter" and Direction 12 "diversify and grow the energy sector" by developing a large-scale solar farm in the region. Objective 1 of the draft Plan 2041 is to "diversify the Hunter's mining, energy and industrial capacity. It identifies that rehabilitated mines could become renewable energy and storage hubs that cover wind, solar, pumped hydro and batteries. The project will form part of the proposed MCIP following the closure of the Muswellbrook Coal Mine.
Muswellbrook Shire 2022–2032 Community Strategic Plan (Muswellbrook Shire Council 2022)	The 2022–2032 Community Strategic Plan (Muswellbrook Shire Council 2022) aims to develop a comprehensive and well co-ordinated strategy to assist in the energy transition in the Hunter.	The Community Strategic Plan notes the masterplan for the Muswellbrook Coal mine to convert the site into an industrial hub with renewable energy projects. This project forms part of that masterplan.
Muswellbrook Clean Industries Precinct (MCIP) Master Plan (draft)	The Draft Master Plan outlines the vision for the Muswellbrook Coal Mine site which has been dubbed the MCIP. This precinct includes a range of renewable energy and other projects at the site including Bells Mountain pumped hydro energy storage projects, solar, battery storage and green hydrogen, along with training facilities.	The project will form the solar and battery storage component of the MCIP.

2.2 Site selection and justification

The project area has been selected to optimise the future land use of the MCC site. With mining at the site ceasing in 2022 after 115 years of operations, this is an opportunity to redevelop the site for new purposes, which could see the site generate post-mine investment and employment in the region.

Idemitsu has developed a Draft Master Plan in collaboration with several industry partners to realise this vision for productive post-mining use of the site. The project area has been integrated with nearby development proposed through the draft Master Plan. The project will be co-located with the Muswellbrook Pumped Hydro-electric project, energy technology pilots, light industrial real estate, ecological stewardship areas, and a range of community and training opportunities.

The Master Plan prepared for the site will allow for these key activities to maximise benefits of the post-mining land use of the site whilst ensuring works are carried out efficiently and with minimal impact to the community. The project will contribute to the legacy of the MCC site and seeks to build on MCC's existing relationships with the community and the capacity of the skilled local workforce.

The site is also ideally located adjacent to existing transmission infrastructure. The project area is traversed by existing 132 kV and 330 kV transmission lines. Given this, it is an ideal site for increasing generation capacity on the NSW electricity grid with minimal requirements for additional transmission infrastructure.

The site location within the Hunter Region is ideally placed to contribute to the development of the Hunter-Central Coast REZ and assist in meeting NSW's energy generation and storage requirements. The project area presents optimal conditions for utility scale solar as it is relatively flat and predominantly cleared land.

Biodiversity values of the project area and surrounds have also been considered through the project scoping and preliminary ecological assessment. Areas of higher value native vegetation have been avoided where practical.

The land in the project area is zoned RU1 Primary Production, SP2 Infrastructure and C3 Environmental Management under the Muswellbrook LEP and is currently partially used for agriculture (grazing). The project will not interfere with the objectives of these zones.

The project will harness a natural resource, namely solar energy. While the development of this project will impact the availability of land for other primary production, it will allow for and encourage diversity in the area's land use and will provide economic stimulus and support to regional communities.

The project area was also selected due to the absence of biophysical strategic agricultural land.

Photographs showing the existing project area conditions are provided in Photograph 2.1 to Photograph 2.4 below.

In summary the project area is considered highly suitable due to:

- its potential to maximise the benefits of post-mining land use at the MCC site
- the location of the project being within the Hunter Region and its alignment with the region's strategic planning objectives and the NSW Government's plans for the Hunter-Central Coast REZ
- its proximity to existing transmission infrastructure and future planned transmission infrastructure
- the project area selection and layout has been amended to retain biodiversity values and no significant adverse biophysical, cultural, social, or economic impacts are anticipated.

Once the project reaches the end of its operational life, a decision will be made to either decommission or re power the facility, subject to approval requirements.

If the project is decommissioned, all above ground structures built as part of the project will be removed and site rehabilitated generally to its pre-existing land use, as far as practicable. The disposal and recycling of the project infrastructure will be done in accordance with current waste management legislation at the time of decommissioning. Wherever possible, efforts will be made to reduce the amount of waste going to landfill in line with best-practice sustainability principles.

If re-powering is proposed, an appropriate stakeholder consultation process will be undertaken, and all necessary approvals will be sought.

Photograph 2.1 Project area – southern section – looking west

Photograph 2.2 Project area – electricity transmission corridor looking north

Photograph 2.3 **Existing Muswellbrook Coal Mine**

Photograph 2.4 **Northern section of the project area, looking north towards Bells Mountain**

2.3 Key features of the site and surrounds

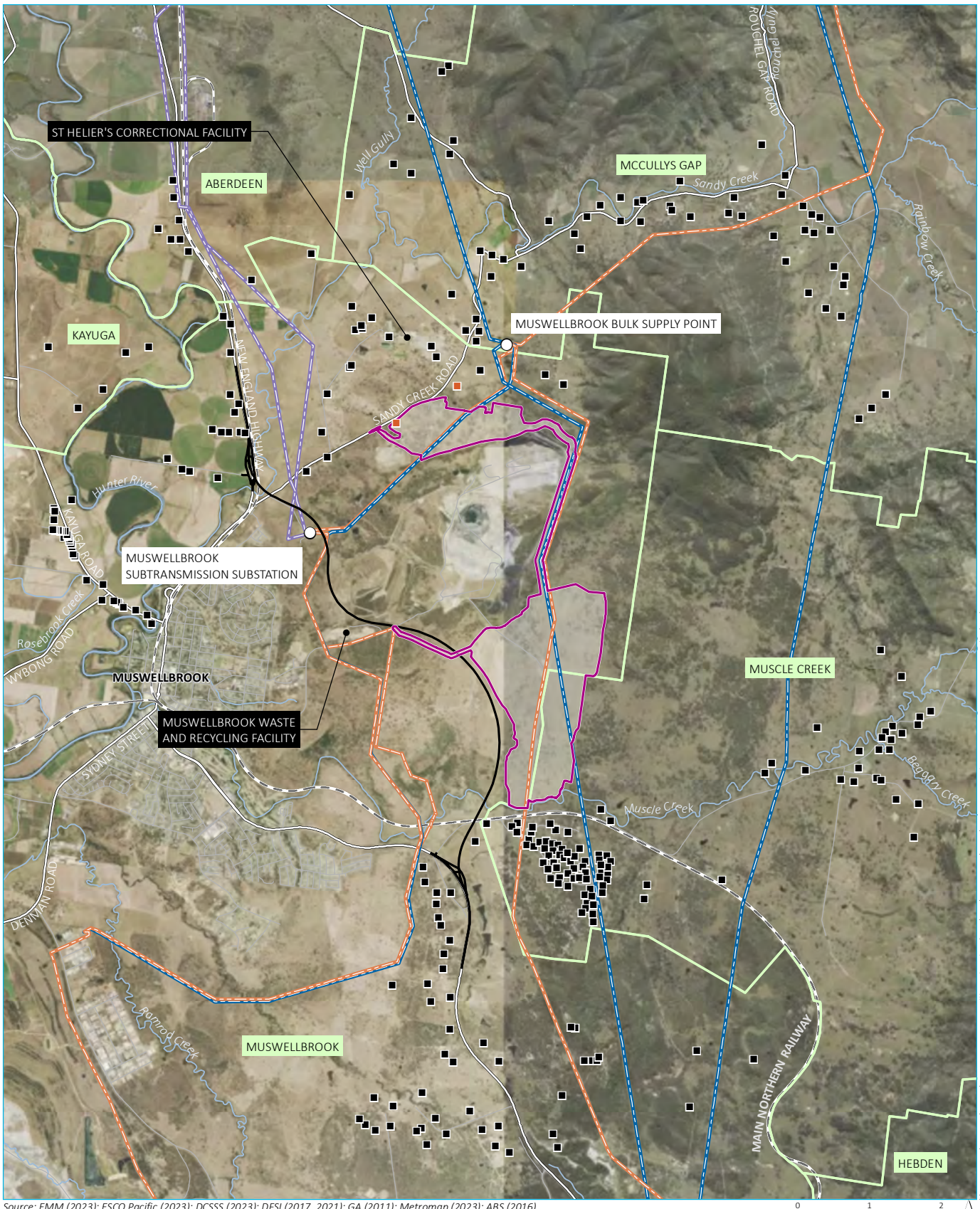
Key features of the site and surrounds are described in Table 2.2 and shown on Figure 2.2. Land zoning is shown on Figure 2.3.

Table 2.2 Key features of the site and surrounds

Aspect	Description
LGA	The project area is within the Muswellbrook LGA.
Land zoning	The site comprises land zoned RU1 Primary Production, SP2 Infrastructure and C3 Environmental Management in the *Muswellbrook Local Environmental Plan 2009* (Muswellbrook LEP) (Figure 2.3). It is noted that land zoned C3 Environmental Management within the project area is not currently a part of any protected area or reserve. Discussion with the current landowners and Council have identified that there are no planned future uses of these areas that require the land to be zoned environmental.
Nearby townships	The nearest population centre to the project is the township of Muswellbrook, approximately 2.5 km west of the project. Muswellbrook has a population of 12,272 (ABS 2021a). Other nearby population centres in the vicinity of the project include Aberdeen (population 2,051), approximately 7.5 km north, Scone (population 5,824), approximately 20 km north, Denman (population 1,821), approximately 25 km south west and Singleton (population 17,018), approximately 40 km south east of the project (ABS 2021a).
Landscape	The project area is situated on land adjacent to the Muswellbrook Coal Mine. Land surrounding the project area contains infrastructure and landforms associated with the Muswellbrook Coal Mine. Muswellbrook township is approximately 2.5 km W of the project area and contains residential and industrial land use. The surrounding area also contains rural residences and properties used for grazing and environmental conservation. The land is characterised by a mix of relatively low slopes (<7.5°), plus areas of undulating terrain with slopes generally not exceeding 10°.
Land use	The north of the project area and internal powerline route is dominated by former open cut mining areas, former underground mines, rehabilitated land, disused and grassed over open cuts, and only a small amount of land that has been avoided by major mining activities. Much of the northern portion of the project area is now even aged regrowth and horses are agisted in a portion of this area. The southern portion of the project area has not been subject to mining and is open paddocks with areas of native vegetation. Grazing continues to occur in the paddocked area and fenced stockyards and sheds are present along with a sealed road, unsealed tracks, electrical pylons, and dams.
Site history	The project area has been affected by past land use for mining and agriculture. Preliminary ecological investigations identified that portions of the project area contain disturbed agricultural land while others contain native grassland and woodland areas.
Land ownership	The project is sited adjacent to the Muswellbrook Coal Mine on land primarily owned by Idemitsu the mine operator. The southern project area includes land owned by a private landowner.
Mining	The project area and surrounds are subject to mining titles (CCL713, ML1562, ML1304 and ML1513) held by MCC (Figure 2.4). CCL713 is a consolidated coal lease and includes the historical underground mine. ML1513 has been cancelled and is no longer active. ML1562 and ML1304 provide for the mine tenure required for the DA boundary. These mining leases are expected to remain in place until completion of mine rehabilitation activities. Historical underground workings are present beneath the northern project area. These mine workings are approximately 200 m beneath the ground surface. There will be no interaction between the underground mine workings and the infrastructure associated with the project.

Table 2.2 Key features of the site and surrounds

Aspect	Description
Residences	There are 107 residences within two kilometres of the project area (Figure 2.2). Of these residences, 49 are within one kilometre, and 13 are within 500 m from the project area. Two of the residences within 500 m are associated residences. Residential areas of the town of Muswellbrook are within 5 km of the project area, as well as the Woodland Ridge estate and properties along the New England Highway to the south, scattered rural properties in the suburb of Muscle Creek to the east, and properties along Sandy Creek Road and New England Highway to the north (refer Figure 2.2).
Nearby natural features	The project area includes some watercourses identified as Strahler stream order of 1st, 2nd, 3rd and 4th. The largest nearby watercourse is Muscle Creek a 5th order stream that runs adjacent to the southernmost part of the project area. Bells Mountain is located to the north-east of the project area and is zoned C3 Environmental Management under the Muswellbrook LEP. The nearest national parks to the project area are the Scone Mountain National Park, approximately 20 km north, the Mount Royal National Park, approximately 25 km east and the Goulburn River and Wollemi National Parks approximately 35 km south west. Other areas of environmental conservation are located near the development including the Brushy Hill Nature Reserve about 20 km north of the site and Manobalai Nature Reserve approximately 30 km west.
Nearby infrastructure	The two primary access points to the project area are via Muscle Creek Road on the south side and Sandy Creek Road on the north side. Muswellbrook Coal Mine and associated infrastructure (operations offices, maintenance sheds, coal handling preparation plan) is located between the northern and southern sections of the project area. The project area contains 330 kV and 132 kV transmission lines which cross both the northern and southern sections as shown in Figure 2.2. Other key features in the local surrounds include the Muswellbrook Waste and Recycling Facility to the west, the Main Northern Railway line to the south and the St Heliers correctional facility to the north of the site.
Planning context	The project area is within land identified as: • bushfire prone land • mine subsidence district (Muswellbrook Mine Subsidence District) • flood prone land. The project area is not within any land identified as: • biophysical strategic agricultural land (BSAL).



Source: EMM (2023); ESCO Pacific (2023); DCSSS (2023); DFSI (2017, 2021); GA (2011); Metromap (2023); ABS (2016)

0 1 2 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS002_LocalContext_20230705_06.mxd 5/07/2023

KEY

- Project area
- Muswellbrook bypass
- Substation
- Associated dwellings
- Dwellings not associated with the project within 5 km

Existing transmission line

- 33 kV
- 132 kV
- 330 kV

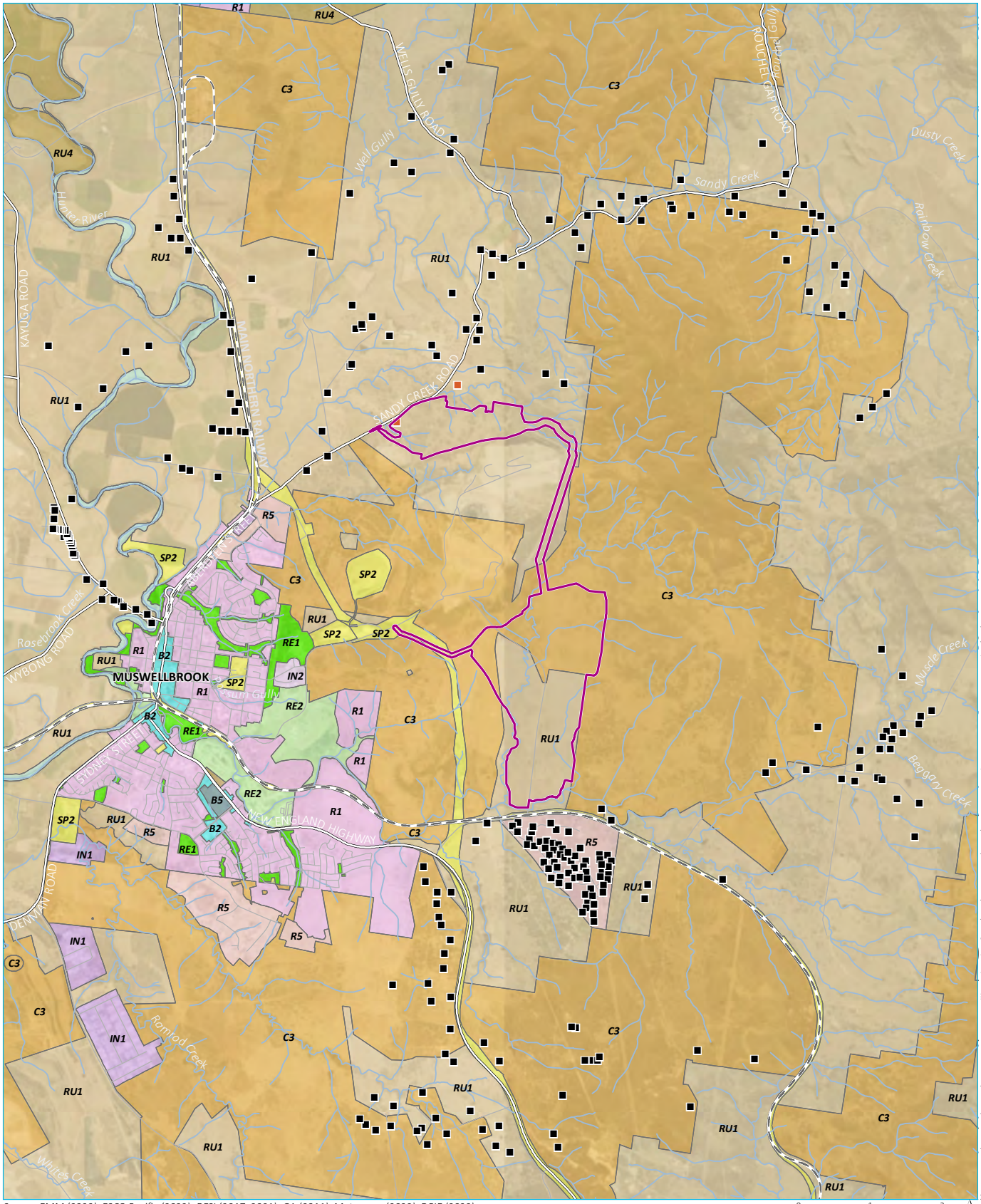
Existing environment

- Rail line
- Major road
- Minor road
- Named watercourse
- Named waterbody
- Suburb boundary

Local context

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.2

EMM creating opportunities



Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2022); DPIE (2022)

0 1 2 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS006_LandZone_20230705_02.mxd 5/07/2023

KEY

- Project area
- Associated dwellings
- Dwellings not associated with the project within 5 km

Land zone

- B2 | Local centre
- B4 | Mixed use
- B5 | Business development
- C3 | Environmental management
- IN1 | General industrial
- IN2 | Light industrial
- R1 | General residential
- R5 | Large lot residential
- RE1 | Public recreation
- RE2 | Private recreation
- RU1 | Primary production
- RU3 | Forestry
- RU4 | Primary production small lots
- SP2 | Infrastructure
- W1 | Natural waterways

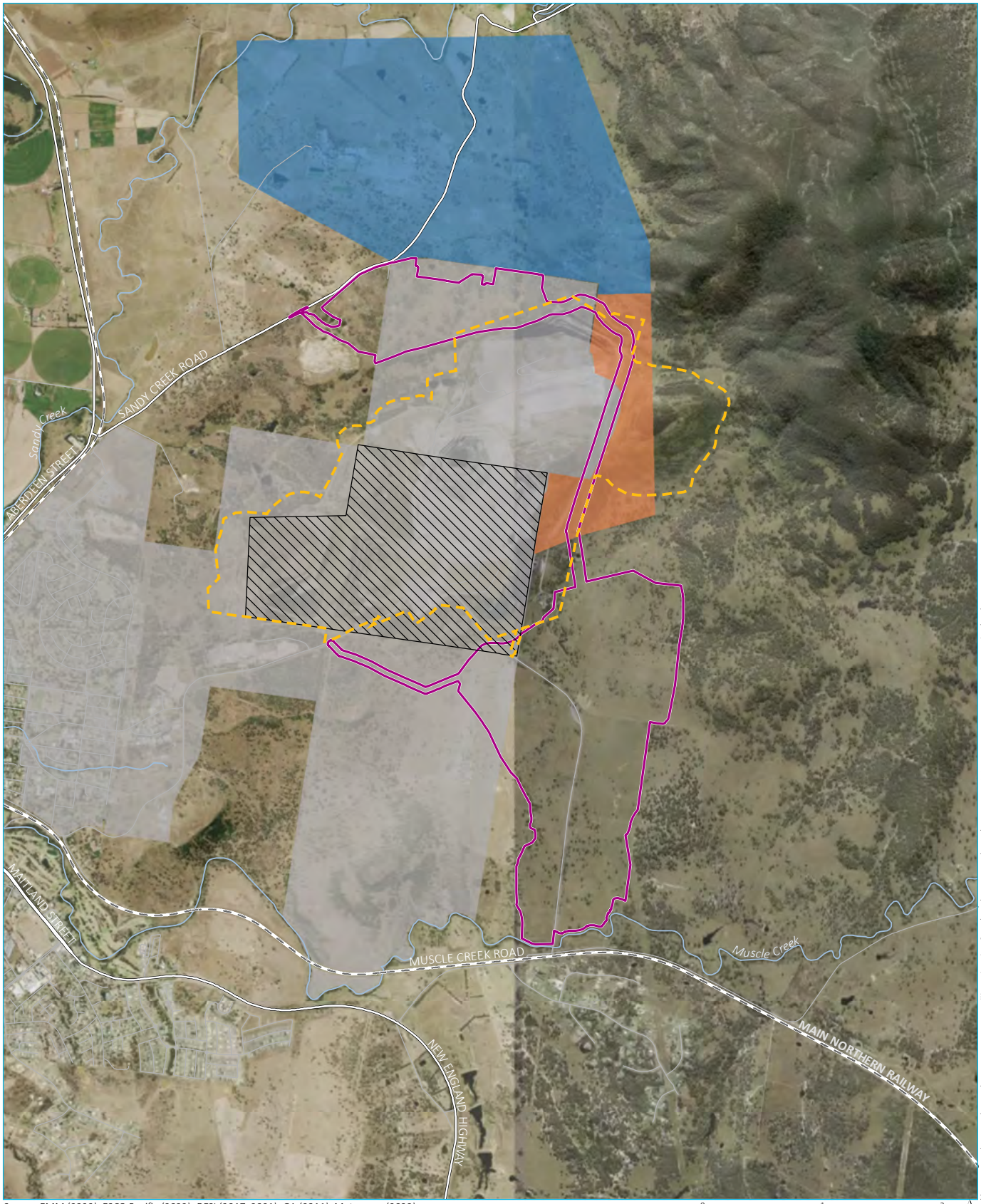
Existing environment

- Rail line
- Major road
- Minor road
- Watercourse/drainage line
- Named waterbody

Land zoning

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.3

EMM creating opportunities



Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2023)

0 1 2 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS007_MiningLeases_20230705_03.mxd 5/07/2023

KEY

- Project area
- DA 205/2002 boundary

Coal lease

- CCL713

Mining lease

- ML1304
- ML1513
- ML 1562

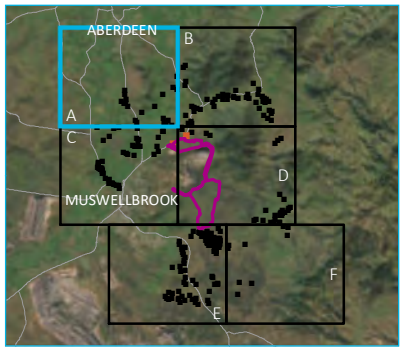
Existing environment

- Rail line
- Major road
- Minor road
- Named watercourse

Mining leases and existing mine DA

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.4

EMM creating opportunities



KEY

- Project area
- Dwellings not associated with the project within 5 km

Existing environment

- Major road
- Minor road
- Vehicular track
- Rail line
- Named watercourse
- Named waterbody

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); ESRI (2022)

0 0.5 1 km

GDA2020 MGA Zone 56

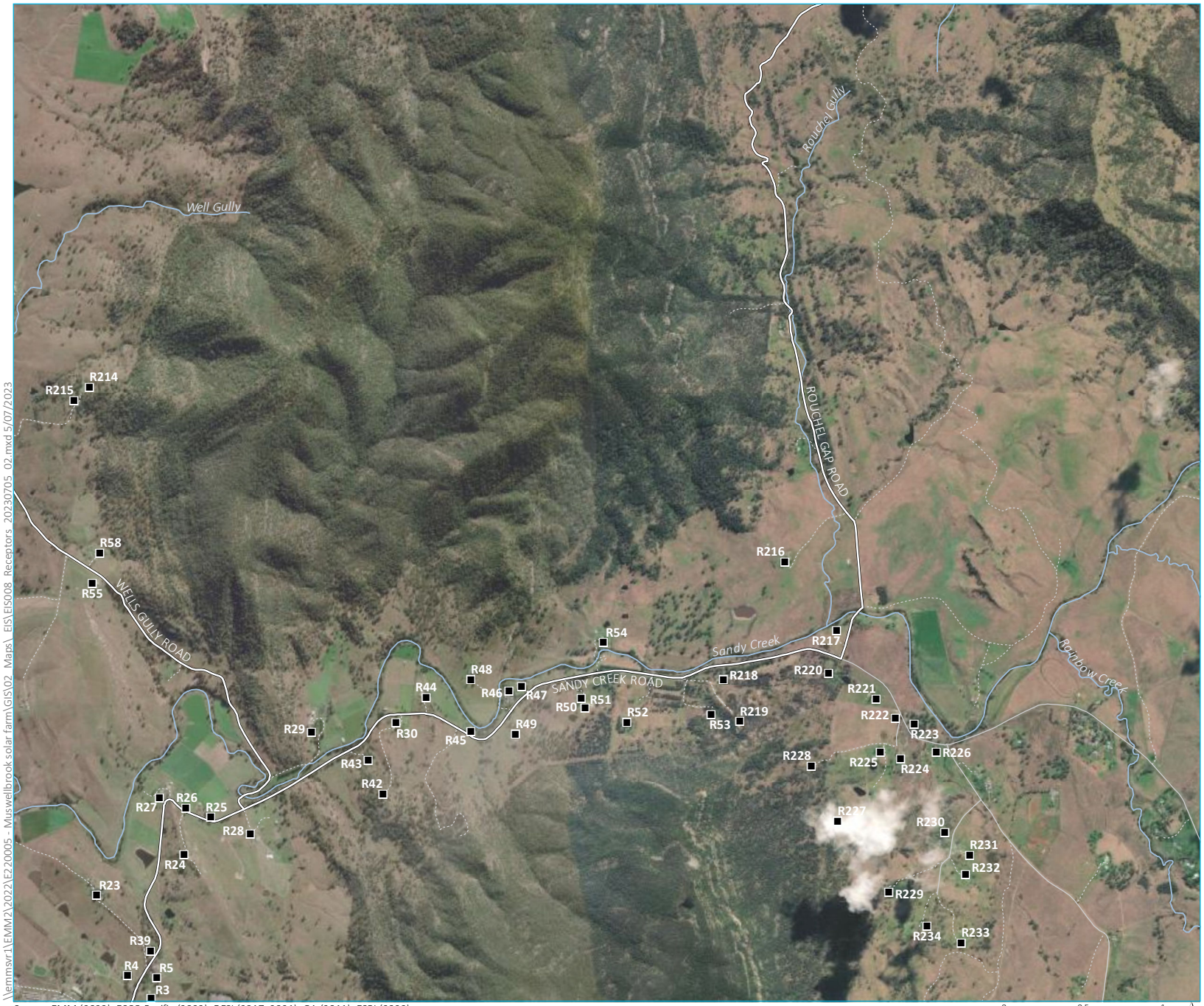
N

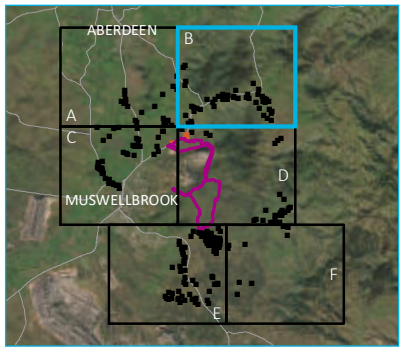
\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS008_Receptors_20230705_02.mxd 5/07/2023

Associated and non-associated residences

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.5a

EMM
creating opportunities





KEY

- Project area
- Dwellings not associated with the project within 5 km

Existing environment

- Major road
- Minor road
- Vehicular track
- Named watercourse

Associated and non-associated residences

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); ESRI (2022)

0 0.5 1 km

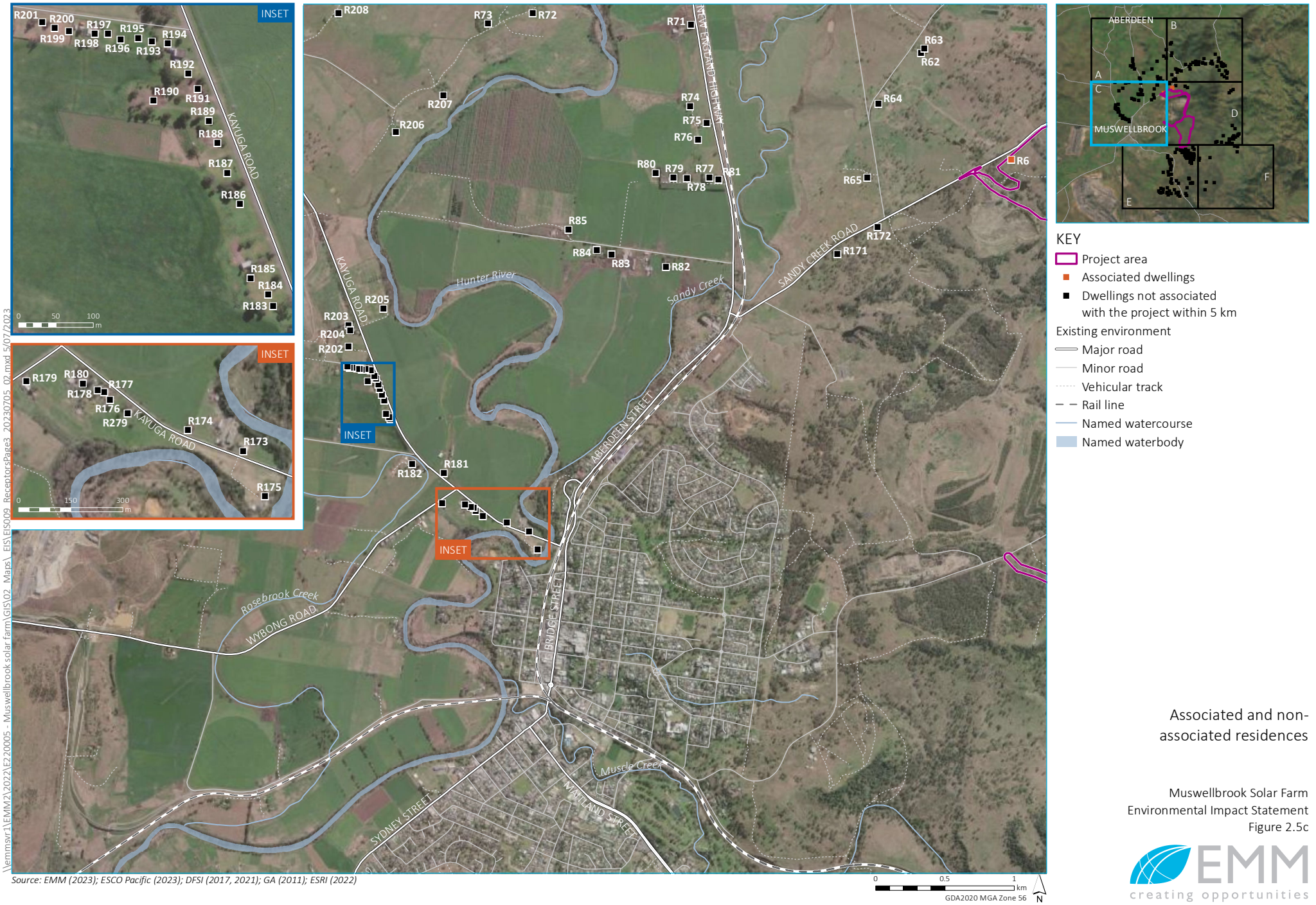
GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02 Maps\ EIS\EIS008 Receptors 20230705 02.mxd 5/07/2023

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.5b

EMM
creating opportunities



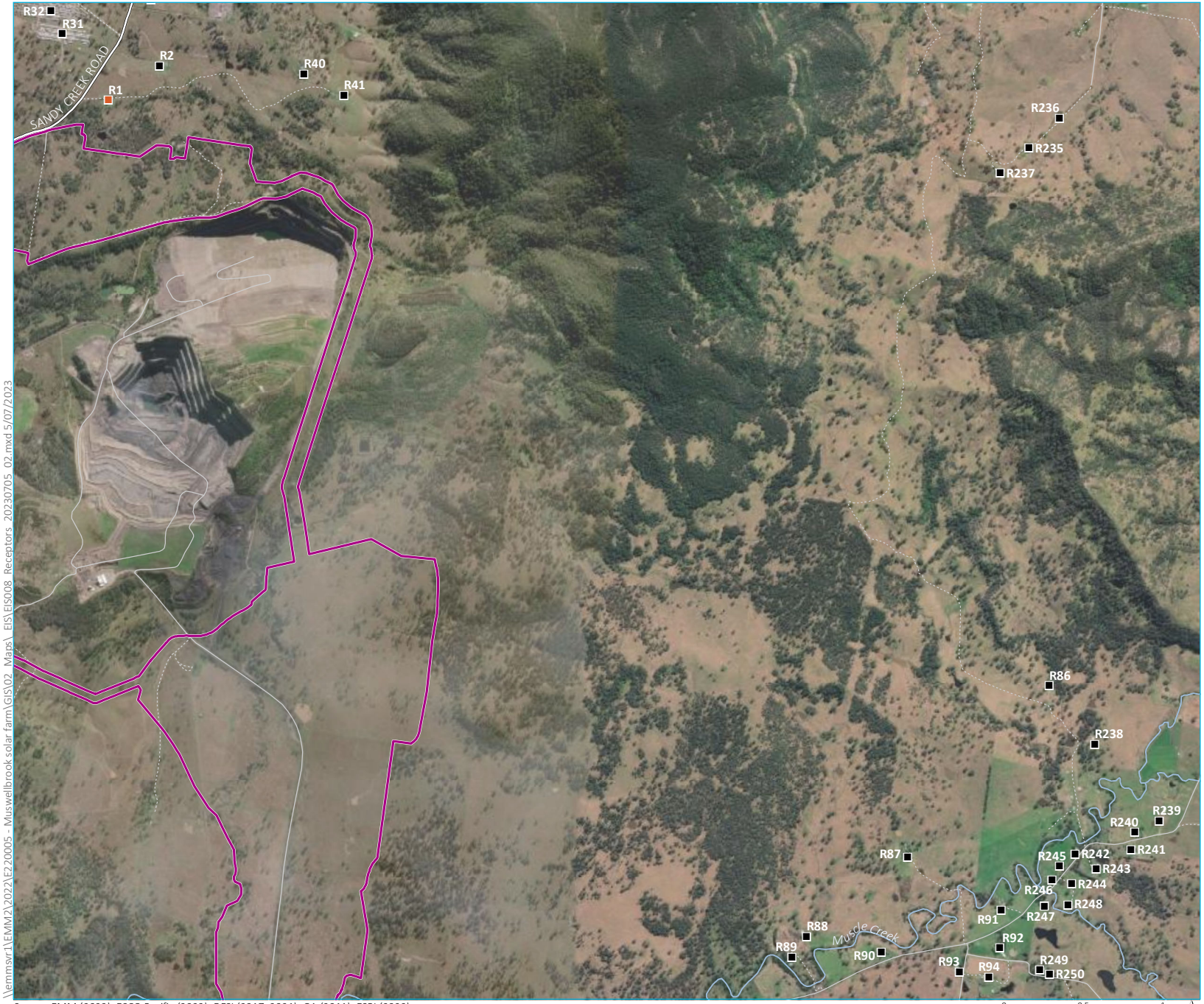
Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); ESRI (2022)

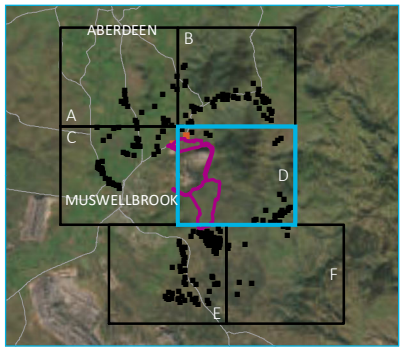
\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS009_ReceptorsPage3_20230705_02.mxd 5/07/2023

Associated and non-associated residences

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.5c

EMM
creating opportunities





KEY

- Project area
- Associated dwellings
- Dwellings not associated with the project within 5 km

Existing environment

- Major road
- Minor road
- Vehicular track
- Named watercourse

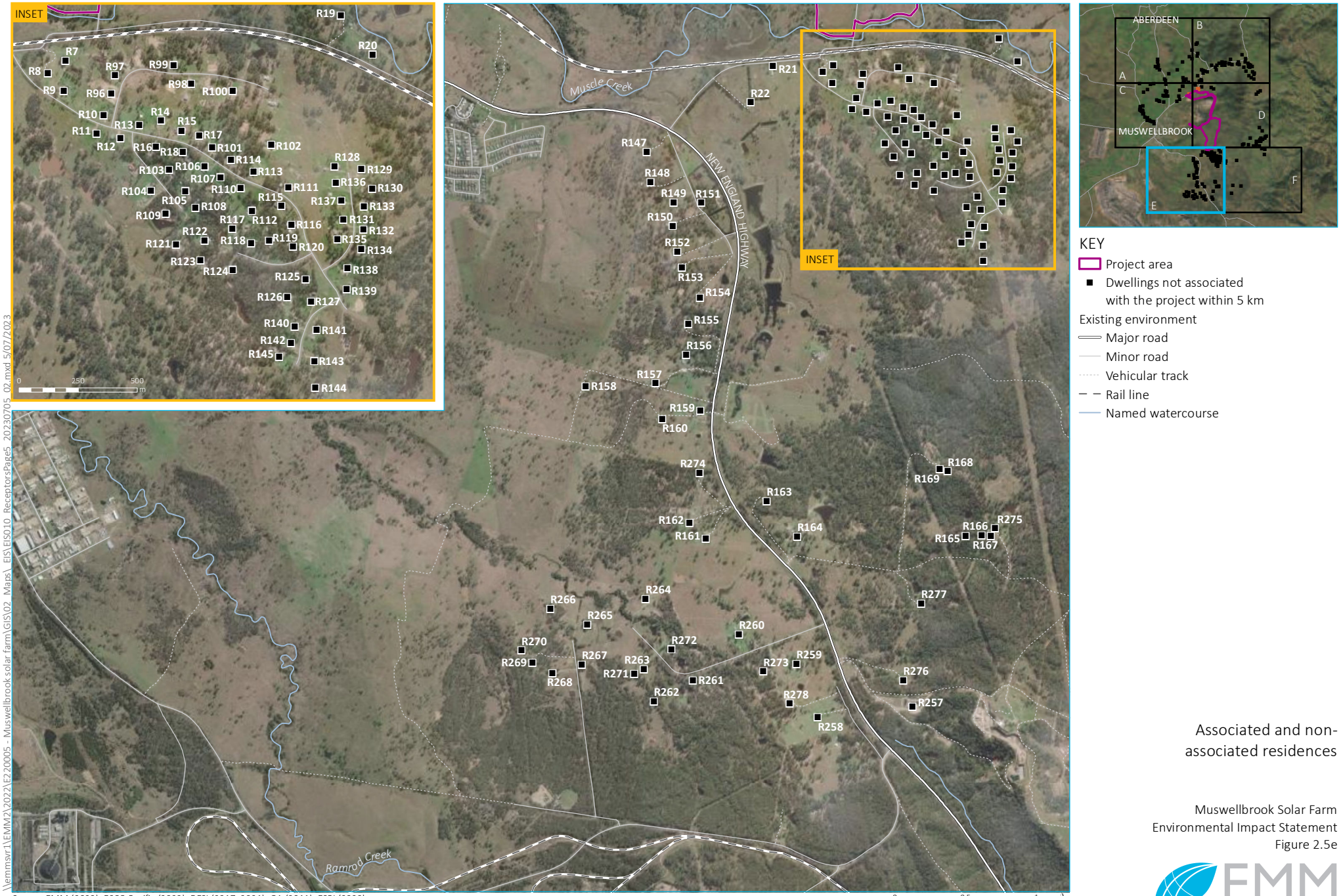
\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS008_Receptors_20230705_02.mxd 5/07/2023

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); ESRI (2022)

Associated and non-associated residences

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.5d

EMM
creating opportunities



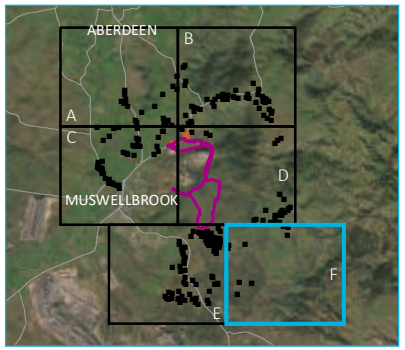
\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS010_ReceptorsPage5_20230705_02.mxd 5/07/2023

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); ESRI (2022)

Associated and non-associated residences

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.5e

EMM
creating opportunities



KEY

- Project area
- Dwellings not associated with the project within 5 km

Existing environment

- Minor road
- Vehicular track
- Rail line
- Named watercourse

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); ESRI (2022)

0 0.5 1 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS008_Receptors_20230705_02.mxd 5/07/2023

Associated and non-associated residences

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.5f

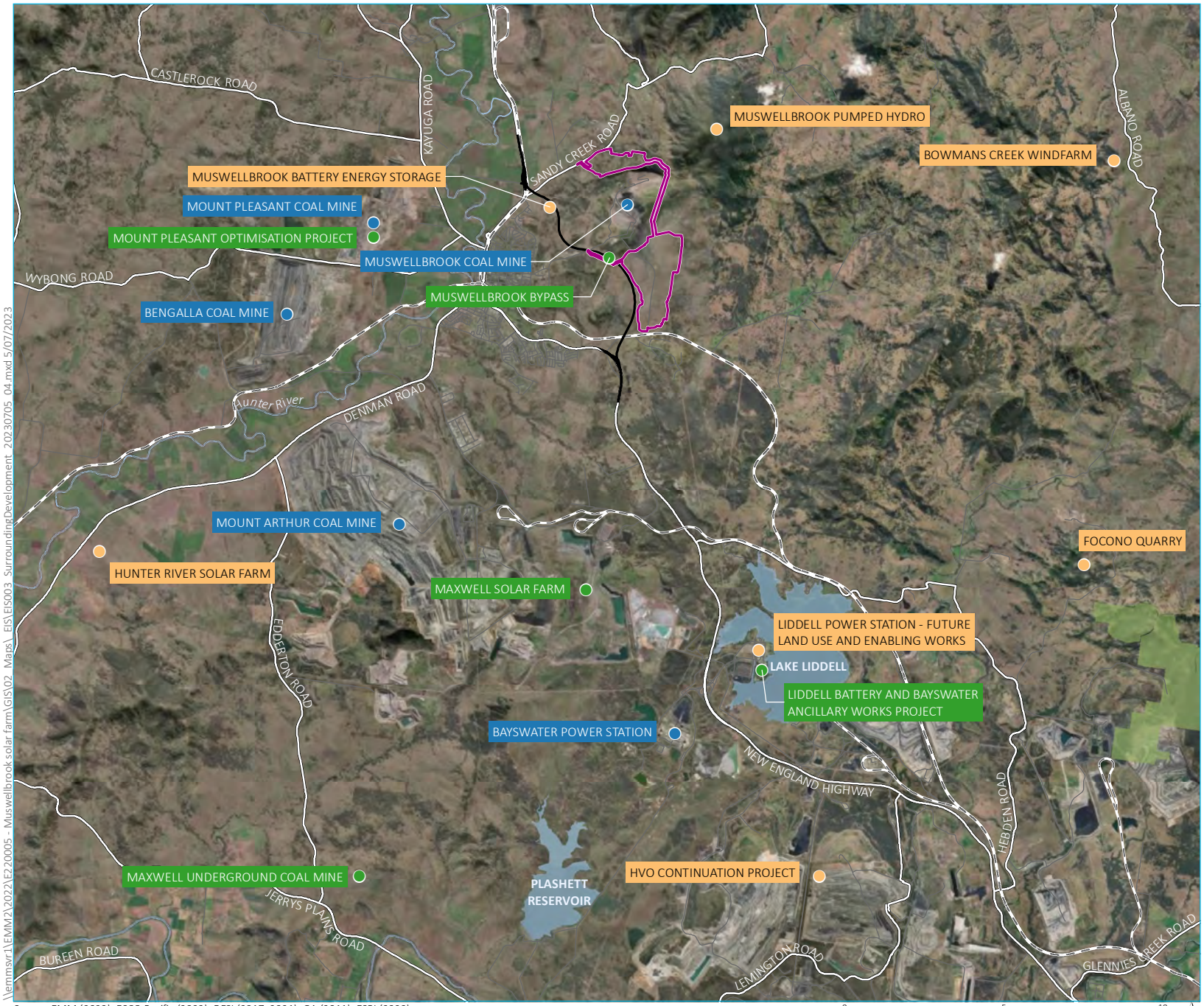
EMM
creating opportunities

2.4 Surrounding development

Key land uses in the broader region include residential, industrial activities, coal mining, electricity generation and transmission as well as agriculture including livestock grazing, equine activities and viticulture. The region hosts a number of major developments including several operational coal mines, the former Liddell Power Station and the operational Bayswater Power Station. Renewable energy is a growing land use in the region with the proposed development of the Hunter-Central Coast REZ.

Proposed, approved, under construction and operational developments known at the time of the EIS preparation in the vicinity of the project area are shown on Figure 2.6, and include:

- Muswellbrook Coal Mine (operational)
- Muswellbrook Bypass (approved – under construction in 2023)
- Mount Pleasant Coal Mine (operational)
- Bengalla Coal Mine (operational)
- Mount Arthur Coal Mine (operational)
- Muswellbrook Pumped Hydro (in planning)
- Bowmans Creek Windfarm (in planning)
- Muswellbrook Battery Energy Storage project (in planning)
- Maxwell Solar Farm (approved)
- Hunter River Solar Farm (in planning).
- Liddell Power Station – Future Land Use and Enabling Works Project (in planning)
- Liddell Battery and Bayswater Ancillary Works Project (approved)
- Focono Quarry (in planning)
- HVO Mine Continuation (in planning)
- Maxwell Underground Coal Mine project (approved – under construction)
- Mount Pleasant Optimisation Project (approved).



KEY

- Project area
- Muswellbrook bypass
- Rail line
- Major road
- Minor road
- Hunter river
- Named waterbody
- State forest

Surrounding development

- Approved
- In planning
- Operating

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS003_SurroundingDevelopment_20230705_04.mxd 5/07/2023

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); ESRI (2022)

0 5 10 km

GDA2020 MGA Zone 56

N

Surrounding development

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.6

EMM creating opportunities

2.5 Project options and alternatives considered

2.5.1 'Do nothing'

The option of not developing a solar and battery storage facility or other renewable project would avoid the residual environmental and social impacts outlined in this EIS; however, it would also mean that the potential project benefits would not accrue, including:

- utilisation of excellent renewable energy resources and utilisation of existing power stations and network infrastructure (NSW Treasury 2022)
- significant contribution to the production of renewable energy, providing a transition away from retiring coal fired power stations
- creation of employment opportunities (up to 200 construction phase jobs and up to nine full time equivalent jobs throughout operation)
- direct and indirect benefits to the local and regional economy, including opportunities for local businesses and suppliers, improvements to public infrastructure, general growth and community development
- diversification of local revenue streams
- faster achievement of State and Commonwealth renewable energy targets and greenhouse gas reductions
- increased energy security.

2.5.2 Alternative project type

While Australia has an abundance of renewable energy sources, alternative power generation options are economically limited from a private investment standpoint, with solar power generation, along with wind, becoming the cheapest forms of new build electricity generating capacity globally, including in Australia. There are significant constraints for the private sector to invest in other technologies (such as pumped hydro) due to their relatively higher costs and higher risks. Replacing retiring coal-fired power plants with a combination of wind farms, solar farms, battery storage systems and pumped hydro is the most economically viable option for the foreseeable future.

It is also noted that in terms of comparing these alternative technologies, large scale wind farms typically take relatively longer to develop than solar farms (up to ten years, compared with up to five years as a rough guide), and that pumped hydro provides back up capacity, which still requires abundant low-cost energy to pump water, which is largely provided by solar during the day. Hence, pumped hydro is not a primary energy source, it is a form of storage. Thus, there is no avoiding the need for large scale solar generation from projects such as this one to secure the State's energy supply in the foreseeable future.

This site does not provide the characteristics for a wind farm. The larger MCC site is being utilised for pumped hydro with the proposed Muswellbrook Pumped Hydro Project. As such, use of the site for large scale solar electricity generation was identified as the preferred option.

2.5.3 Alternative location

The study area is identified as highly suitable for a solar and battery project development as discussed in Section 2.2. Alternative locations for a project of this magnitude are limited due to the requirements of surface area, topography, proximity to existing and/or proposed energy infrastructure and available network capacity, as well as the need to avoid major townships and areas of high biodiversity value.

The project area has been selected to optimise the future land use of the Muswellbrook Coal Mine site for the generation of renewable energy. The project siting has been developed to ensure the project is viable as a solar and storage development and that it will result in maximum benefits for the locality and region in the long term, while minimising impacts to the environment. Key factors in selection of the project area include its position close to existing transmission infrastructure, access, previously disturbed land, and physical conditions suitable for large-scale solar energy generation. The project area has been refined following initial investigations of biodiversity values to minimise potential impacts of the project.

As such, the selected study area is considered optimal for development of the project.

2.5.4 Project refinement

The project design has been progressed in parallel with the preparation of the EIS to allow the outcome of environmental surveys and studies to inform the design process. Environmental and social aspects were a key consideration during the refinement of the project, which was conducted in consultation with key stakeholders, including nearby residents. The development of the project footprint was the key element influenced and refined by technical studies and consultation outcomes.

The detailed project components, including the preliminary project layout within the development footprint, its indicative power generating capacity and the sizing and configuration of the BESS, have been progressed during the preparation of the EIS, but all detailed designs and specific equipment selection decisions will ultimately be determined in the detailed design stage, which will take place after the determination of the project and prior to construction.

The key steps in project refinement are detailed below:

- The original study area considered for development of the project was properties owned by Idemitsu. Mined areas, roads and steep slopes were excluded from consideration. All areas with good slope and aspect were initially considered and higher order streams were avoided.
- The land west of the Muswellbrook Bypass was excluded after discussion with Transport for NSW to avoid construction impacts and unknown construction times related to the bypass.
- Engagement with Ausgrid regarding grid capacity and the connection point for the solar farm identified the available grid capacity as 135 MW and the preferred connection point as the 132 kV 95M transmission line to the west of the project area.
- Two options were considered for the connection to the electricity grid: north of the Muswellbrook Bypass, and south of the bypass. The southern option was chosen to minimise cable route length and impact to native vegetation, while also minimising shading and loss of available PV array area. Consultation with Transport for NSW identified interactions with the Muswellbrook Bypass acquisition and lease areas, and the transmission line connection was moved further south to minimise these interactions.
- Connection between the northern and southern project areas was considered with respect to the mine and existing sensitive vegetation. The 33 kV connection along the eastern side of the mine pit adjacent to the existing easement for the 330 kV transmission line was identified as the most practical option. Other routes were considered impractical based on longer route lengths, terrain, sensitive vegetation and the proposed Muswellbrook Bypass route.
- Two laydown areas (one in the north, and one in the south) were identified and included in the project boundary. The quarry at the north-western area was added as a potential laydown area and ultimately excluded as additional biodiversity surveys would have been required to include this area. The northern laydown was included in the solar array area to be built over as construction progressed.

- Vegetation surveys identified the presence of *Diuris tricolor,* an orchid listed as vulnerable in NSW. Areas in the northern section were excluded based on presence of this species.
- Following initial vegetation feasibility mapping, the private property in the south-east of the project area, known as the Wolfgang property, was added to the footprint. This property added additional capacity lost from the exclusion of the areas west of the proposed bypass and areas excluded in the north for biodiversity reasons.
- An area in the southern section of the project area adjacent to the existing mine access road on the Wolfgang property was excluded due to the presence of high value vegetation.
- Minor adjustments to the solar arrays were made to avoid unsuitable terrain along watercourses after review of new site contour data, including avoidance of gullies, high terrain, and eroded areas.
- The location of the facilities area and BESS was changed following consultation with Transport for NSW regarding the location of the Muswellbrook Bypass and associated acquisition areas. The BESS was moved from the western extent of the southern section of the project area, to a more central location. This location removes conflict with the bypass and allows for a more central connection point for the solar arrays.
- Flood modelling identified a potential flow path through the centre of the BESS area. A diversion channel is proposed to mitigate flood impacts to the BESS by diverting flood water around the BESS to the tributary of Muscle Creek on the western side. The facilities area was re-designed to minimise potential flood impacts and separate the O&M and car park from the BESS.

In instances where potential impacts cannot be avoided, ESCO's design principles have sought to minimise environmental impacts and/or implement mitigation measures to manage the extent and severity of any residual environmental impacts.

Detailed technical environmental investigations have identified environmental and land use constraints that have informed the development footprint, restricted development areas and preliminary infrastructure layout and include:

- Aboriginal cultural heritage sites identified during archaeological surveys
- native vegetation and threatened species habitat mapped during biodiversity surveys
- Crown land (including Crown roads)
- location of higher order watercourses
- flood hazard.

The environmental constraints which have informed the development footprint are shown in Figure 2.7.

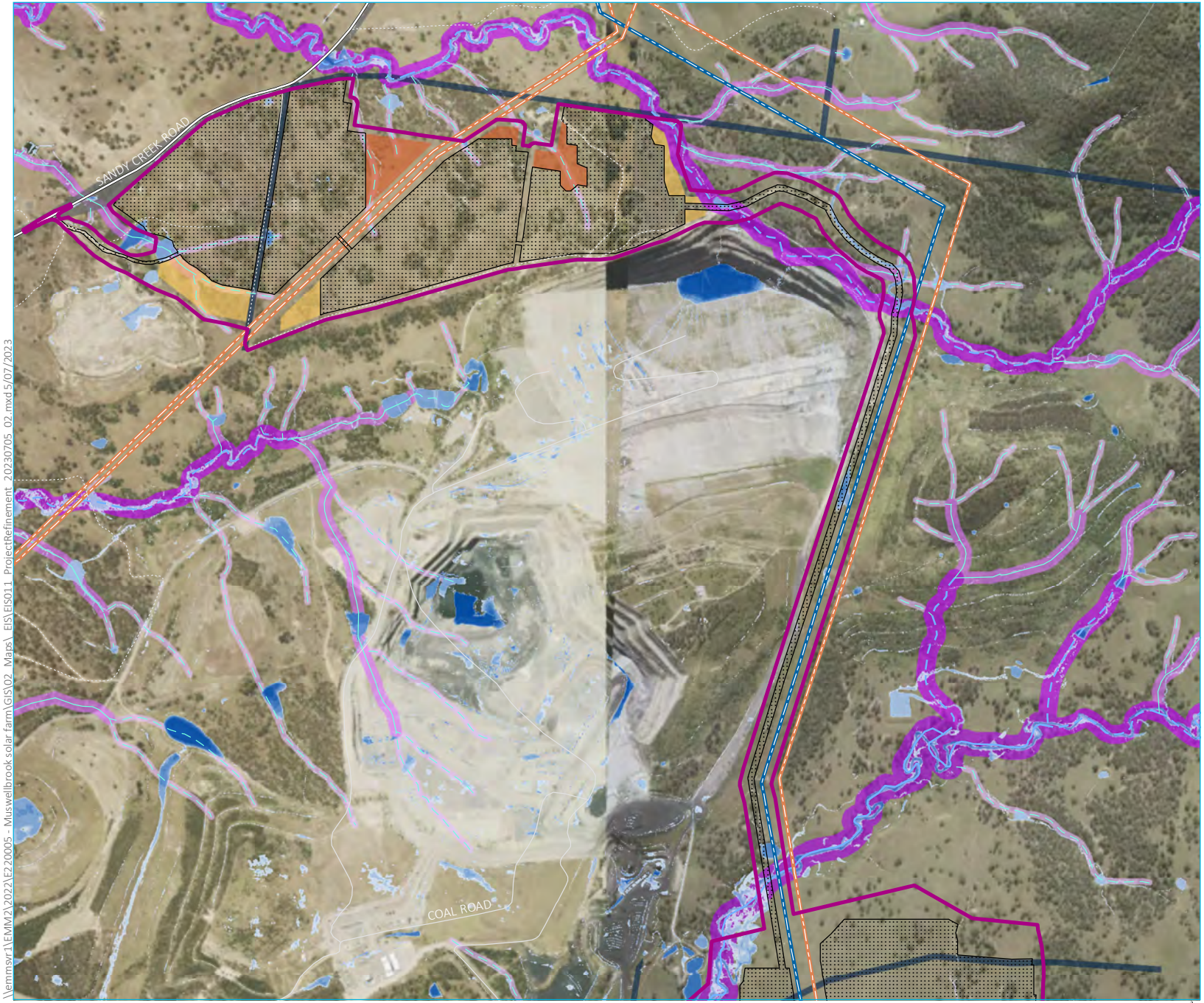
A summary of the key environmental constraints considered as part of the project refinement process and selection of the development footprint is provided in Table 2.3.

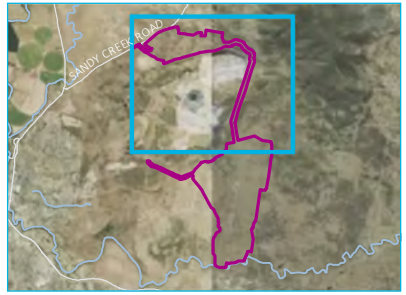
Table 2.3 Matters considered during project refinement

Aspect	Matters considered during project refinement
Biodiversity	Measures to avoid and minimise impacts to vegetation were considered during the project refinement process, resulting in avoidance of significant biodiversity values. As a result, 155.3 ha of PCT 1691, 9.6 ha of PCT 1603, and 9.3 ha of PCT 281 within the study area will be avoided by the project. Preliminary mapping was completed in 2021 and identified areas of intact woodland that were largely avoided as the project area developed. After completion of vegetation integrity plots were completed in March 2022, large areas of degraded native pasture, degraded grassland and low condition DNG were identified. The biodiversity study area for the project encompassed approximately 512 ha. The final area of the development footprint has been reduced by 4.22 ha in the southern project area, and 9.94 ha in the northern project area due to the presence of threatened species *Diuris tricolor* and its habitat. Avoid and minimise has been a key consideration in refining the project footprint with consideration given to: • utilising to the greatest extent possible the areas of degraded pastures/grassland • avoiding impacts to small, yet important areas of PCT 281 (Low) • avoiding impacts, to the greatest extent possible, to areas comprising presence of threatened species habitat within PCT 1603 in the northern section.
Aboriginal cultural heritage	A field survey and test excavations of the project area identified four Aboriginal sites and/or objects (MSF-FA1, MSF-FA-2, MSF-BS1, MSF-CMT1). The project would result in the total or partial loss of all sites, however, portions of MSF-FA1 and MSF-FA2 would be preserved and there would be opportunities for heritage interpretation and public outreach. The methodology for salvage of and an Interpretation Strategy and Plan will be finalised as part of an Aboriginal cultural heritage management plan (ACHMP) to be prepared for the project.
Visual	A key consideration of the project design refinement process has been the potential visibility of project infrastructure from the identified rural dwellings. Visual impacts have been assessed and mitigation considered where appropriate.
Traffic and transport	Consideration of proximity to, and capacity of, the local and regional road network and ability to transport the necessary infrastructure to the array areas and resource the workforce demand during construction. Design of construction traffic routes to avoid conflict with other road users, including school buses. Sandy Creek Road limitations (school bus route, heavy vehicle limitations, and level rail crossing) have been considered in the construction traffic assessment.
Water	The development footprint has been designed to minimise impacts on watercourses, where possible. The placement of project infrastructure within the development footprint has avoided third order streams and above. Appropriate set back from all streams have been provided where possible: • 30 m from 3rd order streams • 40 m from 4th order streams • 50 m from 5th order stream (Muscle Creek). Permanent access tracks across third order waterways or higher are not required. Flood modelling outputs resulted in refinements to the location of the BESS and facilities area. Flood modelling identified a flow path through the BESS. Mitigation to limit flooding of the BESS included the construction of a channel and berm to redirect flood water to the tributary of Muscle Creek to the west of the BESS, and the re-design of infrastructure in the facilities area. The O&M and car park were separated from the BESS infrastructure to minimise and avoid flood impacts.

Table 2.3 Matters considered during project refinement

Aspect	Matters considered during project refinement
Hazards and risks	Separation distances from the project boundary and between BESS sub-units has been considered and incorporated into the design: • The location of the BESS was moved from the western side of the project area to the centre of the southern portion of the development footprint with a view to increase separation distances and reduce fire risk. • The BESS is designed so that the separation distance/clearance between the BESS sub-units meets the requirements of *Standard for the Installation of Stationary Energy Storage Systems* (NFPA 2023). The following controls were identified to limit exposure to electric and magnetic fields (EMF): • The design, selection and procurement of electrical equipment for the project will comply with relevant international and Australian standards. • Location selection for the project infrastructure (i.e. accounts for separation distance to surrounding land uses including neighbouring properties and agricultural operations) and fencing within the project boundary will assist in limiting the exposure to EMF for the general public. • Exposure to EMF (specifically magnetic fields) from electrical equipment will be localised and the strength of the field attenuates rapidly with distance. • Duration of exposure to EMF for personnel onsite will be transient.
Land use	ESCO has designed the project to minimise impacts on agricultural land, wherever possible. In addition, as part of the land use conflict risk assessment (LUCRA) (refer to Appendix I), impacts to neighbouring agricultural operations have also been considered. There is no mapped BSAL within the project area.
Noise	Potential noise-generating infrastructure (including substations and BESS) have been positioned within the centre of the development footprint with a view to maximising distance between this infrastructure and nearby residences where practicable.
Socio-economic	Proximity to local regional towns and subsequent availability of local businesses, services and a local labour force have been considered.





KEY

- Project area
- Development footprint

Existing environment

- Major road
- Minor road
- Vehicular track

Controlling authority

- Crown land
- Local Government Authority

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order

Existing transmission line

- 132 kV
- 330 kV

Biodiversity exclusion area

- 1603 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub
- Diuris tricolor

Watercourse buffer

- 10 m
- 20 m
- 30 m
- 40 m

Existing 1% AEP peak flood depths

Maximum water depth (m)

- < 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2022); DPIE (2020)

0 0.5 1 km

GDA2020 MGA Zone 56

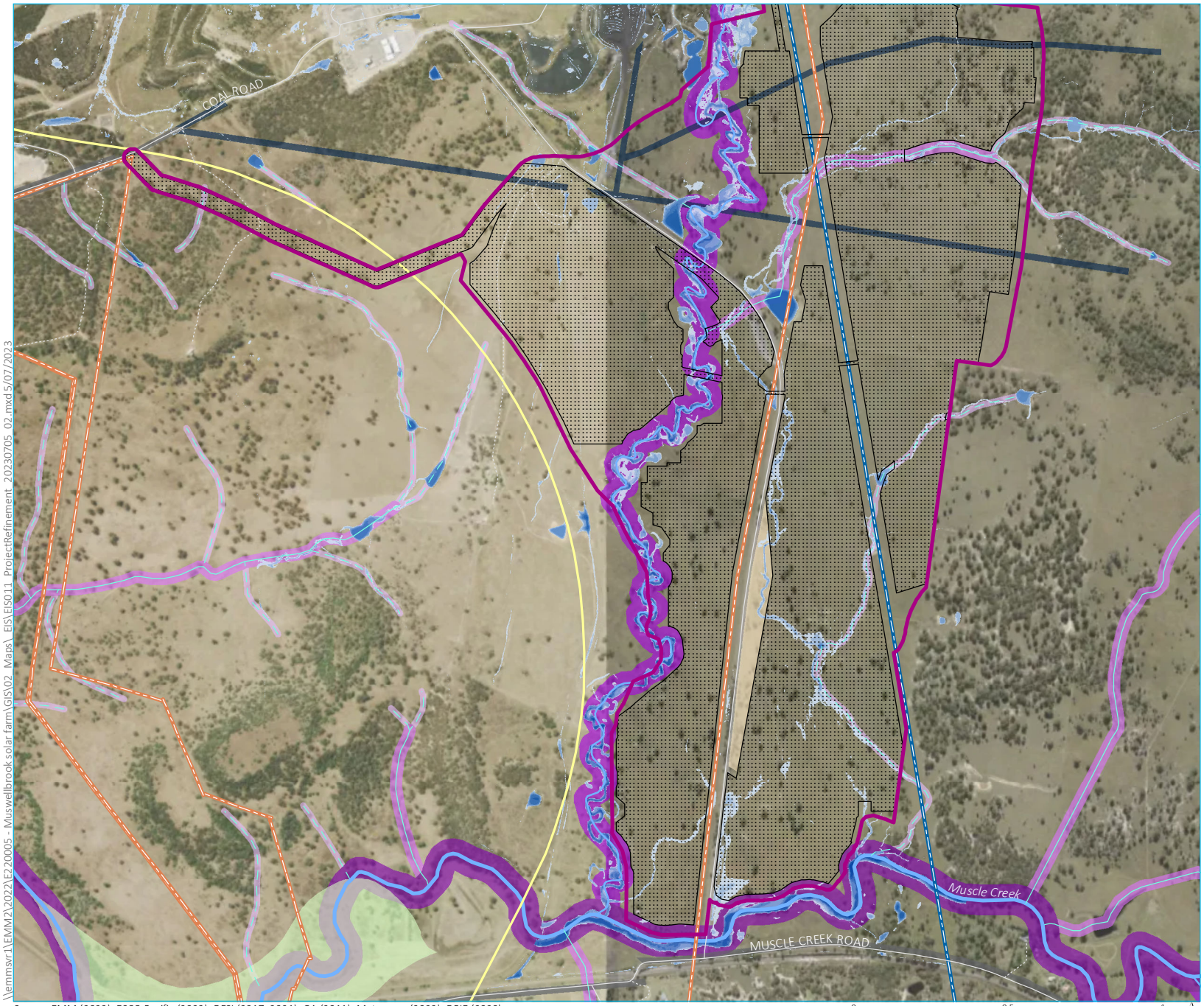
N

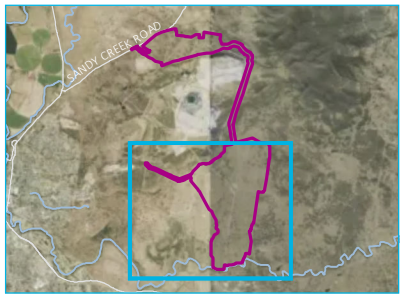
\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS011_ProjectRefinement_20230705_02.mxd 5/07/2023

Project refinement and constraints

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.7a

EMM
creating opportunities





KEY

- Project area
- Development footprint
- Muswellbrook bypass

Existing environment

- Minor road
- Vehicular track
- Biophysical Strategic Agricultural Land

Controlling authority

- Crown land
- Local Government Authority

Strahler stream order

- 1st order
- 2nd order
- 4th order
- 5th order

Existing transmission line

- 132 kV
- 330 kV

Biodiversity exclusion area

- 281 - Rough-Barked Apple - red gum - Yellow Box woodland

Watercourse buffer

- 10 m
- 20 m
- 40 m
- 50 m

Existing 1% AEP peak flood depths

Maximum water depth (m)

- < 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS011_ProjectRefinement_20230705_02.mxd 5/07/2023

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2022); DPIE (2020)

0 0.5 1 km

GDA2020 MGA Zone 56

N

Project refinement and constraints

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 2.7b

EMM
creating opportunities

3 Project description

3.1 Project overview

The project comprises a large-scale solar PV generation facility and a BESS, which is supported by associated infrastructure. The solar project will have a generation capacity of approximately 135 MWac, which will generate the equivalent of approximately 347 GWh of energy annually. The BESS will have a capacity of up to 135 MWac and have provision for up to two hours of storage.

The project is summarised in Table 3.1.

Table 3.1 Project summary

Project element	Summary of project
Project area	The project area is around 482 ha (Figure 3.1).
Site details	The site is located off Muscle Creek Road and is comprised of 21 lots as shown in Figure 3.2: Lot 61 DP1113302, Lot 2 DP614842, Lot 101 DP1148216, Lot 71 DP629631, Lot 19 DP16352, Lot 1 DP184481, Lot 1 DP723294, Lot 6 DP26760, Lot 57 DP752484, Lot 2 DP26760, Lot 58 DP752484, Lot 5 DP26760, Lot 59 DP752484, Lot 3 DP571355, Lot 60 DP752484, Lot 1 DP571355, Lot 97 DP752484, Lot 682 DP611756, Lot 39 DP793463, Lot 1 DP614842, Lot 40 DP793463.
Development footprint	The development footprint is the maximum extent of ground disturbing works associated with the construction and operation of the project and comprises the solar array footprint (areas of solar arrays approximately 300 ha), internal roads, internal transmission lines, and the facilities area. The development footprint is approximately 324 ha (Figure 2.7 and Figure 3.1).
Solar PV generation capacity	135 MWac
Battery storage capacity	135 MWac, 2 hour storage
General infrastructure	Approximately 300,000 PV panels, with associated mounting structures and cabling, Power Conversion Units (PCUs), weather stations, internal access tracks, overhead transmission lines (connecting northern and southern sections, and connecting onsite substation to point of connection to the grid). The facilities area comprises the BESS, transformer substation, switchyard, operations and maintenance facility (offices, amenities, equipment sheds, storage, and parking). The layout of project infrastructure is shown on Figure 3.1.
Site access	Access will be via existing access points for the MCC mine site. Access to the southern section would be via Muscle Creek Road, and to the northern section via Sandy Creek Road.
Access route	Vehicles would access the site via New England Highway and either Muscle Creek Road or Sandy Creek Road. Construction materials and infrastructure are anticipated to be transported to the project area by via road from several locations and may include (Figure 3.3): • Port of Newcastle (via New England Highway and Muscle Creek Road/Sandy Creek Road) • Port Botany (via New England Highway and Muscle Creek Road/Sandy Creek Road) • Melbourne (Glen Waverley) (via National Highway M31, Pacific Motorway M1, and New England Highway).
Construction	Construction is expected to commence in the third quarter of 2024 and occur over period of 31 months. Construction of the solar farm would occur first (15 to 18 months), followed by construction of the BESS (13 months). Construction would occur during standard construction hours.
Operation	The project will operate 24 hours a day, 7 days per week. Except in response to any emergencies, it is likely the site would be staffed from 7:30am to 4:30pm, Monday to Saturday. The project has an operational life of 35 years.

Table 3.1 Project summary

Project element	Summary of project
Decommissioning	Once the project reaches the end of its operational life, a decision will be made to either decommission or re-power the facility, subject to approval requirements. If the project is decommissioned, all above ground structures built as part of the project will be removed and site rehabilitated generally to its pre-existing land use. If re-powering is proposed, an appropriate stakeholder consultation process will be undertaken, and all necessary approvals will be sought.
Workforce	Construction workforce of up to 200 people during peak construction. Operational workforce of up to 6 permanent full-time jobs, plus additional subcontractor roles for vegetation management, weed and pest management, module cleaning and facility cleaning, as well as equipment calibration.
Capital investment	$301,953,424

3.2 Project area

The project area is approximately 482 ha, and a schedule of lands is provided in Table 3.2 and shown in Figure 3.2.

The development footprint sits within the project area and is the maximum extent of ground disturbing works associated with the construction and operation of the project. The development footprint has reduced in size from that originally considered in response to engagement and the outcomes of environmental assessment and identifications of constraints and comprises the solar farm footprint (solar array area), internal roads, internal transmission lines, and the facilities area. The development footprint is approximately 324 ha and is shown on Figure 3.1.

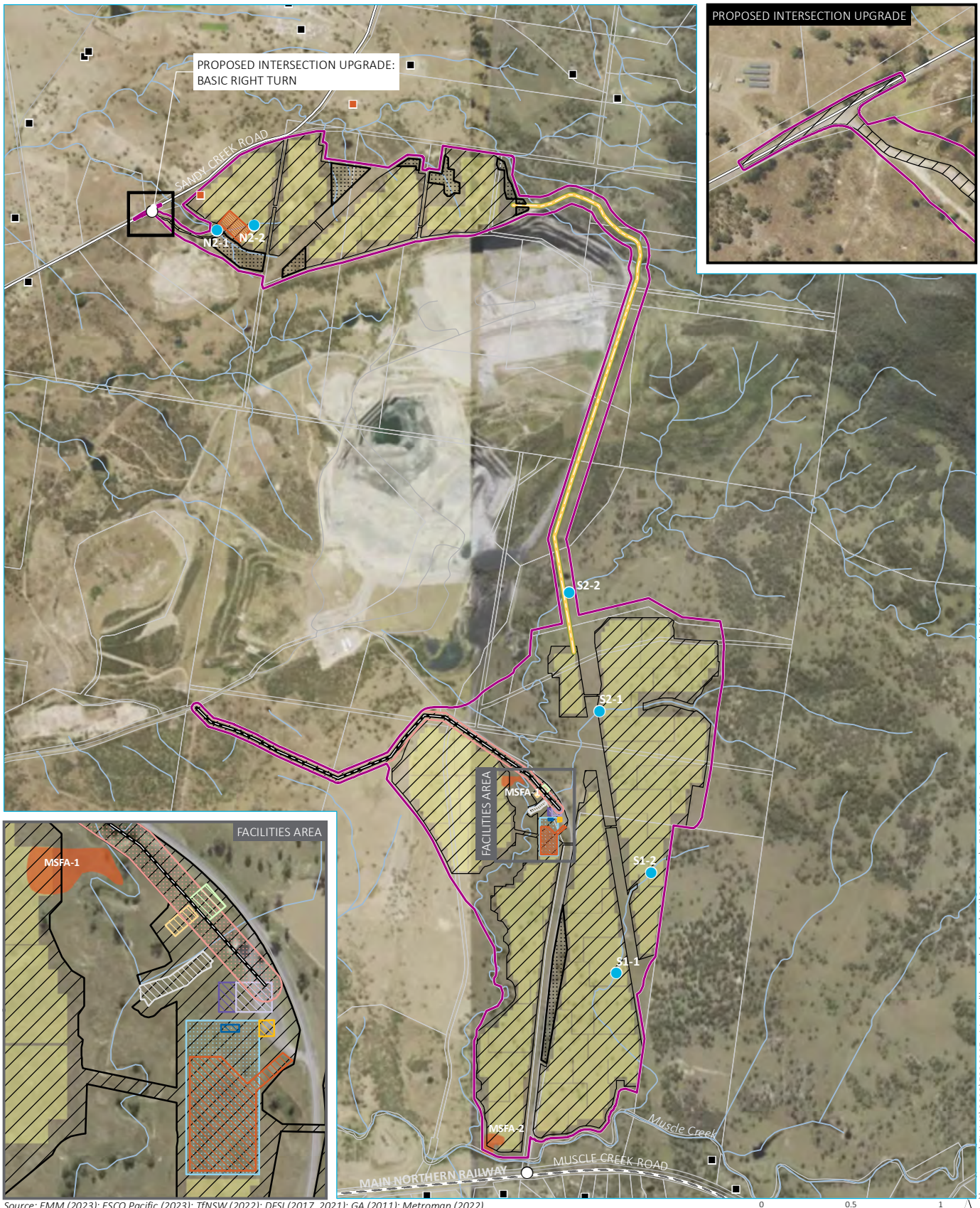
In addition, restricted development areas have been identified and include that within the project area where disturbance will be avoided. Around 14.16 ha was excluded from the development footprint due to the presence of endangered flora species and/or their habitat (biodiversity exclusion area). Buffers were applied to creeks with a Strahler stream order of three and above (30 m for third order streams, 40 m for fourth order streams, and 50 m for fifth order streams). The development footprint avoids creek buffers with the exception of locations where overhead transmission lines cross the creeks. In these areas, poles will be placed either side of the creek and the transmission line strung between them. Creek crossings of third order streams or above will be avoided where possible.

Table 3.2 Schedule of lands within the project boundary

Lot	Deposited plan (DP)	Lot	Deposited plan (DP)
61	DP1113302	2	DP614842
101	DP1148216	71	DP629631
19	DP16352	1	DP723294
1	DP184481	57	DP752484
6	DP26760	58	DP752484
2	DP26760	59	DP752484
5	DP26760	60	DP752484
3	DP571355	97	DP752484

Table 3.2 Schedule of lands within the project boundary

Lot	Deposited plan (DP)	Lot	Deposited plan (DP)
1	DP571355	39	DP793463
682	DP611756	40	DP793463
1	DP614842	A portion of Sandy Creek Road at its intersection with the unnamed access road, approximately 2 km north-east of Sandy Creek Road/New England Highway intersection	



Source: EMM (2023); ESCO Pacific (2023); TfNSW (2022); DFSI (2017, 2021); GA (2011); Metromap (2022)

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS004_ProjectLayout_20230705_05.mxd 5/07/2023

KEY

- Project area
- Site access
- Potential watercourse crossing
- Associated dwellings
- Dwellings not associated with the project within 5 km
- Development footprint
- Indicative panel layout
- Biodiversity exclusion area

Connection route

- 132 kV connection to 95M
- Internal connection route (33 kV)

Site element

- BESS (Battery Energy Storage System)
- BESS Collection Station
- Car Park
- Connection internal north to south buffer
- 132 kV connection to 95M buffer
- Laydown
- O&M
- SF Collection Station
- Switchyard
- Transformer Substation
- Diversion channel
- Aboriginal heritage site: to be salvaged

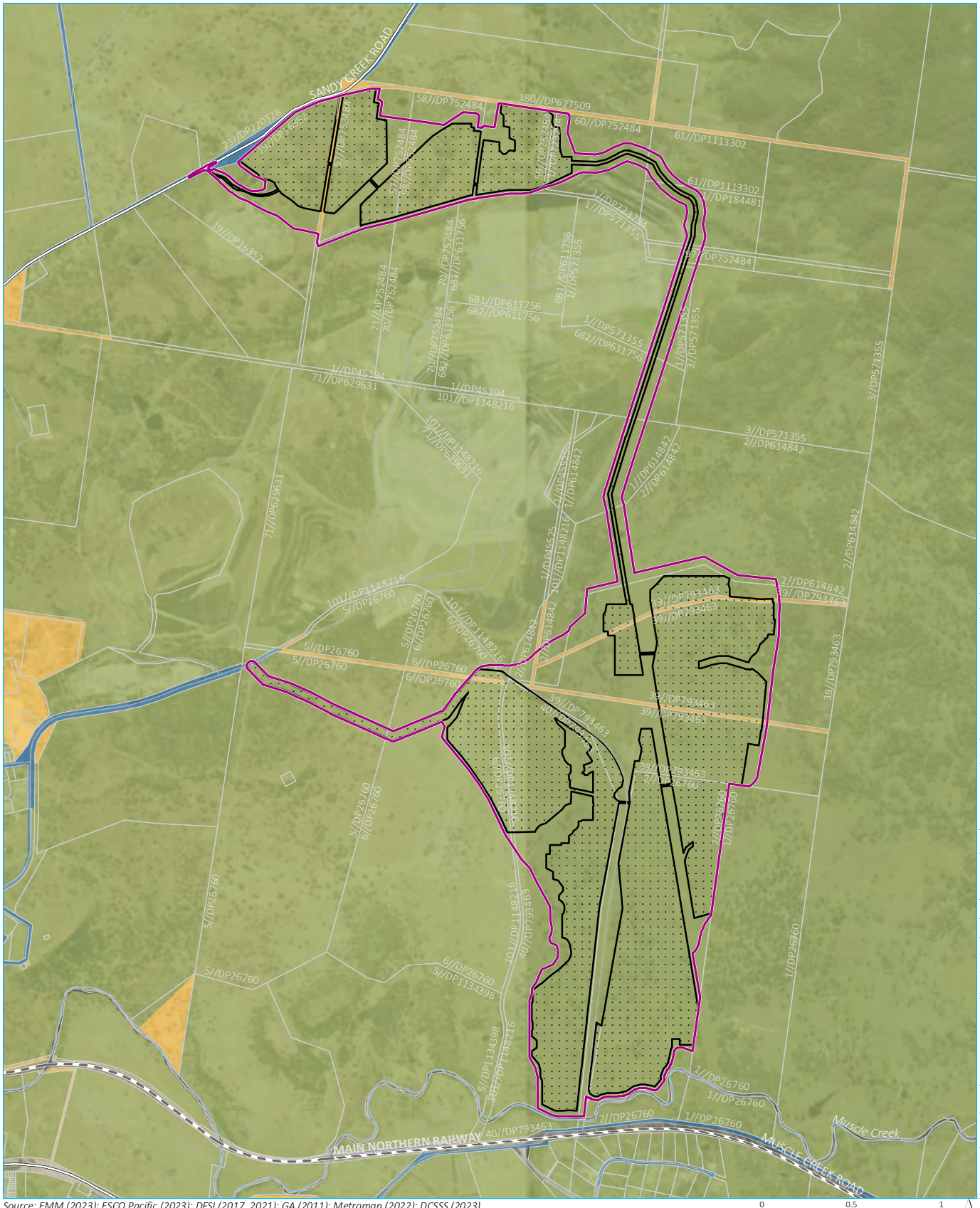
Existing environment

- Rail line
- Major road
- Minor road
- Watercourse/drainage line
- Cadastral boundary

Project layout

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 3.1

EMM creating opportunities



Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2022); DCSSS (2023)

0 0.5 1 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_EIS\EIS005_ScheduleofLands_20230705_05.mxd 5/07/2023

KEY

Project area

Development footprint

Controlling authority

Crown

Freehold

Local Government Authority

NSW Government

Existing environment

Rail line

Major road

Minor road

Named watercourse

Cadastral boundary

Schedule of lands

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 3.2

EMM
creating opportunities

3.3 Physical layout and design

The project is subject to detailed design. Aspects of the project (including the siting of project elements and construction methodology) are subject to change during the detailed design process but will otherwise not lie beyond the development footprint identified on Figure 3.1.

The project area is approximately 482 ha with a development footprint of around 324 ha. The majority of site is located on land owned by MCC, a wholly owned subsidiary of Idemitsu. The southern project area includes land owned by a third-party landowner. The solar farm is divided into two distinct areas, one to the north of the Muswellbrook Coal Mine and one to the south. The northern and southern sections will be connected via approximately 3.3 km of overhead 33 kV line that will run adjacent to the existing 330 kV transmission line to east of the mine pit.

The point of connection to the Ausgrid network is via a tee connection into the 95 M feeder, a 132 kV overhead line to the west of the site. This will require construction of approximately 2.4 km of 132 kV overhead line and a 132 kV switching yard.

The physical layout and design of the project will comprise the following key infrastructure elements:

- **Solar Farm** – to absorb and convert sunlight into electricity. Approximately 300,000 PV Solar Panels would be installed across the site over approximately 300 ha. The solar farm will comprise solar modules, mounting structures, Power Conversion Units (PCUs), weather stations, internal access tracks and associated cabling.
- **Battery energy storage system** (BESS) – to store and discharge electricity when required with embedded storage capacity of approximately 135 megawatt of AC Power (MWac)/2 hour (2.1 ha).
- **Electrical collection systems, substation, and switchyard**– a facility substation connected to the solar farm and BESS as well as a switchyard will be established to connect the project to the transmission network (0.37 ha total).
- **Electricity Transmission Line (ETL) infrastructure** – connecting to the grid, and connecting the northern and southern sections of the solar farm (17.6 ha inclusive of easements, noting this is the maximum area as the width of easements may reduce during detailed design).
- **Operations and maintenance (O&M) facility** – including offices, amenities, equipment sheds, storage and parking areas (0.2 ha total).
- **Site access** – including access from Sandy Creek Road to the north and Muscle Creek Road to the south of the site.
- **Diversion channel** – a channel and berm designed to mitigate flood impacts to the BESS by diverting flood water away from the BESS to a tributary of Muscle Creek (0.2 ha).

3.3.1 Project components

i Solar farm

The project will include the installation of PV panels mounted on single-axis-tracking structures that will be configured in rows positioned to maximise the use of the solar resource available at the site. Panels will be fixed to and supported by ground-mounted framing. The maximum height of the solar panels when fully tilted is expected to be 4 m (including mounting structure) and panels would be approximately 2.4 m wide. The mounting structure will be driven steel piles. An example of the type of similar Solar PV panels is provided in Photograph 3.1.

Approximately 300,000 PV panels will be installed for the project, and this will be refined during detailed design. The panels will be divided into two areas, a northern section and a southern section of solar panel arrays. The number of panels has been calculated based on available grid capacity as advised by Ausgrid and the availability of suitable land within the project area.

The PV modules will be installed in rows generally spaced 6.5 m apart (centre to centre). The rows of PV modules will be aligned in a north-south direction, allowing the panels to rotate from east to west during the day, tracking the sun's movement.

Photograph 3.1 Example of solar PV modules at Ross River Solar Farm

Source: ESCO

Solar panels will be wired in a string array with each group feeding an inverter station. Inverter stations would convert DC current generated from the PV panels into AC current that can be stepped up to 132 kV at the substation and subsequently exported to the national electricity grid. PCUs will contain the DC-AC inverters, medium-voltage transformers, switchgear, Supervisory Control and Data Acquisition (SCADA) and communications equipment. PCUs are normally housed within shipping container-like open structures that measure approximately 6–12 m long x 2.5 m wide x 2.9 m high. PCUs will be skid mounted open structures on either a concrete pad or driven steel piles. An aerial photograph showing the arrangement of Solar Panel arrays and PCU's at Ross River Solar Farm is provided in Photograph 3.2 below.

DC cabling will be installed in trenches between the ends of the PV trackers and the PCUs. 33 kV AC cabling will be installed in trenches between the PCUs and the 33 kV collection station adjacent to the solar farm substation.

The northern and southern solar panels arrays would be connected via a 33 kV overhead line that will run adjacent to the existing 330 kV transmission line to east of the existing MCC mine pit as shown on Figure 2.2.

Approximately five weather stations will be distributed within the PV arrays and mounted on either a concrete pad or drive steel piles.

Photograph 3.2 Solar Panel arrays at Ross River Solar Farm

Source: ESCO

ii Battery energy storage system

The project includes a BESS which will provide the capacity to deliver electricity to the transmission network on demand and more closely follow demand fluctuations. Renewable energy generation is intermittent in nature and subject to fluctuations in solar and wind availability. Batteries mitigate these natural fluctuations through their ability to store and discharge electricity when required. The BESS will have a capacity of up to 135 MWac and up to two hours of storage. The BESS will provide both storage as well as firming capacity to the NEM and assist in grid stability by providing frequency control ancillary services. The BESS will allow for the storage and export of renewable energy within the network so that it can be used during times of peak demand.

The BESS will comprise containerised lithium-ion batteries. Concrete footings would likely be laid to support the structures. The BESS will be located adjacent to the substation and would be connected via underground or overhead cables. The combined footprint of the BESS and substation is approximately 2.7 ha, and its location is shown in Figure 3.1.

iii Electrical collection system, substation and switchyard

A substation will be constructed within the project area to convert the onsite AC reticulated 33 kV electricity to 132 kV for export to the grid. The electrical infrastructure components are generally expected to be between five metres to 10 m tall.

The switchyard will be approximately 0.2 ha and the transformer substation will be approximately 0.1 ha. There will be a solar farm collection station and a BESS collection station.

iv Electricity transmission line infrastructure

The preferred point of connection to the Ausgrid network is via a tee connection into the 95 M feeder, an existing 132 kV overhead line to the west of the site. This will require construction of a switchyard as well as approximately 2.4 km of 132 kV overhead line from the onsite substation to the point of connection on the west side of the project's southern section.

v Operations and maintenance facility and supporting infrastructure

An O&M facility would occupy an area of approximately 20 m by 40 m and may include the following:

- office building, consisting of office, toilets, showers, staff room and kitchen
- equipment shed
- septic tank.

Both the office building and equipment shed are expected to be constructed using neutral Colorbond™ – style materials and would be single storey. The SCADA system and control panels will be located in the office building. Buildings will comply with all the relevant Australian building standards and regulations.

The car parking area will be gravelled and located next to the O&M buildings, with an expected nine parking spaces provided for operations and maintenance staff. An area of approximately 30 m by 40 m has been allowed for car parking.

Internal access tracks will be required during construction and for operational access to all PCUs. Operational internal access tracks will be a gravel track approximately 4 m wide.

Security fencing will also be installed around the perimeter of the solar farm and high voltage electrical equipment such as the BESS facilities, grid connection and switchyard. Signage will be clearly displayed identifying hazards present within the project.

Lighting will be installed where necessary for safety, maintenance, and security purposes. Lightning protection is likely to be provided for in key locations of the administration and control area, BESS equipment, substation and building entrances, switchyard, and inverter stations.

vi Laydown

Two temporary laydown areas, one for the northern section and one for the southern section, will be required during the construction phase of the project as shown on Figure 3.1.

As the BESS will be constructed after the solar farm, the BESS location will be used as a laydown for the construction of the solar farm.

The area used for the temporary laydown area in the north will have PV modules and associated infrastructure installed once it is no longer required.

3.3.2 Project access

i Access

The primary vehicle access route will be via the New England Highway. Two main access points will be established for the project as shown in Figure 3.1. Vehicles travelling to the northern section of the project will use the access point on Sandy Creek Road. Vehicles accessing the southern section of the project will use the access point on Muscle Creek Road.

Internal access roads will be constructed to facilitate access across the project area. Existing roads within the project boundary include:

- Mine Access Road
- North-South Shared Access Road
- Sandy Creek Road/Quarry Shared Access Road.

These existing roads are currently used by the MCC mine site and may provide shared access for MCC mine rehabilitation works, other MCIP projects, and construction of the Muswellbrook Bypass (considered in Cumulative Impacts Section 6.14).

In addition, waterway crossings will be required to facilitate vehicle movements and cable crossings within the development footprint. Proposed waterway crossings are shown on Figure 3.1.It is assumed that each crossing will require a disturbance corridor of up to 40 m wide (including road and cable corridors). The design and construction of waterway crossings and cable crossings will generally comply with the *Controlled activities – Guidelines for riparian corridors on waterfront land* (DPE 2022c), *Controlled activities – Guidelines for laying pipes and cables in watercourses on waterfront land* (DPE 2022f), *Policy and guidelines for fish habitat conservation and management (update 2013)* (DPI 2013), and *Controlled activities – Guidelines for watercourse crossings on waterfront land* (DPE 2022g).

Proposed transport routes from both Sydney and Newcastle ports are shown on Figure 3.3.

ii Road upgrades

An upgrade of the Sandy Creek Road/northern access road intersection is proposed to allow for a basic right turn treatment to cater for heavy vehicles accessing the northern section of the project area. This would occur prior to construction. A concept engineering design has been developed as part of the traffic impact assessment (TIA) (Appendix K).

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); ESRI (2023)

0 25 50 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_TIA\TIA003_ProposedTransportRoutes_20230705_02.mxd 5/07/2023

KEY

- Project area
- Major road
- Named waterbody

Proposed transport route

- Newcastle (from Port of Newcastle to project area)
- Sydney (from Port Botany to project area)

Proposed transport routes

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 3.3

EMM creating opportunities

3.3.3 Services

i Water

Non-potable water demands for the project during both construction and operation will be sourced from existing water access licences currently owned by MCC which currently total around 4.6 gigalitres (GL):

- WAL39806
- WAL41503
- WAL41521.

Groundwater inflows into excavations will be monitored, recorded and reported during construction, and a Water Access Licence (WAL) and appropriate entitlement obtained should inflows exceed the licensing exemption threshold of 3 ML per year established under the WM Regulation, or an agreement be developed with Muswellbrook Coal Company to use their available allocation.

It is estimated that approximately 144 kilolitres (kL) of water per day will be required during construction of the solar farm, which equates to approximately 78 megalitres (ML) over the 18 month construction period. The water requirements during the construction of the BESS would be less than that of the solar farm.

During operations, approximately 18 kL of water per day, or around 6.6 ML per year will be required for ongoing maintenance, cleaning of the PV modules, vegetation management, amenities and fire protection. This equates to approximately 230 ML over the 35 year operational life of the project.

Operational water use will be serviced by a combination of potable water and/or rainwater and licenced groundwater take. Potable water would be sourced from an appropriately licensed facility, trucked in and stored in tanks.

Proposed surface water take will not require licensing under harvestable rights and excluded works provisions in the *Water Management (General) Regulation 2018* (WM Regulation).

ii Electricity

Access to electricity during construction activities will be via the local distribution network where available and via diesel generation where access to the grid is unavailable.

Electricity requirements during operation will include lighting, staff computers, domestic appliances and on-site security systems during operations. Electricity generated by the project will be used for most activities during operations, except for maintaining the inverters and transformers during the night which will involve a small amount of auxiliary load being supplied from the grid or BESS.

3.4 Uses and activities

3.4.1 Construction

i Staging

The anticipated period of construction for the project is 31 months, which is expected to commence in Q3 2024. The construction of the project will be in two main stages each with 3 phases, with the construction of the solar farm (15–18 months), followed by the construction of the BESS (13 months) as outlined in Table 3.3.

Table 3.3 Construction staging

Timing	Stage	Phase: Construction activities	Duration
Q3 2024	Stage 1 – Solar farm construction	1. Site establishment and mobilisation	1 months
		2. Equipment procurement and installation of infrastructure	10–13 months
		3. Testing and commissioning	4 months
Q1 2026	Stage 2 – BESS construction	1. Site establishment and mobilisation	1 months
		2. Equipment procurement and installation of infrastructure	9 months
		3. Testing and commissioning	3 months

ii Site establishment

Temporary infrastructure required during the construction phase of the project will include construction compounds and internal access tracks. Minor earthworks would be required for the preparation of the site, including minimal site levelling, laying of access tracks and drainage works. Most of the infrastructure would be pre-fabricated off-site, delivered and then assembled on-site.

Where required, additional or improved drainage channels, sediment control ponds and dust control measures will be implemented. In addition laydown areas and waste handling, fuel and chemical storage areas will be strategically placed to minimise potential environmental impacts during the construction phase of the project.

iii Activities

Upon completion of the site establishment and pre-construction activities described above, construction activities will be staged as follows:

- installation of the solar farm
- installation of steel piles and mounting system for the tracking system and PV modules
- secure PV modules to mounting system
- trenching and installation of DC cabling and medium voltage cables
- installation of PCUs either on steel skids, concrete pads or in modified shipping containers
- construction of workshop and associated infrastructure, temperature-controlled spare parts storage facility, permanent staff office, operations and control room, meeting facilities, amenities and carparking
- construction of the switchyard and substation (including grid connection-related infrastructure)
- construction of the 33 kV and 132 kV overhead lines
- testing and commissioning of the solar farm infrastructure
- installation of the BESS
- earthworks for flood diversion channel
- establishment of the BESS compound (earthworks for BESS pad)

- installation of battery racks either in cabinets, modified shipping containers or sheds
- installation of inverters associated with the BESS
- testing and commissioning of the BESS infrastructure
- removal of temporary construction facilities.

iv Plant and equipment

The plant and equipment required for the construction of the project will include:

- earthmoving equipment for site preparation (excavator, dozer, chainsaw, tree mulcher, dump truck)
- light vehicles
- delivery trucks/semi-trailers
- compactors
- asphalt paver and tipper lorry
- bobcat
- mobile crane
- cable trenching and cable laying equipment
- concrete truck and agitator
- piling rig
- generator
- water trucks for dust suppression.

v Delivery of construction materials and infrastructure

Construction materials and infrastructure will be transported to the project area via road. Heavy vehicles up to 26 m in length and over-size over-mass vehicles will require access to the development footprint.

Construction materials and infrastructure delivered to the development footprint will include:

- PV modules
- piles
- tracking tubes and associated tracker equipment (e.g. motors, bearings, drivetrains)
- electrical infrastructure including cabling and PCUs
- transformer
- switchgear

- construction and permanent operations and maintenance buildings and associated infrastructure
- earthworks and lifting machinery and equipment.
- civil materials
- battery containers
- overhead electricity line poles

vi Transport routes and vehicle movements

Construction materials and infrastructure are anticipated to be transported to the project area by via road from several locations and may include:

- Port of Newcastle (via New England Highway and Muscle Creek Road/Sandy Creek Road)
- Port Botany (via Pacific Motorway M1, New England Highway and Muscle Creek Road/Sandy Creek Road)
- Melbourne (Glen Waverley) (via National Highway M31, Pacific Motorway M1, and New England Highway) (for the transformer).

Deliveries may also come from elsewhere in Australia, subject to supplier selection, port capabilities and fees.

The origins of project-related light vehicle movements and preferred transport routes will be dependent on the geographic area from which people travel to the study area; however, it is anticipated to include people travelling from Muswellbrook, Singleton, Denman, Aberdeen, Scone and surrounds.

All project-related vehicles will use the primary vehicle access route described in Section 3.3.2i.

One oversize and/or overmass (OSOM) vehicle will be required during the construction phase for delivery of the transformer. The need for additional OSOM movements will be confirmed during detailed design. The maximum length of the OSOM vehicle is estimated to be up to 33 m. It is anticipated that decommissioning will require the same number of OSOM vehicles (i.e. to remove the infrastructure).

No OSOM vehicle movements are anticipated during operations.

The following daily construction vehicle movements are anticipated:

- a maximum of 200 light vehicle trips per day (200 in and 200 out) during the construction works phase
- a maximum of 90 heavy vehicle trips per day (90 in and 90 out) during the construction works phase
- an average of 24 heavy vehicle trips per day (24 in and 24 out) during the construction works phase.

The potential impacts of project-related vehicle movements on the local and regional road network have been assessed as part of the Traffic impact assessment (TIA, refer to Section 6.7 and Appendix K).

vii Hours

Construction activities will be undertaken during standard daytime construction hours consistent with the *Interim Construction Noise Guideline* (ICNG) (DECC 2009):

- 7:00 am – 6:00 pm Monday to Friday
- 8:00 am – 1:00 pm Saturday

- no work on Sundays or public holidays.

Exceptions to these standard working hours may arise from staff arriving and leaving site and the delivery of large solar farm components. Any activity outside normal construction hours will only be undertaken in accordance with approvals from relevant authorities. In general, construction activity will not take place on Sundays or public holidays.

viii Workforce

The project will require a peak construction workforce of up to 200 people during construction of the solar farm, and up to 50 people during construction of the BESS infrastructure. Peak and average personnel numbers for each stage of the project are provided in Table 3.4. The peak workforce is expected to occur at approximately halfway through Phase 2 of each stage, however this can vary depending on the construction methodology.

Consultation will continue with Muswellbrook Council, Transport for NSW, business owners and key stakeholders throughout the assessment and development phases of the project regarding managing potential impacts and opportunities associated with the construction workforce and accommodation capacity.

The construction workforce will be sourced from the local area as far as practicable.

Accommodation required for non-local hires is anticipated to be sourced through the use of available rental and motel accommodation in surrounding townships and regional centres (i.e. Muswellbrook, Singleton, Aberdeen, Scone, Denman, and surrounding areas).

Potential cumulative impacts have been considered as part of the social impact assessment (SIA, refer to Section 6.4 and Appendix G).

Table 3.4 Workforce staging

Construction activities	Duration	Workforce (approximate)
Stage 1: Solar farm infrastructure		
1. Site establishment and mobilisation	1 month	50 people
2. Equipment procurement and installation of infrastructure	10-13 months	Peak: 200 people for 1 month Average: 60 to 80 people
3. Testing and commissioning	4 months	20 to 80 people
Stage 2: BESS infrastructure		
1. Site establishment and mobilisation	1 months	25 people
2. Equipment procurement and installation of infrastructure	9 months	Peak: 70 people for 4 months Average: 60 people
3. Testing and commissioning	3 months	15 people

3.4.2 Operation

i Activities

The primary activities conducted on site will include day-to-day routine operations, maintenance of infrastructure, and general site maintenance and security. The project is expected to generate six full time operation manager roles and 2.5 full time equivalent (FTE) contractor roles for maintenance activities.

The operation of the solar farm will be supported by contractor roles for vegetation, weed and pest management, annual module cleaning and equipment calibration, internal road maintenance and facility cleaning.

The operational lifespan of the project is expected to be in excess of 35 years, depending on the nature of solar PV technology and energy markets. It is also expected that the operational solar farm will feature some co-location of livestock grazing on the site throughout the life of the project.

ii Transport and vehicle movements

All project-related vehicles will use the primary vehicle access route described in Section 3.3.2i.

Regular light vehicle access will be required throughout operations; however, is not anticipated to exceed approximately 12 light vehicles per day. Heavy vehicles may be required occasionally for replacing larger components of project infrastructure including inverters, transformers or components of the BESS.

iii Hours

As the solar farm only generates power during daylight hours, the site will only be manned during the daytime to provide operational and maintenance support. Except in response to any emergencies, it is likely staff would work 7:30 am to 4:30 pm, Monday to Saturday.

iv Workforce

Six permanent full-time jobs will be required to ensure the effective operation of the solar farm (operation manager roles).

Up to three FTE contractor roles for maintenance activities would also be required for vegetation, weed and pest management, module cleaning and facility cleaning, as well as equipment calibration.

3.4.3 Decommissioning

Once the project reaches the end of its operational life, a decision will be made to either decommission or re-power the facility, subject to approval requirements.

If the project is decommissioned, all above ground structures built as part of the project will be removed and site rehabilitated generally to its pre-existing land use, as far as practicable. The disposal and recycling of the project infrastructure will be done in accordance with current waste management legislation at the time of decommissioning. Whenever possible, efforts will be made to reduce the amount going to landfill in line with best-practice sustainability principles.

If re-powering is proposed, an appropriate stakeholder consultation process will be undertaken, and all necessary approvals will be sought.

3.5 Timing

The anticipated period of construction for the project is 31 months, which is expected to commence in the third quarter of 2024. The construction of the project will be in two main stages with the construction of the solar farm (15 to 18 months), followed by the construction of the BESS (13 months) as outlined in Table 3.3.

The operational lifespan of the project is expected to be in excess of 35 years, depending on the nature of solar PV technology and energy markets.

Once the project reaches the end of its operational life, a decision will be made to either decommission or re-power the facility, subject to approval requirements. The decision to re-power the solar farm will depend on the economics of solar PV technology and energy market conditions at that time.

3.6 Environmental management

An environmental management strategy will be implemented to provide the strategic framework for environmental management of the project. The strategy will:

- incorporate a project environmental management plan (EMP), all other required plans, protocols, management and mitigation measures proposed in this EIS
- identify all relevant statutory approvals
- establish roles, responsibility, authority and accountability of all key personnel involved in the environmental management of the project
- establish procedures for consulting with the local community and relevant agencies about the operation and environmental performance of the development
- establish procedures for handling of complaints, disputes, non-compliances and emergency response.

A consolidated summary of the management measures that will be implemented during the construction and operation of the project to manage, mitigate and/or monitor potential impacts identified within this EIS is provided in Appendix C.

4 Statutory context

4.1 Introduction

This chapter identifies the key relevant statutory requirements for the project having regard to the EP&A Act and EP&A Regulation, and other relevant NSW and Commonwealth legislation and environmental planning instruments.

This section addresses:

- power to grant approval (ie approval pathway)
- permissibility
- other approvals
- pre-conditions to exercising the power to grant approval
- mandatory matters for consideration.

Relevant statutory requirements are considered in detail in the assessment sections of the EIS (Chapter 6) and supporting technical reports in Appendix D to Appendix O.

This chapter identifies the statutory requirements relevant to the assessment and evaluation of the project. All relevant statutory requirements, including administrative requirements, relevant to the project are provided in Appendix B.

4.2 Power to grant approval

Approval for the project is sought under Division 4.7 of the EP&A Act, which relates to the application pathway for SSD. The project is classified as SSD as it meets both the requirements of Section 2.6 of the State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP), namely:

- it requires development consent (Section 4.3)
- is specified in Schedule 1, Section 20 (development for the purpose of electricity generating works that has a capital investment value of more than $30 million).

The consent authority for SSD is either the NSW Independent Planning Commission or the NSW Minister for Planning.

4.3 Permissibility

Section 2.36(1)(b) of State Environmental Planning Policy (Transport and Infrastructure) 2021 (Transport and Infrastructure SEPP) states that development for the purpose of electricity generating works may be carried out by any person with consent on any land in a prescribed non-residential zone.

The project area is on land predominantly zoned RU1 Primary Production but also contains land zoned C3 Environmental Management and SP2 Infrastructure. Electricity generating works are prohibited in these zones under the Muswellbrook LEP. However, RU1 Primary Production and SP2 Infrastructure are both defined as a “prescribed non-residential zone” in the Section 2.35 of the Transport and Infrastructure SEPP which permits with consent development for the purpose of electricity generating works.

C3 Environmental Management is not listed as a "prescribed non-residential zone" under Section 2.35 of the Transport and Infrastructure SEPP. Therefore the development is partly prohibited by this environmental planning instrument.

Section 4.38(3) of the EP&A Act addresses consent for SSD and states that:

> (3) Development consent may be granted despite the development being partly prohibited by an environmental planning instrument.

Therefore, development may be granted for the project despite it being partly prohibited by an environmental planning instrument.

4.4 Existing approvals

The existing Muswellbrook mine is operated under DA consent from Muswellbrook Council (DA 205/2002). A small portion of the project area overlaps with the DA boundary for the mine. The project will not interfere with the consent conditions of the existing DA.

4.5 Other approvals

This section identifies the other approvals that are required to carry out the project and explains why they are required. These approvals are outlined in Table 4.1 and have been grouped into the following categories:

- Commonwealth approvals, includes consideration of applicability of Commonwealth legislation
- consistent approvals, which are approvals that cannot be refused and are required to be issued consistently under section 4.42 of the EP&A Act if the project is approved
- other approvals, which are approvals that are not expressly integrated into the SSD application process
- approvals not required, which are approvals that would be required if the project was not SSD as per Section 4.41 of the EP&A Act.

Table 4.1 Approvals and licences required

Approval	Requirement
Commonwealth approval	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Under the EPBC Act, a proponent proposing to undertake an action that may or will have a significant impact on matters of national environmental significance (MNES), or the environment generally for 'Commonwealth agencies', is to be referred to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) for determination as to whether or not it is a controlled action. A search of the Commonwealth Protected Matters Search Tool indicates that there are no World Heritage Properties, National Heritage Places or wetlands of international importance within the vicinity of the project area. A referral under the EPBC Act was made in September 2022 (EPBC 2022/09303) and the project was deemed a controlled action on 14 October 2022. Sections 18 and 18A of the EPBC Act were considered controlling provisions. The project will be assessed under the assessment bilateral agreement with NSW. A biodiversity development assessment report (BDAR) was prepared for the project (Appendix D).

Table 4.1 Approvals and licences required

Approval	Requirement
Native Title Act 1993	The Commonwealth *Native Title Act 1993* recognises and protects native title rights in Australia. It allows a native title determination application (native title claim) to be made for land or waters where native title has not been validly extinguished, for example, extinguished by the grant of freehold title to land. There are no current native title claims relevant to the project area.
Consistent approvals	
An approval under section 138 of the NSW *Roads Act 1993*	Approval will be required under section 138 of the NSW *Roads Act 1993*, for any works in, on or over a public road. This will include the access road upgrade. Approval will be required from: • Muswellbrook Shire Council (for proposed Sandy Creek Road intersection upgrade).
Other approvals	
NSW *Conveyancing Act 1919*	An easement established under Section 88B of the *Conveyancing Act 1919* is likely to be required for the connection to the Ausgrid network.
NSW *Crown Land Management Act 2016*	A number of Crown roads have been identified within the project area, as shown in Figure 3.2. Crown roads within the project area will require closing or an application for tenure, which will be undertaken in consultation with NSW Crown Lands in parallel with the assessment process for the project.
Approvals not required	
A permit under the NSW *Fisheries Management Act 1994* to block fish passage or dredge or carry out reclamation work on water land	The project will require works within waterfront land, including upgrades of existing road crossings and/or establishing new crossings over watercourse within the project area and the construction of a flood diversion channel. These works will be undertaken generally in accordance with NSW DPI *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI 2013) and the DPE's guidelines on controlled activities and the protection of waterfront land (DPE 2022c, 2022f, 2022g, 2022h, 2022i, 2022j).
An Aboriginal heritage impact permit under Section 90 of the *National Parks and Wildlife Act 1974*	Four Aboriginal sites and/or places will be impacted by the project (refer to Section 6.2). An ACHMP will be developed post determination and pre-construction in consultation with DPE, registered Aboriginal Parties (RAPs) and Heritage NSW and will detail the management and mitigation of known Aboriginal sites and will include an unanticipated finds procedure, and training and reporting protocols.
A bushfire safety authority under Section 100B of the *NSW Rural Fires Act 1997*	Bushfire risks associated with the project have been assessed in accordance with *Planning for Bushfire Protection* (PBP) (RFS 2019) (refer to Section 6.10).
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*	Works near or within watercourses within the project area will be required as part of the project and will be carried out generally in accordance with the DPE's guidelines on controlled activities and the protection of waterfront land (DPE 2022c, 2022f, 2022g, 2022h, 2022i, 2022j).

4.6 Pre-condition to exercising the power to grant approval

Pre-conditions for the consent authority in exercising the power to grant approval for the project are provided in Table 4.2.

Table 4.2 Pre-conditions to being able to grant approval for the project

Statutory reference	Pre-condition	Relevance	Section in EIS
State Environmental Planning Policy (Resilience and Hazards) 2021, section 4.6(1) (contamination and remediation to be considered in determining development application)	A consent authority must not consent to the carrying out of any development on land unless: a) it has considered whether the land is contaminated, and b) if the land is contaminated, it is satisfied that the land is suitable in its contaminated state (or will be suitable, after remediation) for the purpose for which the development is proposed to be carried out, and c) if the land requires remediation to be made suitable for the purpose for which the development is proposed to be carried out, it is satisfied that the land will be remediated before the land is used for that purpose.	The project involves a change of use from agricultural use (grazing) and mining lease to electrical generating works. Agricultural activities have occurred on and near the development footprint; however, no potentially contaminated locations have been identified to date. Mining activities have occurred adjacent to the project area however, no potentially contaminated locations have been identified to date. An assessment of land use and soils has been conducted as part of the EIS.	Section 6.5 and Appendix H
State Environmental Planning Policy (Transport and Infrastructure) 2021, section 2.118 (development with frontage to classified road)	The consent authority must not grant consent to development on land that has a frontage to a classified road unless it is satisfied that: (a) where practicable and safe, vehicular access to the land is provided by a road other than the classified road, and (b) the safety, efficiency and ongoing operation of the classified road will not be adversely affected by the development as a result of (i) the design of the vehicular access to the land, or (ii) the emission of smoke or dust from the development, or (iii) the nature, volume or frequency of vehicles using the classified road to gain access to the land, and (c) the development is of a type that is not sensitive to traffic noise or vehicle emissions, or is appropriately located and designed, or includes measures, to ameliorate potential traffic noise or vehicle emissions within the site of the development arising from the adjacent classified road.	The closest classified road to the study area is the New England Highway, which is approximately 1.1 km south-west of the project area at its closest point. Upgrades to Sandy Creek Road, which connects to the New England Highway, will be required as part of the project; however, these upgrades are not expected to impact the safety, efficiency and ongoing operation of the New England Highway. Project-related vehicle movements on the New England Highway during construction and operation have been considered as part of the TIA.	Section 6.7 and Appendix K

Table 4.2 Pre-conditions to being able to grant approval for the project

Statutory reference	Pre-condition	Relevance	Section in EIS
Muswellbrook LEP, clause 7.1 (Terrestrial biodiversity)	(3) Development consent must not be granted for development on land to which this clause applies unless the consent authority is satisfied that the development satisfies the objective of this clause and— (a) the development is designed and will be located and managed to avoid any potential adverse environmental impact, or (b) if a potential adverse environmental impact cannot be avoided, the development— (i) is designed and located so as to have minimum adverse impact, and (ii) incorporates effective measures to remedy or mitigate any adverse impact caused.	Part of the project area is identified as "Biodiversity" on the Terrestrial Biodiversity Map of the Muswellbrook LEP. Potential impacts to biodiversity have been assessed as part of the BDAR for the project.	Section 6.1 and Appendix D

4.7 Mandatory matters for consideration

The mandatory conditions that must be satisfied before the consent authority may grant approval for the project are listed in Table 4.3.

Table 4.3 Mandatory considerations for the project

Statutory document	Section reference	Mandatory consideration	Section in EIS
Considerations under the EP&A Act and EP&A Regulation			
NSW *Environmental Planning and Assessment Act 1979*	Section 1.3	Relevant objects of the Act	Section 7.4
	Section 4.15(1)	Matters for consideration – general In determining a development application, a consent authority is to take into consideration such of the following matters as are of relevance to the development the subject of the development application:	
		(a) the provisions of— (i) any relevant environmental planning instruments, and … (iv) the regulations (to the extent that they prescribe matters for the purposes of this paragraph), That apply to the land to which the development application relates.	See below
		(b) the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality.	Chapter 6
		(c) the suitability of the site for the development.	Section 2.2
		(e) the public interest.	Chapter 7

Table 4.3 Mandatory considerations for the project

Statutory document	Section reference	Mandatory consideration	Section in EIS
Environmental Planning and Assessment Regulation 2021	Section 24	(1) A development application must— (a) be in the approved form, and (b) contain all of the information and documents required by: (i) the approved form, and (ii) the Act of this Regulation, and (c) be submitted on the NSW planning portal.	The EIS will be submitted via the NSW planning portal and has been prepared in the approved form.
	Section 190	(1) An environmental impact statement must contain the following information –	
		(a) the name, address and professional qualifications of the person who prepared the statement,	Certification page
		(b) the name and address of the responsible person,	Table 1.1
		(c) the address of the land— (i) to which the development application relates, or (ii) on which the activity or infrastructure to which the statement relates will be carried out,	Table 3.2
		(d) a description of the development, activity or infrastructure,	Chapter 3
		(e) an assessment by the person who prepared the statement of the environmental impact of the development, activity or infrastructure, dealing with the matters referred to in this Division.	This table
		(2) The person preparing the statement must have regard to—	
		(a) for State significant development—the *State Significant Development Guidelines*	The EIS has been prepared in accordance with the *State significant development guidelines – preparing an environmental impact statement* (DPE 2022).
		(3) An environmental impact statement must also contain a declaration by the person who prepared the statement of the following—	
		(a) the statement has been prepared in accordance with this Division, and	Certification page
		(b) the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure, and	
		(c) the information contained in the statement is not false or misleading	
		(d) for State significant development or State significant infrastructure—the statement contains the information required under the *Registered Environmental Assessment Practitioner Guidelines.*	Certification page
	Section 192	(1) An environmental impact statement must contain the following –	

Table 4.3 Mandatory considerations for the project

Statutory document	Section reference	Mandatory consideration	Section in EIS
		(a) a summary of the environmental impact statement,	Executive summary
		(b) a statement of the objectives of the development, activity or infrastructure,	Section 2.1
		(c) an analysis of feasible alternatives to the carrying out of the development, activity or infrastructure, considering its objectives, including the consequences of not carrying out the development, activity or infrastructure,	Section 2.5
		(d) an analysis of the development, activity or infrastructure, including—	
		(i) a full description of the development, activity or infrastructure, and	Chapter 3
		(ii) a general description of the environment likely to be affected by the development, activity or infrastructure and a detailed description of the aspects of the environment that are likely to be significantly affected, and	Section 2.3 Chapter 6
		(iii) the likely impact on the environment of the development, activity or infrastructure, and	Chapter 6 and Appendix D to Appendix O
		(iv) a full description of the measures to mitigate adverse effects of the development, activity or infrastructure on the environment, and	Appendix C
		(v) a list of the approvals that must be obtained under another Act or law before the development, activity or infrastructure may lawfully be carried out,	Table 4.1
		(e) a compilation, in a single section of the environmental impact statement, of the measures referred to in paragraph (d)(iv),	Appendix C
		(f) the reasons justifying the carrying out of the development, activity or infrastructure, considering biophysical, economic and social factors, including the principles of ecologically sustainable development set out in Section 193.	Chapter 7

Table 4.3 Mandatory considerations for the project

Statutory document	Section reference	Mandatory consideration	Section in EIS
Mandatory relevant considerations under EPIs			
State Environmental Planning Policy (Transport and Infrastructure) 2021	Part 2.3, division 17, section 2.121	(4) Before determining a development application for development to which this section applies, the consent authority must: … (b) take into consideration: (ii) the accessibility of the site concerned, including— (A) the efficiency of movement of people and freight to and from the site and the extent of multi-purpose trips, and (B) the potential to minimise the need for travel by car and to maximise movement of freight in containers or bulk freight by rail, and (iii) any potential traffic safety, road congestion or parking implications of the development.	Section 6.7 and Appendix K
State Environmental Planning Policy (Resilience and Hazards) 2021	Part 3.7	In determining whether a development is— (a) a hazardous storage establishment, hazardous industry or other potentially hazardous industry, or (b) an offensive storage establishment, offensive industry or other potentially offensive industry, consideration must be given to current circulars or guidelines published by the Department of Planning relating to hazardous or offensive development.	Section 6.9 and Appendix M
Muswellbrook Local Environmental Plan 2009	Clause 2.3 (2)	The consent authority must have regard to the objectives for development in a zone when determining a development application in respect of land within the zone.	Section 2.2
	Clause 7.6 Earthworks	(3) Before granting development consent for earthworks, the consent authority must consider the following matters— (a) the likely disruption of, or any detrimental effect on, existing drainage patterns and soil stability in the locality, (b) the effect of the proposed development on the likely future use or redevelopment of the land, (c) the quality of the fill or of the soil to be excavated, or both, (d) the effect of the proposed development on the existing and likely amenity of adjoining properties, (e) the source of any fill material or the destination of any excavated material, (f) the likelihood of disturbing relics, (g) the proximity to and potential for adverse impacts on any watercourse, drinking water catchment or environmentally sensitive area.	Chapter 6
Considerations under other legislation			
NSW *Biodiversity Conservation Act 2016*	Section 7.14	(2) The Minister for Planning, when determining in accordance with the NSW *Environmental Planning and Assessment Act 1979* any such application, is to take into consideration under that Act the likely impact of the proposed development on biodiversity values as assessed in the biodiversity development assessment report. The Minister for Planning may (but is not required to) further consider under that Act the likely impact of the proposed development on biodiversity values.	Section 6.1 and Appendix D

5 Engagement

5.1 Introduction

Idemitsu has a long-standing relationship with stakeholders and the local community from the operation of the Muswellbrook Coal Mine. Throughout the development of this project, ESCO have used a range of engagement mechanisms to consult with stakeholders including local landholders, neighbouring property owners, Muswellbrook Council, community groups and local service providers.

This chapter provides an overview of the communication and engagement activities carried out before and during the preparation of this EIS, as well as those proposed for future engagement activities. It also summarises the community views in relation to the project, as understood by the data and information gathered from the consultation undertaken. In doing so, this chapter demonstrates compliance with the consultation requirements set out in the *Undertaking Engagement Guidelines for State Significant Projects* (SSD Engagement Guidelines) (DPE 2022k).

This chapter discusses community engagement, where 'community' is defined in accordance with the SSD Engagement Guidelines (DPE 2022k) as:

- The people and groups that are interested in, or affected by a State significant project, such as local residents, community groups, Aboriginal and Torres Strait Islander communities, culturally and linguistically diverse communities, peak bodies, and businesses.

Further details on the issues raised by the community during engagement for the project, and where these issues have been addressed in the EIS, is provided in Table 5.1.

5.2 Regulatory requirements

Engagement has been undertaken by ESCO in accordance with the requirements of the SSD Engagement Guidelines (DPE 2022k) and the project SEARs. Table 5.1 demonstrates engagement was consistent with the community participation objectives in the SSD Engagement Guidelines.

In addition to the EIS consultation undertaken by ESCO, EMM has undertaken consultation specifically to inform the Aboriginal Cultural Heritage Assessment (ACHA) and the Social Impact Assessment (SIA).

ACHA consultation has been undertaken in accordance with Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (DECCW 2010b). A full description of the ACHA engagement program is provided in the ACHA (Appendix E).

SIA consultation has been undertaken in accordance with the DPE's Social Impact Assessment Guideline for State Significant Projects (SIA Guideline 2023) (DPE 2023a); and the Technical Supplement: Social Impact Assessment Guideline for State significant Projects (SIA Technical Supplement 2023) (DPE 2023b). A full description of the SIA engagement program is provided in the SIA (refer to Appendix G).

Table 5.1 Compliance with community participation objectives

Community participation objectives	Compliance
Identify the people or groups who are interested in or are likely to be affected by the project.	Interested and affected parties for the project are summarised in Section 5.3.3.

Table 5.1 Compliance with community participation objectives

Community participation objectives	Compliance
Use appropriate engagement techniques. This is particularly important when engaging with specific groups, such as Aboriginal and Torres Strait Islander groups, where engagement should be a discrete, planned activity undertaken by and with experienced Indigenous engagement specialist.	A number of different and complementary engagement techniques were adopted for the EIS consultation program as discussed in Section 5.3 and Table 5.4 and Table 5.5. Section 6.2 provides a summary of engagement with Aboriginal and Torres Strait Islander individuals and groups for the purpose of the Aboriginal Cultural Heritage Assessment.
Ensure the community are provided with safe, respectful and inclusive opportunities to express their views.	A number of different and complementary engagement techniques were adopted for the EIS consultation program as discussed in Section 5.3.4 and Table 5.4.
Ensure the community are provided with safe, respectful and inclusive opportunities to express their views.	A number of different and complementary engagement techniques were adopted for the EIS consultation program as discussed in Section 5.3.4 and Table 5.5.
Involve the community, councils and government agencies early in the development of the proposal, to enable their views to be considered in project planning and design.	Since early 2021 the project has been discussed with relevant Government and community stakeholders. Full details can be found in Section 5.1 of the Scoping Report (https://www.planningportal.nsw.gov.au/major-projects/projects/muswellbrook-solar-farm).
Be innovative in their engagement approach and tailor engagement activities to suit the context, scale and nature of the project.	A number of different and complementary engagement techniques were adopted for the EIS consultation program as discussed in Section 5.3 and Table 5.4 and Table 5.5.
Provide clear and concise information about what is proposed and the likely impacts for the relevant people or group they are engaging with.	The project description is provided in Chapter 3, and a summary of impacts in Chapter 6. A community information session was held for the project by ESCO, in which information on the project was provided to the community. Newsletters, specific landowner letters and individual discussions with community members have also taken place during the development of the project.
Clearly outline how and when the community can be involved in the process.	As described in Section 5.3.4, a website was established for the project. In addition to providing regular updates on the project and links to key project documents, the website details opportunities for participation. Section 5.3 describes the various methods ESCO has adopted to keep the community informed of opportunities for participation in the EIS process. Section 5.4 describes how ESCO proposes to engage with the community as the project progresses.
Make it easy for the community to access information and provide feedback.	Section 5.3.4 and 5.3.5 describes the various information tools used to provide the community to provide an opportunity for the public to provide feedback.
Seek to understand issues of concern for all affected people and groups and respond appropriately to those concerns.	Section 5.3.5 and Table 5.5 describe a summary of the concerns raised by each of the different stakeholder groups.
Provide feedback about how community and stakeholder views were used to shape the project or considered in making decisions.	Table 4.1 of the SIA (Appendix G) describes how feedback from community engagement was considered and where it is addressed throughout the EIS.

Table 5.1 Compliance with community participation objectives

Community participation objectives	Compliance
Be able to demonstrate how the demography of the area affected has been considered in how and what engagement activities have been undertaken.	The SIA social baseline (Appendix G) informed the development of the SIA survey and targeted engagement with stakeholders (i.e. social housing providers, short-term accommodation providers, health care providers). In addition, consideration was given to the high percentage of shift workers in Muswellbrook. Engagement activities included drop-in sessions at times that crossed shift changeover (3:30 pm – 6:30 pm based on advice from MCC), provision of online engagement to enable participation from a wider range of people, and included mail outs, phone calls, online surveys and social media.

5.3 Consultation approach

5.3.1 Community engagement plan

In order to deliver meaningful engagement that considered the needs of all stakeholders, ESCO prepared a Community Engagement Plan (engagement plan). The engagement plan was prepared in accordance with the SSD Engagement Guidelines, which incorporates the adoption of best practice objectives for community participation in state significant projects: that it should be open and inclusive; easy to access; relevant; timely; and meaningful.

ESCO uses the International Association for Public Participation (IAP2) best practice principles for community participation, as reflected in the five levels of the IAP2's spectrum of public participation. The spectrum has been applied to the project engagement activities according to the level of engagement for various stakeholder groups as outlined in Table 5.3. A combination of face to face and online consultation opportunities was considered appropriate in order to:

- capture views of the general community on the project, answer questions and provide opportunity for suggestions
- include targeted consultations with key stakeholders.

5.3.2 Communication and engagement objectives

The communication and stakeholder engagement objectives for the project, as described in the engagement plan are to:

- build high levels of key stakeholder awareness, understanding and acceptance of the project purpose, scope, timeframes and outcomes
- ensure there is consistent and accurate project information in the public domain
- collect representative key stakeholder and community inputs about existing and potential future risks, impacts, and benefits associated with the project.

5.3.3 Key stakeholders

ESCO has developed an extensive and comprehensive stakeholder list of organisations and individuals, with stakeholders categorised into sub-groups based on organisation or individual type. Key stakeholders have been identified and grouped based on organisation type, individual interest or interaction with the project. Identified project stakeholders have been assessed and classified according to the anticipated levels of project impacts and their levels of interest and potential influence on project delivery outcomes.

Table 5.2 outlines the assessment criteria and categories. Table 5.3 provides an overview of key stakeholders and their level of engagement, based on the International Association of Public Participation Spectrum.

Table 5.2 Stakeholder assessment and classification criteria and levels

Details	Level 1	Level 2	Level 3	Level 4
Project impacts on the stakeholder	High impact	Low impact	High impact	Low impact
Stakeholder levels of interest/influence on project decision-making/ outcomes	High interest/influence	High interest/influence	Low/medium interest/influence	Low interest/influence

Table 5.3 Project stakeholder list and engagement level

Classification	Stakeholder Group	Stakeholder Name	IAP2 Spectrum Level of Engagement
1	Federal regulatory authorities	• Department of Climate Change, Energy, the Environment • and Water (DCCEEW)	Inform Consult
1	State regulatory authorities	• DPE • DPE – Biodiversity and Conservation Division (BCD) • Transport for NSW (TfNSW) • Heritage NSW	Inform Consult
2	State regulatory authorities	• Energy Corporation of NSW • NSW Department of Primary Industries • Crown Lands • NSW Rural Fire Service • Fire and Rescue NSW • Water NSW	Inform Consult
1	Local Government Departments	• Muswellbrook Shire Council	Inform Consult Collaborate
2	Elected representatives	• Federal: – Hon Dan Repacholi MP, Member for Hunter, NSW	Inform
3		• State: – Mr Dave Layzell, MP Member for Upper Hunter, NSW	Inform
3		• Local: – Cr Steve Reynolds, Mayor Muswellbrook Shire Council	Inform Consult

Table 5.3 Project stakeholder list and engagement level

Classification	Stakeholder Group	Stakeholder Name	IAP2 Spectrum Level of Engagement
1	Landholders associated with the project	• Associated landowners	Inform Consult Collaborate
1	Landowners/ businesses not associated with the project, but potentially directly impacted	• There are 105 non-associated residences within 2 km of the study area, 47 within 1 km and 11 within 500 m • Residents of Muswellbrook and Muscle Creek	Inform Consult Collaborate
3	Landowners/ businesses not associated with the project, but potentially indirectly impacted	• Residents of Muswellbrook, Muscle Creek and McCully Gaps • Road users of Muscle Creek Road and Sandy Creek Road	Inform
2	Local Aboriginal groups / people	• Local Aboriginal Land Council • Registered Aboriginal Parties	Inform Consult Collaborate
4	Broader community	• Aberdeen, Scone, Denman and Singleton business operators including: – short-term accommodation providers – real-estate agents – employment and training organisations.	Inform
3	Community service providers	• St Heliers Correction Centre • Upper Hunter Community Service • Muswellbrook – Hunter Valley Community Health Service • Muswellbrook TAFE and Hunter Region Innovation Precinct • Social housing providers • NSW Police service operations in Muswellbrook • Muswellbrook Fire Station • Muswellbrook State Emergency Service (SES)	Inform Consult
3	Interest groups	• Lions Club of Muswellbrook • Rotary Club of Muswellbrook • CWA Muswellbrook • Muswellbrook Chamber of Commerce and Industry • Muswellbrook Coal Company Community Consultative Committee (CCC) • Friends of the Upper Hunter Community Group	Inform Consult
4	Transport user groups	• Osborn's Transport • Bowditch Transport • Howard's Bus & Charter	Inform Consult
1	Utility providers	• AusGrid • TransGrid • Energy Corporation of NSW	Inform Consult

Table 5.3 Project stakeholder list and engagement level

Classification	Stakeholder Group	Stakeholder Name	IAP2 Spectrum Level of Engagement
3	Local media	• The Hunter Valley News • The Muswellbrook Chronicle	Inform

5.3.4 Engagement Tools

The engagement process was designed to be inclusive, transparent, structured and meaningful for the local community and broader stakeholders. It included a variety of communication tools and activities to promote awareness of the project, provide information and encourage feedback. Examples of project communication materials can be found in Table 5.4.

Multiple and diverse opportunities to engage and provide feedback were incorporated in the EIS engagement program, including community information sessions, and traditional communication channels like letters, project updates and a company phone line. This approach encouraged the representation of diverse stakeholder groups and age demographics within the consultation process.

Table 5.4 presents a summary of the communication and engagement tools utilised.

Table 5.4 Summary of Communication and Engagement Tools utilised

Tool	Description	Timing	Target Stakeholder Groups
Project website	Provides regular updates on the project, links to key project documents, and details opportunities for participation. The project website can be accessed via the following link: https://www.escopacific.com.au/projects/Muswellbrook-solar-farm This site also includes a query/ feedback form.	Ongoing	All stakeholders
Project email address	An accessible email address – info@escopacific.com.au – answers queries from neighbours and stakeholders.	Ongoing	All stakeholders
Community information line	Provides an avenue for the community to enquire about the project or provide feedback. Community information line: 03 8595 2406	Ongoing	All stakeholders
Face-to-face meetings	Provides an opportunity for all stakeholders to meet with the project team to express feedback or concerns and receive updates on the project.	Ongoing	Associated and non-associated landowners
In-depth SIA interviews	Used to gather information on community values, strengths and vulnerabilities and determine the potential impacts on those directly affected by the project. Fifteen in-depth interviews were undertaken in person, over the telephone, teleconferences and video conference.	August to October 2022	Associated and non-associated landowners, business, community service providers, interest groups.
SIA Survey	Used to gain an understanding from the broader community of the potential social impacts and benefits of the project. The community survey was publicised via the Muswellbrook Community and Singleton + Surrounds NSW Noticeboard Facebook pages.	August to October 2022	Broader community: Business owners

Table 5.4 Summary of Communication and Engagement Tools utilised

Tool	Description	Timing	Target Stakeholder Groups
Community Information Sessions and drop-in session	A drop-in session where community members and stakeholders can ask questions and/or provide verbal or written feedback to members of the project team.	February 2023	All stakeholders
Project fact sheet	Provide key information on the project and upcoming activities. A project update and letters were delivered via letter box drop to the local community and published on the project website.	Ongoing	All stakeholders
Presentations and briefings	Used to keep identified stakeholders updated on specific events and activities tailored to the stakeholder group being consulted.	Ongoing	Associated and non-associated landowners, community service providers, special interest groups
Media advertising	ESCO has utilised media including print and online journalism and paid advertisements and Community Facebook groups to advertise project related community events.	Ongoing	All stakeholders, local and regional community
Project email mailing list	An avenue for community members to subscribe to receive regular project updates.	Ongoing	All stakeholders, local and regional community
Procurement and employment register	Will allow for registration of interest for employment opportunities during all phases of the project.	Ongoing	All stakeholders, local and regional community, employment agencies, contractors, local businesses

5.3.5 Early project and EIS communication and engagement

ESCO recognises the importance of stakeholder engagement to the success of the project. Consultation and engagement with affected parties, stakeholders, and the broader community has been an integral part of the development of the project as well as informing the scoping of investigations for this EIS.

A strong emphasis needs to be placed on engagement to inform stakeholders as to the nature of such projects, to fully describe potential project impacts, to explain proposed measures for impact management and mitigation, and to provide opportunities for stakeholder input into the development process.

Initial stakeholder engagement was undertaken in relation to the broader MCIP. A summary of stakeholder meetings held to date regarding the MCIP is provided in Table 5.1 of the Scoping Report (https://www.planningportal.nsw.gov.au/major-projects/projects/muswellbrook-solar-farm). All stakeholder engagement has been supportive towards Idemitsu's post mining land use masterplan, which includes the solar project. In particular, the concept of incorporating a green energy, training and industrial precinct together and the long-term regional legacy associated with this type of development has been well received.

Engagement undertaken by ESCO, specifically in relation to the Muswellbrook Solar Farm is presented in Table 5.5. Table 5.5 also includes a summary of matters raised by the community and stakeholders.

Table 5.5 Stakeholder engagement conducted to date

Stakeholder	Methods of engagement	Summary of engagement	Key matters raised for EIS assessment
Associated landowners	Face to face meetings (where possible) Phone calls and follow up emails	ESCO has been in regular contact with associated landowners since 2021. The engagement is undertaken through a combination of face-to-face discussions, telephone discussions and written (email or letter) communications.	Site access, project layout, consultation process and assessment process, project schedule, livestock and farming.
Non-associated landowners and broader community	Face to face meetings (where possible) Phone calls and follow up emails Email Website Media advertisements	ESCO has engaged with non-associated landowners/tenants and the broader community since May 2022. This included the following main points of engagement as listed below. Numerous phone calls and emails to interested neighbours and community members has also taken place during the development of the EIS: • A letterbox drop to 90 landowners closest to the project in May 2022. • A project information sheet also included reference to the project website, contact details an overview of the project, the company and the development process. The key objectives were to introduce the project, introduce ESCO, and discuss any concerns. • Phone interviews were held with four nearby residents involved in the MCC CCC to further discuss the project and seek feedback. • MCC newsletter distributed in May 2022 included information on the project. • A letter posted to all residents within 2km in July 2022 advising Scoping Report was available on DPE Major Projects Portal and inviting people to get in touch if they wanted to discuss the project. • SIA interviews were conducted between August and October 2022 with 15 stakeholders (Appendix G). • A letter posted to all residents within 2km in February 2023 inviting them to attend the Community Session or get in touch for one on one discussions if they were unable to attend the session. • In February 2023, a drop-in session for the project held at Muswellbrook RSL, approximately 25 people attended. The event was promoted through socials, newspapers, letters and emails. • MCC newsletter distributed in May 2023 included information on the project. • Photomontages were provided to a number of neighbours to the project as requested during a community drop-in session. An offer for a follow up meeting to discuss the photomontages and visual amenity in further detail was made.	Visual amenity, waste management and rehabilitation, noise, construction traffic, hazards and safety, housing and accommodation, water quality and water security, employment opportunities, local procurement opportunities, livestock and farming practices, biodiversity and environmental impacts, community benefit sharing.

Table 5.5 Stakeholder engagement conducted to date

Stakeholder	Methods of engagement	Summary of engagement	Key matters raised for EIS assessment
Muswellbrook Shire Council (MSC)	Face to face meetings Phone calls and follow up emails	MSC provided written advice to DPE in response to the Scoping Report. ESCO has had the following meetings with representatives of MSC: • In May 2022, ESCO provided a presentation of the proposed project, including indicative development footprint, timeframes and general strategy. No specific issues were raised at this time. ESCO committed to ongoing consultation with MSC. The meeting was attended by Fiona Plesman – MSC General Manager, Sharon Pope – MSC Executive Manager Planning, Environment and Regulatory Services, Derek Finnigan – MSC Deputy General Manager, Steven Reynolds – MSC Mayor, Shaelee Welchman – UHEDC, Grant Clounten – MCC, Laurence Wallis – EMM, Carla Evans, ESCO, Grant Dickins – ESCO. • In July 2022, a meeting of the State Significant Development Committee of Muswellbrook Shire Council recommended the development application for the project be lodged with the Department of Planning, Industry and Environment, in order for it to be assessed on its merits. • In August 2022, ESCO and EMM had a Teams meeting with Theresa Folpp -MSC Development Compliance Officer, Hamish McTaggart – MSC, Peter Chambers of MSC Chief Engineer to discuss the Traffic Impact Assessment. The discussion focused on the rail crossing, required road upgrades and site access points. No concerns were raised. • In February 2023, ESCO provided a project update and discussed a Voluntary Planning Agreement and MSC's expectations. The meeting was attended by Theresa Folpp – MSC Development Compliance Officer, Sharon Pope – MSC Executive Manager Planning, Kellie Scholes – MSC Manager Roads, Drainage and Technical Services. The terms of the VPA will continue to be discussed with MSC over the coming months to reach a satisfactory agreement. • In July 2023, MSC provided consent to the making of the development application, acknowledging the proposed intersection upgrade on Sandy Creek Road, and reserving the right to make a formal submission once the EIS is on exhibition. Further follow up phone calls and emails in relation to traffic impacts, road upgrades and the VPA.	Construction traffic, sourcing a local workforce, accommodation for workers, waste management, cumulative impacts, community benefit sharing, decommissioning, economic impacts and opportunities
DPE – Energy Assessments	Meeting, phone calls and follow up emails.	In May 2022, ESCO and EMM provided a presentation of the proposed development to DPE and enquired whether there were any specific requirements to be considered prior to lodgement of the Scoping Report. DPE noted specific items to be addressed. ESCO has consulted with DPE on a number of occasions, to keep the department informed of the project.	As per project SEARS

Table 5.5 Stakeholder engagement conducted to date

Stakeholder	Methods of engagement	Summary of engagement	Key matters raised for EIS assessment
DPE – Biodiversity and Conservation Division	Phone call	BCD provided written advice to DPE in response to the Scoping Report. In June 2023, ESCO spoke with Robert Gibson – Senior Regional Biodiversity Conservation Officer to advise that the EIS and BDAR would be submitted shortly. Discussed SAII within the Development Footprint and bilateral requirements given that the project is a controlled action under the EPBC Act. Robert advised that during the exhibition period a member of the BCD team may like to undertake a site inspection. ESCO agreed to facilitate a site inspection.	Biodiversity
TfNSW	Meetings, phone calls and follow up emails	TfNSW provided written advice to DPE in response to the Scoping Report. A meeting in February 2022 with Hannah Gilbert from TfNSW and other members of the team discussed the proposed Muswellbrook bypass and its alignment adjacent to the proposed Muswellbrook solar farm. In particular, the location of transmission lines and substation equipment. A meeting in March 2022 with Anthony Samuals from TfNSW and other members of the team continued the discussion to resolve potential overlap between Muswellbrook Solar Farm and the Muswellbrook Bypass project and discuss the siting of infrastructure (particularly transmission lines and substation). Further follow up phone calls and emails in relation to the above issue, leading to a refinement in the project layout to accommodate concerns. In June 2023, ESCO spoke with Alex Power – Team Leader Renewable Resources to advise that the EIS and TIA would be submitted shortly. Discussed TfNSW expectations around OSOM assessment.	Traffic
DECCEW	Meeting	A pre-referral meeting held in May 2022 to discuss the EPBC referral. Key matters discussed included: nature and scale of development, MNES located on the project site, level of detail to be provided in the referral, assessment pathway under the bilateral agreement with NSW. Further follow up phone calls and emails in relation to the EPBC referral and Commonwealth SEARS have been made. After detailed discussion with DECCEW, Muswellbrook Coal rehabilitation areas have been avoided during the project design to prevent conflict with existing rehabilitation objectives at the site.	Biodiversity
Aboriginal stakeholders	Face to face meeting Site visit Phone calls, letters and emails Advertisements placed in local newspapers	Engagement associated with the Aboriginal Cultural Heritage Assessment (ACHA) for the project in accordance with the *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW 2010) has commenced. To date, this includes engagement with relevant government agencies, local Aboriginal groups and the local community. Further detail on this process is provided in Chapter 6 of the EIS and Appendix E. Eighteen registered Aboriginal parties (RAPs) have registered for consultation on the project.	Aboriginal cultural heritage, employment and skills development

Table 5.5 Stakeholder engagement conducted to date

Stakeholder	Methods of engagement	Summary of engagement	Key matters raised for EIS assessment
		In August 2022 the RAPs received a letter that provided an overview of the project and requested feedback on the proposed ACHA methods and invited further information on cultural values associated with the project. An on-site consultation meeting with the RAPs was held in September 2022 to discuss the project, the assessment approach and to identify key issues. A field survey was then undertaken between 24 October and 28 October 2022 and test excavations occurred between 14 November 2022 and 25 November 2022 with EMM archaeologists and representatives of seven of the RAPs.	
NSW Crown Lands (Land and Asset Management)	Email Phone calls	Crown Lands provided written advice to DPE in response to the Scoping Report. Engagement with Crown Lands has been undertaken in relation to obtaining the required landowner's consent for the project, due to the presence of Crown land and roads within the study area. DPE will request Crown Lands review the EIS and provide comment on any affected Crown land as part of the normal process. Discussions with Idemitsu and Crown Lands have resulted in 'Limestone Road' being retained and avoided during project design.	Crown land
Local service providers: • St Heliers Correctional Centre • Upper Hunter Community Services • Muswellbrook Chamber of Commerce • Blackrock industries	In-depth interviews conducted by telephone Phone calls and emails	In depth interviews conducted in August to October 2022. Key themes raised were: • the transition from coal mining to renewable energy • visual impact of the project and resulting impacts on sense of place, rural character, visual amenity and community values • employment and training opportunities as well as opportunities for new skilled workers coming into the local area to fill the shortages • housing and accommodation • potential impacts to Aboriginal cultural heritage • public safety/fire risks – perceived public safety and health risks due to the project • impacts to local environmental values (e.g. erosion, noise, habitat loss) • traffic congestion during construction • training and upskilling opportunities in the local area • exploring long term sustainable employment opportunities • the potential for the project to offer apprenticeships.	Visual amenity, noise, construction traffic, hazards and safety, housing and accommodation, employment and training opportunities, Aboriginal cultural heritage, biodiversity, erosion.

Table 5.5 Stakeholder engagement conducted to date

Stakeholder	Methods of engagement	Summary of engagement	Key matters raised for EIS assessment
Short-term accommodation providers	Telephone survey	The provider indicated consistently high occupancy rates as a result of mine workers and contractors staying in the area. Tourism also contributes to demand for short-term accommodation. The provider expressed the view that there is insufficient rental housing and short-term accommodation available in Muswellbrook and surrounding towns relative to demand. Local residents including vulnerable groups may experience reduced availability and affordability of rental housing and short-term accommodation as a result of project construction workers taking up supply. There are towns such as Denman, Aberdeen, Scone or Singleton in commutable distance from the project where the external workforce could be accommodated. If workers choose to disperse to these towns, this will reduce the potential impact on rental housing and short-term accommodation in Muswellbrook.	Accommodation for workers
EnergyCo	Meeting	ESCO attended a Idemitsu/EnergyCo monthly meeting to provide an overview of the Muswellbrook Solar Farm. EnergyCo offered to provide Case Management services to ESCO as part of the wider case management services it is currently providing to Idemitsu for the MCIP.	-
NSW Rural Fire Service (RFS)	Phone call	In October 2022, ESCO spoke with Alan Bawden – Team Leader – Development and Assessment Planning regarding expectations regarding the Bushfire Impact Assessment.	Hazards and safety including bushfires

5.4 Engagement to be carried out

This section provides a summary of the community engagement that will be carried out if the project is approved, having regard to the findings of the community engagement during the preparation of the EIS and the community participation objectives in the SSD Engagement Guidelines 2021.

Engagement with key stakeholders will continue through EIS exhibition and subsequent phases of the assessment, including:

- Ongoing consultation and negotiations with Muswellbrook Shire Council, and TfNSW relating to project planning and design issues, in particular associated with site access design (road and intersection upgrades), construction programming and contributions required for the project.
- Ongoing consultation with other agencies as required to address issues raised during exhibition of the EIS and as part of preparation of the response to submissions report.
- Ongoing consultation with adjoining neighbours, landowners and local businesses through provision of:
    - project updates via email
    - project website update
    - a community newsletter in July 2023 containing submission information and an invitation to an information session
    - a second information session in July/August 2023 to coincide with the Eis public exhibition period
    - one on one meetings, as required.
- Engagement with accommodation providers, real estate agents, Muswellbrook Shire Council and other Major Project developers in the locality to inform an accommodation strategy closer to construction.
- Industry briefings, led by ICN, to target industry, local businesses, and service providers to provide details of the work packages available during construction and operation and gain an understanding of available local workforce.

If development consent is granted for the project, ESCO will continue with ongoing consultation activities with stakeholders, including community members throughout the construction and operation of the project.

Principle engagement and consultation activities that will be considered beyond determination of the project, if approved, are:

- ongoing regular local stakeholder briefings and meetings, including:
    - Muswellbrook Shire Council
    - TfNSW
    - adjoining neighbours and landowners
- regularly updating and promoting information on the project website
- regular community notifications and updates as the project progresses through construction and into operation

- ongoing operation of the community telephone line, email address, mailbox and website, with set response times for project queries and complaints.

5.4.1 Community Benefit Sharing Plan

Throughout the EIS community engagement process, ESCO has demonstrated their intention to establish a positive, long-term connection with the local community. ESCO will be developing a community benefit sharing plan (CBSP) with Muswellbrook Shire Council and the local community. Consultation with a range of stakeholders, will shape the proposed design of the CBSP, to create a positive conversation around shared benefit opportunities that the project can provide.

While conversations will continue throughout the development, construction, and operations phases, ESCO has considered the outcomes of engagement to date and early design of the CBSP has two key focus areas:

- support for Muswellbrook Shire Council's community grants program which allocates funding to enhance and support local community initiatives
- support for regional jobs and procurement.

i Community Grants Program

The Muswellbrook Shire Council currently operates a Community Grants Program. This program funds many different not for profit community groups in the area to improve community facilities and contribute to a more engaged, sustainable and healthy community.

A landcare and sustainability grant exists as part of the grants program which has a strong focus on energy, water and waste initiatives.

ESCO understands that Muswellbrook Shire Council is currently investigating other community funding models for SSD projects in the region.

Further consultation activities with Muswellbrook Shire Council and the community will take place to refine a potential partnership with the grants program or other community funding model.

This will aim to maximise benefits already being delivered through the Community Grants Program, or other model as agreed with Muswellbrook Shire Council, and avoid duplication.

ii Voluntary Planning Agreement

ESCO has engaged with Muswellbrook Shire Council regarding how a community benefits fund could be administered through a Voluntary Planning Agreement (VPA).

The terms of the VPA will continue to be discussed with MSC over the coming months to refine the agreement.

5.4.2 Monitoring and Evaluation

Part of the evaluation process would also be to facilitate open communication and active complaint resolution. It is important that local stakeholders can raise issues and complaints in a formal way.

A complaints investigation and response plan will be developed and implemented for the project which includes a complaints management process. This complaints management process will allow anyone in the community to submit complaints if they believe a practice is having a detrimental impact on the community, the environment, or their quality of life. The complaints management process will be made publicly available and include a feedback process through which the complainant is provided with information in relation to how their concern has been assessed, considered and, where feasible, addressed.

An escalation process will also be outlined for complaints that are unable to be resolved satisfactorily.

6 Assessment and mitigation of impacts

6.1 Biodiversity

6.1.1 Introduction

A biodiversity development assessment report (BDAR) for the project has been prepared by Eco Logical (2023) and is provided in Appendix D. The BDAR has been prepared in accordance with the requirements of the Biodiversity Assessment Method (BAM) (DPIE 2020c) established under the NSW *Biodiversity Conservation Act 2016* (BC Act). The relevant SEARs and how they are addressed are summarised in Appendix A of the EIS.

It is understood that the Department of Planning and Environment (DPE) has completed the BAM-Calculator update to include revised Plant Community Types in eastern NSW, and that Transitional arrangements apply to proposals that establish a BAM-C case after the date of the BAM-C update. As this project was 'in-progress' within the BAM-C prior to the introduction of these new PCTs, the BDAR, and the BAM-C relate to the original 'post' revision PCTs only.

The term 'subject land' used in this chapter is the land to which the BAM is applied in Stage 1 to assess the biodiversity values of the land (i.e. the 'project area' as defined in Section 1.7 of this EIS) and is used in accordance with the 'subject land' described in the BAM (DPIE 2020c).

The 'study area' used in this chapter is used to describe the area in which initial investigations were completed as the broader preliminary feasibility study area.

This chapter provides a summary of the key findings of the BDAR.

6.1.2 Existing environment

i Landscape features

The subject land is within the Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) bioregion and the Hunter IBRA subregion. The Central Hunter Foothills NSW (Mitchell) Landscape dominates the subject land with a small area of Upper Hunter Channels and Floodplain.

The subject land is roughly divided into two distinct areas: the northern project area, and the southern project area (described in Section 1.7).

Habitat connectivity allows for the movement of species between areas of habitat. The subject land has good habitat connectivity in the northern project area with large patches of vegetation outside the development footprint to allow fauna movement through the landscape. The southern project area has poor habitat connectivity which comprises of widely spaced paddock trees and small patches of vegetation. Vegetation along Muscle Creek to the south of the project area provides some habitat connectivity outside the development footprint.

The southern project area is characterised by degraded native grasslands and modifies pastures with widely scattered remnant paddock trees with poor habitat connectivity. The northern project area predominantly comprises regenerating even-aged regrowth and has good habitat connectivity.

There are no Areas of Outstanding Biodiversity Value.

ii Rivers, streams, estuaries and wetlands

A number of unnamed first, second, third and fourth order streams occur within the subject land. Muscle Creek, a fifth order stream, is located to the south of the subject land. This watercourse does not always flow, however, it is semi-permanent particularly during wetter periods.

A fourth order ephemeral stream in the southern project area (an unnamed tributary of Muscle Creek) is mapped as Key Fish Habitat (KFH), however it does not have any associated habitat listed for any threatened species under the *Fisheries Management Act 1994* (FM Act).

Numerous farm dams of various sizes are found within the development footprint. All farm dams occur within grassland areas and are accessible to livestock. The majority of farm dams are considered to provide minimal habitat, with fringing vegetation either absent or comprising a mixture of exotic and native grass species with little to no emergent aquatic vegetation. Farm dams may provide fauna with a water source and may provide habitat to some waterbirds, turtles and fish species, however, most dams are considered to provide a fairly low quality water resource.

There are no mapped wetlands in the subject land.

iii Native vegetation

The southern project area is characterised by varying levels of degraded native grasslands and modified pastures with widely scattered remnant paddock trees with dominant species including *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus moluccana* (Grey Box), *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus blakelyi* (Blakely's red gum) and *Eucalyptus melliodora* (Yellow Box).

The northern project area predominantly comprises regenerating even-aged regrowth *E. crebra* with occasional remnant trees, sparsely scattered shrubs and degraded native grasslands. A small portion of the northern project area, to the north-east and within the eastern transmission line comprises *E. blaklei* and *Angophora floribunda* (Rough-barked Apple).

a Plant community types

Four plant community types (PCT) were identified within the development footprint, as described in Table 6.1 and shown on Figure 6.1.

Table 6.1 Plant community types within the development footprint

Vegetation name	Vegetation class	Vegetation formation	Percent cleared	Area (ha)
PCT 1691 – Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	Coastal Valley Grassy Woodlands	Grassy Woodlands	77	125.2
PCT 281 – Rough-Barked Apple – red gum – Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	Western Slopes Grassy Woodlands	Grassy Woodlands	67	118.0
PCT 1603 – Narrow-leaved Ironbark – Bull Oak – Grey Box shrub – grass open forest of the central and lower Hunter	Western Slopes Grassy Woodlands	Grassy Woodlands	32	71.4
PCT 1607 – Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter	North-west Slopes Dry Sclerophyll Woodlands	Dry Sclerophyll Forests (Shrub/grass subformation)	51	1.1
Planted native vegetation	-	-	-	0.33
Exotic vegetation	-	-	-	2.99
Total area				**319.02**

Each PCT was divided into vegetation zones based on the condition of the vegetation. Nine vegetation zones were identified. The vegetation zone and vegetation integrity scores are presented in Table 6.2 and shown on Figure 6.1. Vegetation integrity is a measure from 1–100 of the condition (composition, structure and function) of native vegetation against a benchmark vegetation site of the same PCT, based on survey data collected by the assessor.

Table 6.2 Vegetation zones and integrity scores

Vegetation zone	PCT ID	PCT Name	Condition	Area (ha)	Vegetation integrity score
1	1691	Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	Moderate	1	49
2			Low	9.7	42
3			Degraded native pasture (DNP)	114.5	7.3
4	281	Rough-Barked Apple – red gum – Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	Low	9	54.9
5			Degraded Native Grasslands (DNG)– regeneration	52	15.2
6			DNG – low	57	1.9
7	1603	Narrow-leaved Ironbark – Bull Oak – Grey Box shrub – grass open forest of the central and lower Hunter	Moderate	24.4	50.6
8			DNG	47	0.4
9	1607	Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter	Moderate	1.1	42.5
		Total native vegetation		**315.7**	
-	-	Planted native veg (north)	-	0.02	
-	-	Panted native veg (south)	-	0.3	

b Threatened ecological communities

The four PCTs identified within the development footprint align with Threatened Ecological Communities (TECs) listed under the NSW BC Act and EPBC Act and are summarised in Table 6.3 and shown on Figure 6.2 and Figure 6.3 respectively.

Table 6.3 Threatened ecological communities

Vegetation name	Consistency with TEC listed under NSW BC Act	Area (ha)	Consistency with TEC listed under EPBC Act	Area (ha)
PCT 1691 – Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	*Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregion* (Endangered)	10.7	*Central Hunter Valley eucalypt forest and woodland* (Critically Endangered)	6.7

Table 6.3 Threatened ecological communities

Vegetation name	Consistency with TEC listed under NSW BC Act	Area (ha)	Consistency with TEC listed under EPBC Act	Area (ha)
PCT 281 – Rough-Barked Apple – red gum – Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	*White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions* (Critically Endangered)	118	*White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (Critically Endangered)	61
PCT 1603 – Narrow-leaved Ironbark – Bull Oak – Grey Box shrub – grass open forest of the central and lower Hunter	*Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregion* (Endangered)	24.4	*Central Hunter Valley eucalypt forest and woodland* (Critically Endangered)	24
PCT 1607 – Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter	*Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregion* (Endangered)	1.1	Central Hunter Valley eucalypt forest and woodland (Critically Endangered)	1.1
Total area		**154.2**		**92.8**

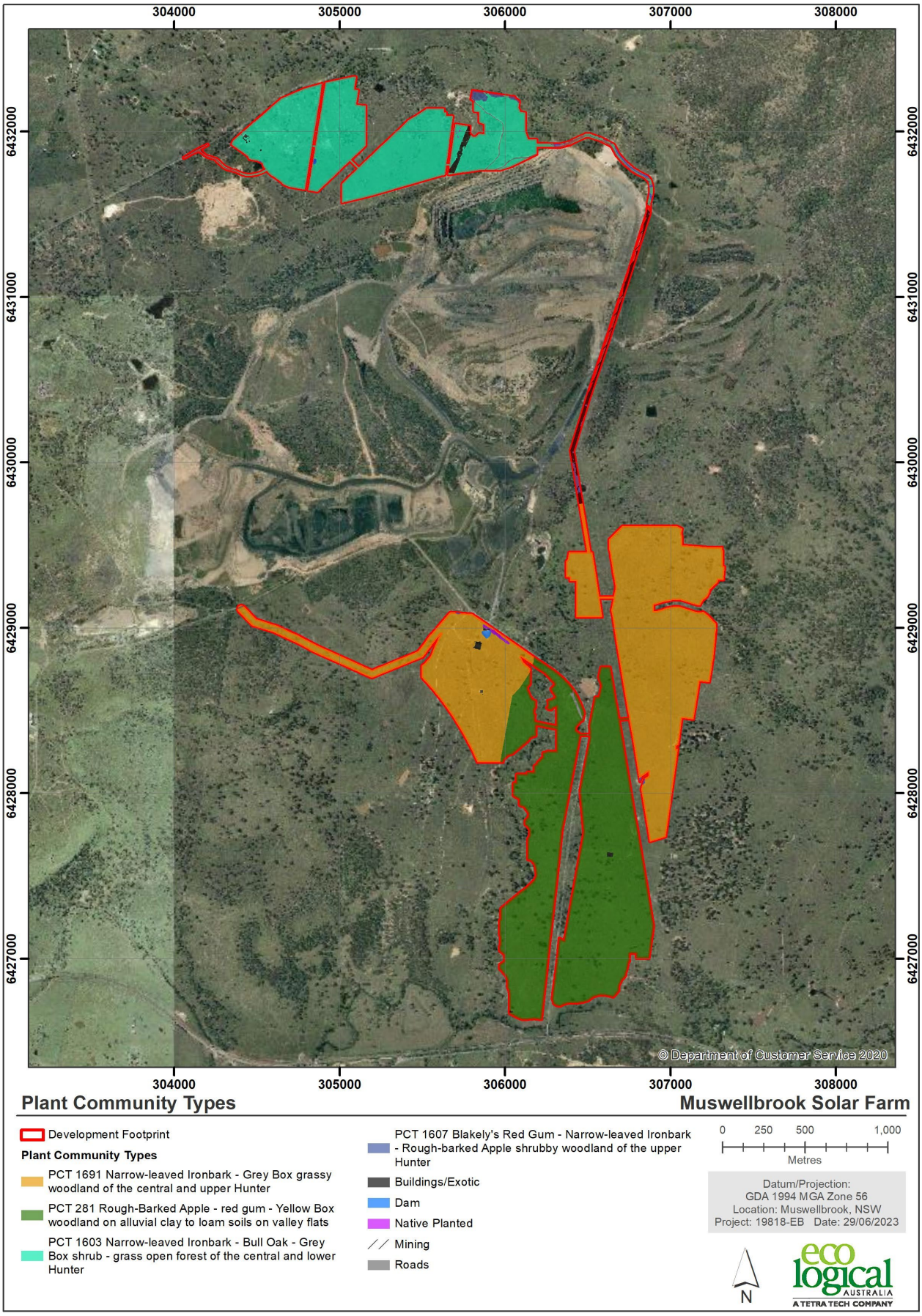


Figure 6.1 **Plant community types**

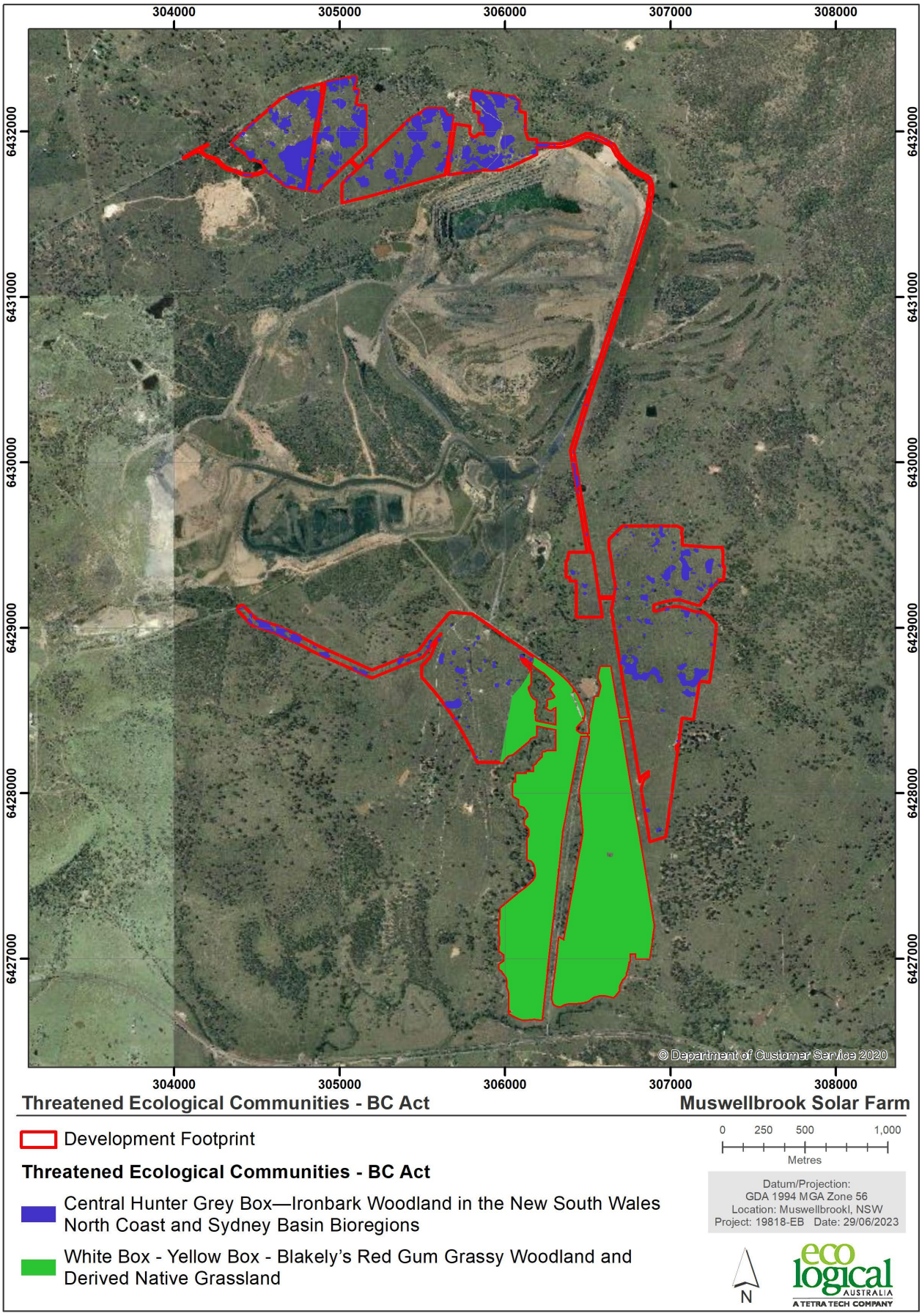


Figure 6.2 **Threatened ecological communities – BC Act**

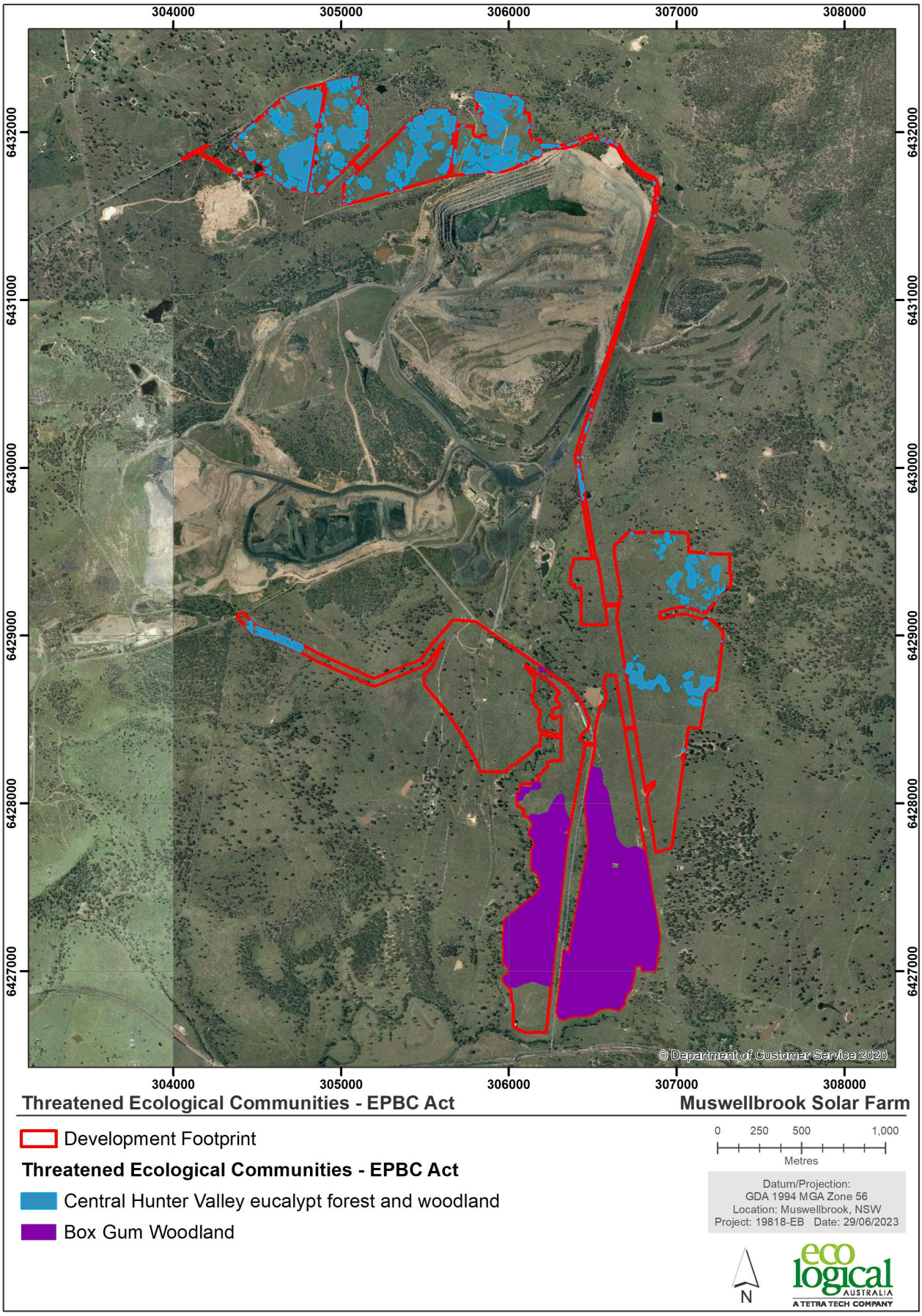


Figure 6.3 **Threatened ecological communities – EPBC Act**

iv Threatened species

Targeted surveys were undertaken for 16 flora species and 21 fauna species.

Two threatened flora species were identified during surveys including *Diuris tricolor* (Pine Donkey Orchid) (endangered population) and *Cymbidium canaliculatum* (Channelled boat-lip orchid) (endangered population).

D. tricolor was identified in the northern project area. This species is listed as vulnerable under the BC Act, however it is also listed as an endangered population in the Muswellbrook LGA. In this instance, based on the location of the species, being within the Muswellbrook LGA, the occurrence of *D. tricol*or has been assessed as the endangered population listing (i.e. the higher threat status).

Cymbidium canaliculatum is listed as an endangered population in the Hunter Catchment under the BC Act. One small individual was identified in the southern portion of the development footprint. One large individual was identified to the north of the subject land, and as part of 'avoid and minimise', the development footprint has been designed to avoid this individual.

The fauna survey effort identified the following:

- fifty-two species of bird were identified across avifauna surveys, three of which are listed under the BC Act. None of the identified species are candidate species
- microbat recordings identified 11 species with confidence and an additional 13 species potentially recorded. Four of these species are listed as threatened and two are candidate species
- no evidence of Koala was detected
- no threatened amphibian species were detected during aural-visual surveys
- no threatened reptiles were recorded during any of the artificial shelter targeted surveys.

The full list of fauna species identified during survey is presented in Appendix G of the BDAR.

During the time that surveys were occurring, it was confirmed that a legless lizard from the Hunter Valley represented a new species, the Hunter Valley Delma (*Delma vescolineata* sp. Nov), distinct from the vulnerable Stiped Legless Lizard (*Delma impar*). This newly described species (Hunter Valley Delma) was recorded during targeted surveys. As this species of Delma is not a listed species under either the NSW BC Act or the Commonwealth EPBC Act, no further assessment, or calculation of credits has been undertaken.

Table 6.4 summarises the species credit species identified during the survey and included in the BAM assessment. The location of flora species and habitat in the development footprint are shown on Figure 6.4, and fauna species and habitat are shown on Figure 6.5, Figure 6.6, Figure 6.7, and Figure 6.8.

Table 6.4 Species credit species

Species	Common name	Species presence	No. individuals/ habitat (ha)	BC Act status	EPBC Act status
Diuris tricolor – endangered population	Pine Donkey Orchid population in the Muswellbrook local government area	Yes (surveyed)	23.2 ha	Endangered population	Not listed
Cymbidium canaliculatum – endangered population	Cymbidium canaliculatum population in the Hunter Catchment	Yes (surveyed)	1 individual	Endangered population	Not listed
Chalinolobus dwyeri	Large-eared pied bat	Yes (surveyed)	3.2 ha	Vulnerable	Vulnerable
Myotis macropus	Southern Myotis	Yes (surveyed)	0.4 ha	Vulnerable	Not listed
Phascogale tapaotafa	Brush-tailed Phascogale	Yes (surveyed)	19.8 ha	Vulnerable	Not listed
Petaurus norfolcensis	Squirrel glider	Yes (surveyed)	42.8 ha	Vulnerable	Not listed

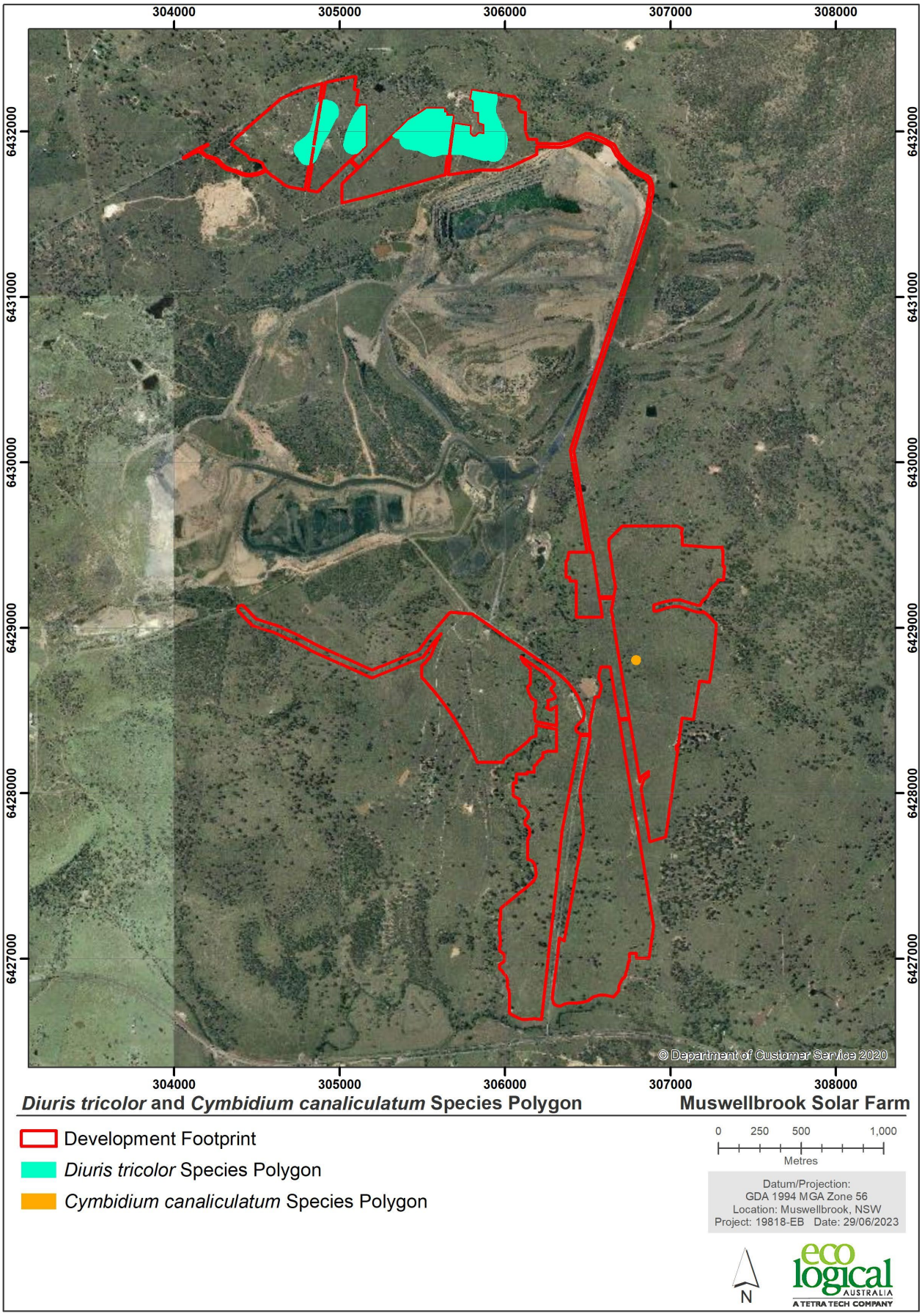


Figure 6.4 **Threatened flora species: *Diuris tricolor* and *Cymbidium canaliculatum***

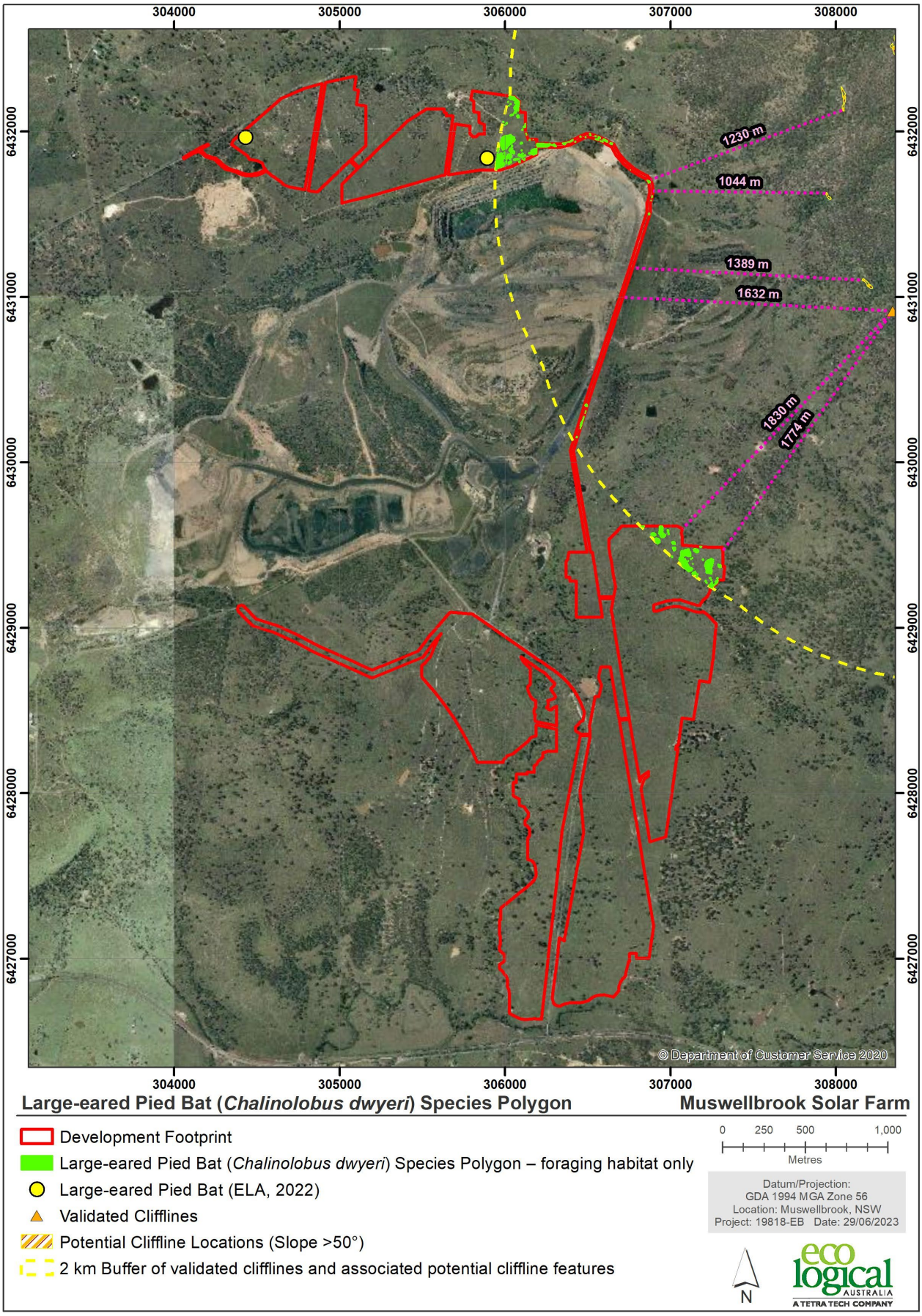


Figure 6.5 **Threatened fauna species: Large-eared Pied Bat (*Chalinolobus dwyen*)**

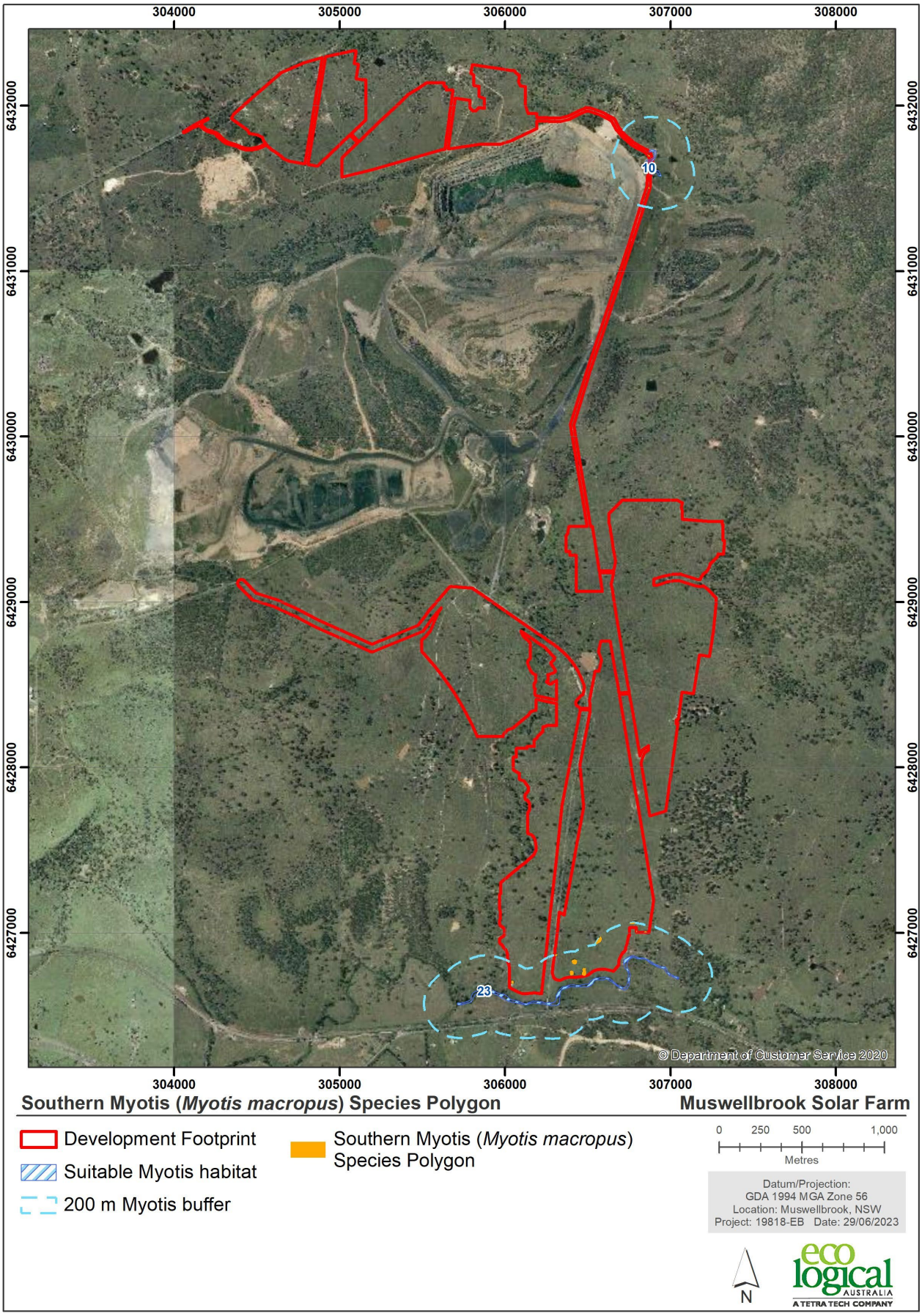


Figure 6.6 **Threatened fauna species: Southern Myotis (*Myotis macropus*)**

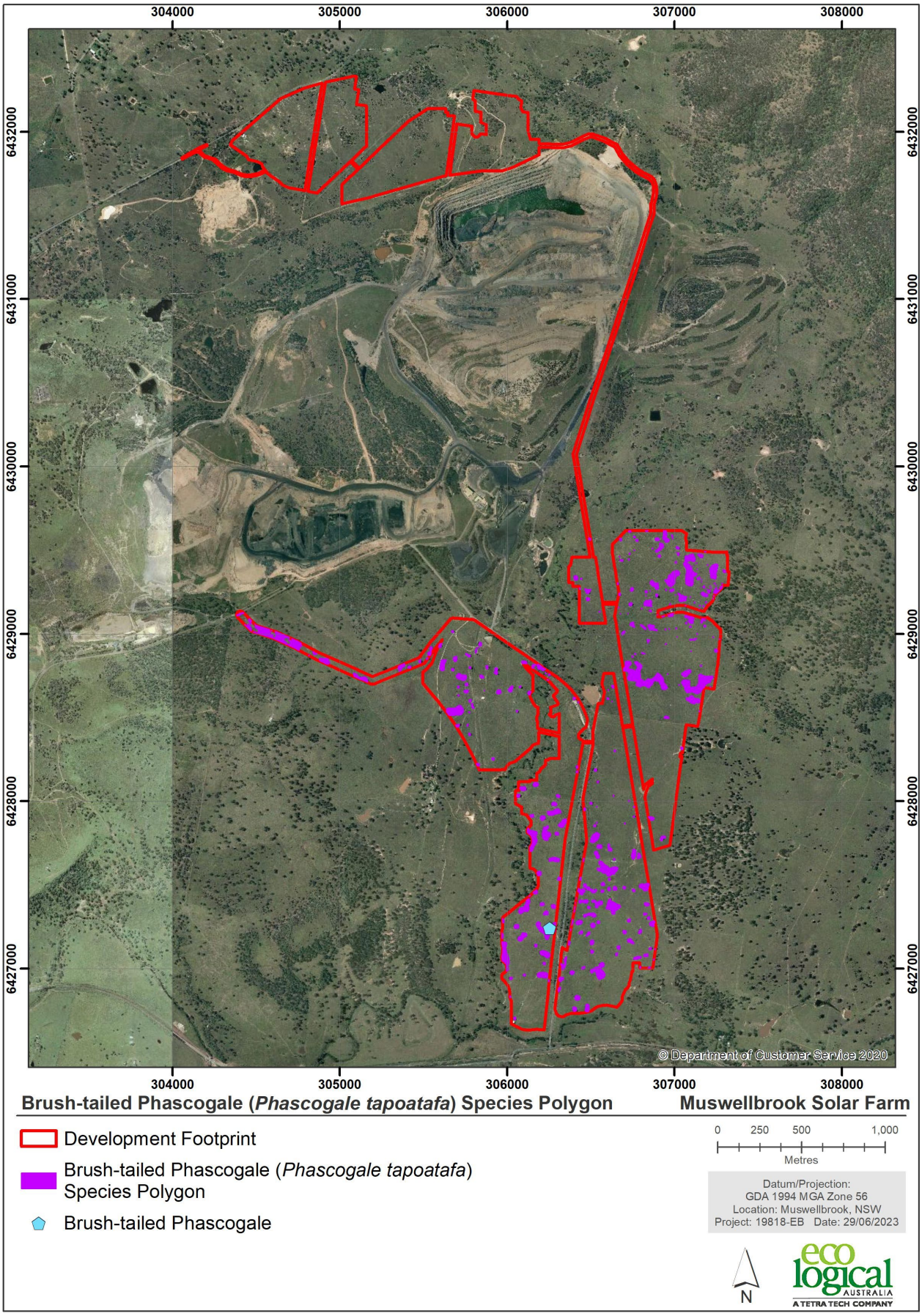


Figure 6.7 **Threatened fauna species: Brush-tailed Phascogale (*Phascogale tapoatafa*)**

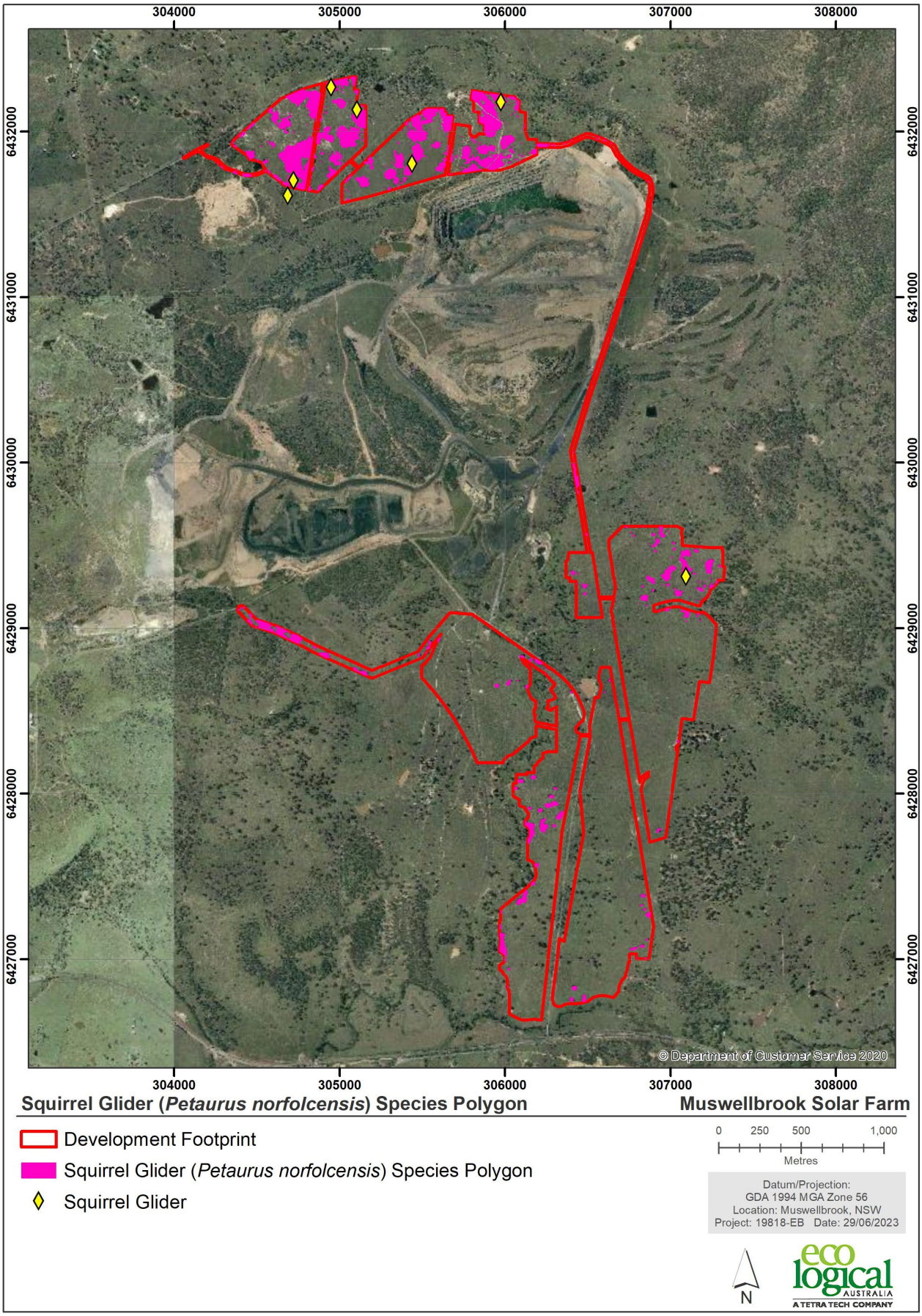


Figure 6.8 **Threatened fauna species: Squirrel glider (*Petaurus norfolcensis*)**

6.1.3 Avoidance and minimisation through design

Avoidance of impacts to native vegetation was a key consideration in the project refinement process, resulting in the avoidance of significant biodiversity values.

An initial biodiversity assessment was completed in 2021 that involved a preliminary feasibility study area which identified significant areas of intact woodland. The study area was refined to avoid these larger intact woodland areas.

The avoidance of high value vegetation such as Critically endangered ecological communities (CEECs) and threatened flora and fauna habitat was considered a priority and influenced the placement and design of solar panel arrays and associated infrastructure. An 'avoid and minimise' workshop was undertaken in July 2022 to further refine the project footprint with the following in mind:

- utilise to the greatest extent possible the areas of degraded pastures/grassland
- avoid impacts to small, yet more intact areas of PCT 281 'Low' woodland (Biodiversity Exclusion Zone)
- further refine and avoid impacts to PCT 281 woodland along the 4th order stream
- avoid impacts, to the greatest extent possible, to areas comprising presence of threatened flora species habitat within PCT 1603 for *Diuris tricolor* in the northern portion of the Development footprint. The insert in Figure 30 of the BDAR shows where efforts have been made to avoid the highest density of *D. tricolor* individuals, whilst still working within the limits of suitable solar panel array options.

A high-level analysis of avoidance, from the preliminary 'study area' to the final development footprint of mapped woodland for each PCT is presented in Table 6.5 and shown on Figure 6.9.

All areas of aquatic waterway habitat have primarily been avoided through solar panel array placement. One waterway within the project area (ephemeral 4th order stream) has been identified as potential Key Fish Habitat for threatened species. Transmission lines will span this waterway at three locations. During construction of the transmission lines, disturbance will be avoided within the watercourse itself, therefore limited to no impacts are proposed within the riparian corridor of the aquatic habitats.

Table 6.5 Avoidance of PCTs through design

PCT ID	Preliminary study area (ha)	Development footprint (ha) 'woodland'	Avoidance (ha)	% reduction in impacts
1691	166	10.7	155.3	94%
1603	34	24.4	9.6	28%
281	19	9.7	9.3	49%

In summary, the development footprint was placed around areas of lowest biodiversity value (degraded native pastures and degraded native grassland) to avoid larger more intact woodland areas where possible:

- In the southern portion of the project area, the majority of larger intact woodland areas have been avoided, and the more disturbed woodland areas, comprising of scattered paddock trees and smaller isolated patches of woodland have been utilised.
- In the northern portion of the project area, woodland areas comprise even-aged young regrowth, minimising the removal of larger remnant trees. Solar panel placement was redesigned to avoid the highest concentration of habitat and individuals of *Diuris tricolor*.
- The internal transmission line connecting the northern and southern portions of the project area occurs along an existing larger powerline easement, and utilises highly degraded vegetation areas with little to no good quality vegetation.
- The transmission line to the west does impact better quality woodland, however, the area of impact has been minimised as far as practical and has been located to take the shortest pathway possible from the solar farm to the connection point.

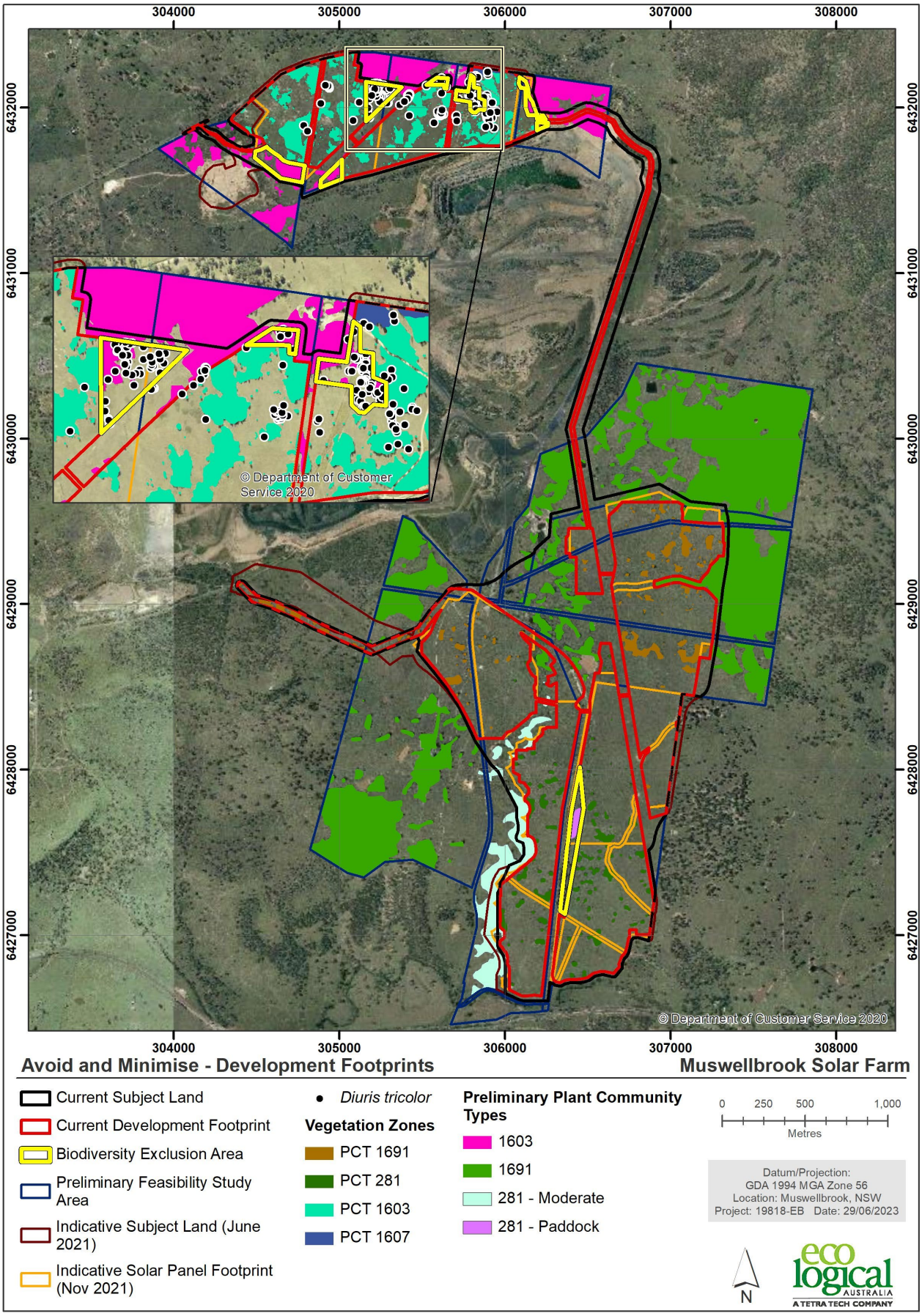


Figure 6.9 **Avoidance through design**

6.1.4 Potential impacts

i Direct impacts

a Impacts requiring offsets

After avoidance and minimisation, the project will result in direct residual impacts to native vegetation and threatened ecological communities. The impacts that require offsetting under the NSW Biodiversity Offset Scheme (BOS) are outlined in Table 6.6 and shown in Figure 6.11.

Table 6.6 Impacts to native vegetation and threatened species that require offsets

PCT/Species	Direct impact
Native vegetation	
PCT 1691 (Moderate)	1.0 ha
PCT 1691 (Low)	9.7 ha
PCT 281 (Low)	9.0 ha
PCT 281 (DNG – regen)	52.0 ha
PCT 1603 (Moderate)	24.4 ha
PCT 1607 (Moderate)	1.1 ha
Threatened species and threatened species habitat	
Pine Donkey Orchid population in the Muswellbrook local government area	23.2 ha
Cymbidium canaliculatum population in the Hunter Catchment	1 individual
Large-eared pied bat	3.2 ha (foraging habitat associated with buffers)
Southern Myotis	0.4 ha (foraging habitat associated with buffers)
Brush-tailed Phascogale	19.8 ha
Squirrel glider	42.8 ha

b Impacts not requiring offsets

Three vegetation zones identified within the subject land have a vegetation integrity score lower than the thresholds and consequently, do not require offsetting. These are outlined in Table 6.7 and shown on Figure 6.11.

Table 6.7 Impacts to native vegetation that do not require offsets

PCT	Direct impact
PCT 1691 (DNP)	114.5 ha
PCT 281 (DNG – low)	57 ha
PCT 1603 (DNG)	47 ha

Potential impacts to aquatic habitat are associated with disturbance during construction of transmission lines over the fourth order stream on the western side of the southern project area and the construction of the flood diversion channel. During construction of the transmission line, all disturbance will be avoided within the watercourse itself and the transmission lines will span areas of KFH. A drainage diversion structure with flood protection bund will be required upstream of the proposed BESS. This diversion structure will reinstate the existing mapped watercourse. The drainage diversion will interface to the 4th order stream. There may be some minor instream works including completion of some earthwork interfaces and erosion management (such as placed rock). Given the degraded nature of the aquatic habitat present and mitigation measures proposed, the direct impacts to aquatic habitat are unlikely to be significant.

ii Indirect impacts

Without any measures to avoid, minimise or mitigate impacts, the project could result in the following indirect impacts on biodiversity:

- inadvertent impacts to adjacent habitat or vegetation
- reduced viability of adjacent habitat or vegetation due to edge effects,
- reduced viability of adjacent habitat or vegetation noise, dust or light spill
- transport of weeds and pathogens from site to adjacent vegetation
- rubbish dumping
- wood collection
- removal of rocks including bush rock.

Mitigation measures are proposed, as described in Section 6.1.6, to minimise the potential for indirect impacts to occur.

iii Serious and irreversible impacts

One NSW BC Act listed TEC at risk of serious and irreversible impacts (SAII) occurs within the subject land, and one BC Act listed fauna species at risk of SAII has potential foraging habitat within the subject land.

White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions (Box Gum Woodland) is considered a potential entity to meet the serious and irreversible impacts principle. The total area of the TEC to be impacted by the proposal is 118 ha, comprising of 9 ha of 'Low' condition woodland, 52 ha of DNG-Regeneration and 57 ha of DNG – Low.

The BDAR noted that while clearing within the development footprint may exacerbate habitat fragmentation, the majority of the development footprint is located in an already highly fragmented landscape and is unlikely to further reduce connectivity of the TEC. The impacts are unlikely to result in substantial change to the community locally.

The Large-eared Pied Bat (*Chalinolobus dwyeri*) has 3.2 ha of foraging habitat associated with buffers within the subject land. No breeding habitat will be impacted as part of the proposed works and therefore the threshold for SAII has not been met. This species was not considered further as an SAII entity.

The TEC and fauna species have been assessed in accordance with Section 9.1 of the BAM (DPIE 2020) and the assessment is presented in Section 7.1 of the BDAR.

iv Matters of national environmental significance

This project was referred to the Commonwealth Minister for the Environment in 2022, and was declared a controlled action due to potential significant impacts to two TECs being Box Gum Woodland CEEC and Central Hunter Valley eucalypt forest and woodland CEEC (Referral 2022/09303). Three additional threatened species were also considered to be potentially significantly impacted being:

- Regent Honeyeater (*Anthochaera phrygia*) – Critically Endangered
- Grey-headed Flying-fox (*Pteropus poliocephalus*) – Vulnerable
- Striped Legless Lizard (*Delma impar*) – Vulnerable.

The presence of additional EPBC Act listed threatened species within 5 km of the proposed action area which may be impacted by the proposed action include the following:

- Koala (*Phascolarctos cinereus* combined populations of QLD, NSW, and the ACT) – Endangered
- Swift Parrot (*Lathamus discolor*) – Critically Endangered
- Pink-tailed Worm-lizard (*Aprasia parapulchella*) – Vulnerable
- Spotted-tail Quoll (*Dasyurus maculatus maculatus*, SE mainland population) – Endangered
- Gang-gang Cockatoo (*Callocephalon fimbriatum*) – Endangered
- Large-eared Pied Bat (*Chalinolobus dwyeri*) – Vulnerable
- Grey Falcon (*Falco hypoleucos*) – Vulnerable
- South-eastern Glossy Black Cockatoo (*Calyptorhynchus lathami lathami*) – Vulnerable
- Corben's Long-eared Bat (*Nyctophilus corbeni*) – Vulnerable.

Assessments in accordance with the *Matters of National Environmental Significance – Significant Impact Guidelines 1.1* (DoE 2013) were undertaken in the BDAR (Section 9.2 of the BDAR). The conclusions are summarised in Table 6.8. The location of MNES identified in the subject land is shown on Figure 6.10.

Table 6.8 Assessment of project against EPBC Act

MNES	Project specifics	Potential for significant impact
Threatened species	Twelve fauna species were considered as having potential to be impacted on by the project. The project would result in the removal of vegetation that is potential foraging habitat for several of the species.	Significant impact unlikely to result from project.
Threatened ecological communities	The project will result in the removal of the following vegetation: • the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CEEC) (61 ha) • Central Hunter Valley eucalypt forest and woodland (Endangered) (32 ha).	**Significant impact** The assessment criteria and discussion is available in Section 9.2.1 of the BDAR (Appendix D of this EIS)
Migratory species	Two migratory species were considered to have potential to occur in the project area: • White-throated Needletail (Vulnerable and Migratory) • Fork-tailed Swift (Migratory).	Significant impact unlikely to result from project.
Wetlands of international importance	The development footprint does not flow directly into a Ramsar site, and the project is not likely to result in a significant impact. The nearest Ramsar wetland is the Hunter estuary wetlands, approximately 90 km, south-east of the development footprint.	Significant impact unlikely to result from project.

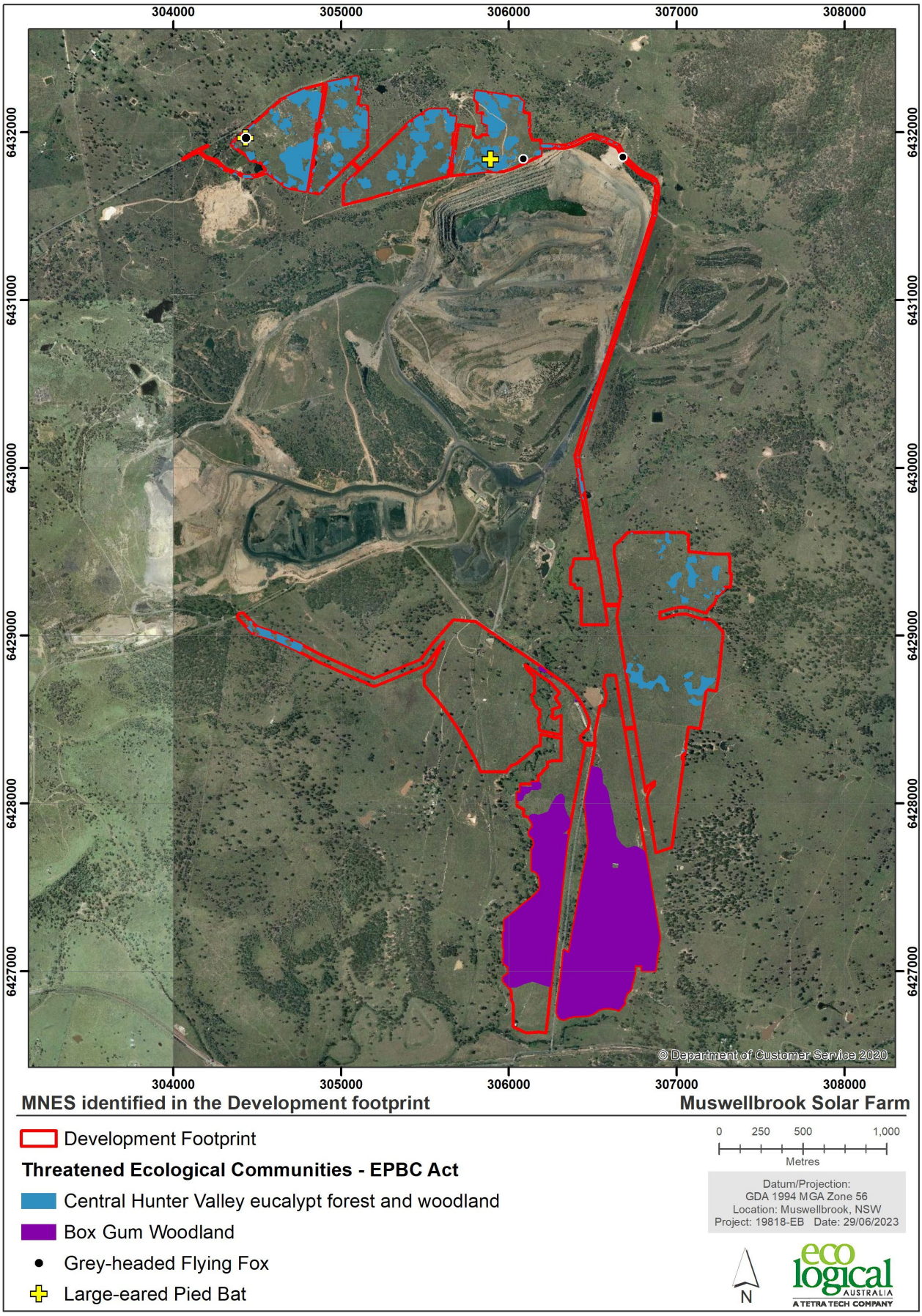


Figure 6.10 MNES in the development footprint

6.1.5 Biodiversity offset strategy

A biodiversity offset strategy will be implemented for the project to ensure that all residual impacts on biodiversity of the project are appropriately offset.

A summary of the credit requirements for the project is provided in Table 6.9, and areas requiring offset are shown in Figure 6.11. A credit report is provided in Appendix K of the BDAR (refer to Appendix D).

The final ecosystem credit and species credit liability must generally be 'retired' prior to any impacts occurring. These credits can be retired by:

- establishing conservation agreements called Biodiversity Stewardship Agreements (BSAs) on land which generates the matching credit
- by purchase of the appropriate credits from a vendor (who has established a BSA on their own land)
- by payment to the Biodiversity Conservation Fund (BCF) at the price provided in the Biodiversity Offsets Payment Calculator (BOPC).

Based on the preliminary credit calculations the project requires 878 credits of Central Hunter Grey Box – Ironbark Woodland) and 843 credits of Box Gum Woodland, which based on a conservative average credit yield of 5 credits/ha (generated at a Stewardship site), corresponds to approximately 176 ha and 169 ha of offsets.

There are two parcels of land, adjacent to the southern portion of the development area that are currently being investigated for BSAs (Figure 6.12). Site 1 is approximately 316 ha and occurs to the west of the development area. Site 2 is approximately 494 ha and located to the north and north-east of the development area. Preliminary PCT mapping has been completed (partially field validated) and considerable surveys undertaken, including use of IR cameras and songmeters for the detection of threatened arboreal mammals.

Preliminary assessments have identified a significant amount of activity, across both Site 1 and Site 2 for both threatened species Squirrel Glider and Brush-tailed Phascogale. Additionally, a significant proportion of these proposed BSA sites comprise vegetation considered to conform to the EEC Central Hunter Grey Box – Ironbark Woodland. A small proportion of Site 1 may conform to the CEEC Box Gum Woodland, however, additional surveys are required to ascertain the quantum of credits that may be available. It is considered likely that the proponent will need to source the majority of these credits via the offset options discussed above.

Should the proponent elect to make payment to the BCF to resolve their offset liability, they will need to seek a quote from the BCF as current pricings from the BOPC are no longer available.

Table 6.9 Summary of biodiversity credit requirements

PCT/Species	Area (ha)	Credit
Ecosystem credits		
PCT 1691 (Moderate)	1	25
PCT 1691 (Low)	9.7	207
PCT 281 (Low)	9	330
PCT 281 (DNG – regen)	52	513
PCT 1603 (Moderate)	24.4	625
PCT 1607 (Moderate)	1.1	21
Total PCT credits		**1721**
Species credits		
Pine Donkey Orchid population in the Muswellbrook local government area	23.2 ha	278
Cymbidium canaliculatum population in the Hunter Catchment	1 individual	2
Large-eared pied bat	3.2 ha	111
Southern Myotis	0.4 ha	13
Brush-tailed Phascogale	19.8 ha	496
Squirrel glider	42.8 ha	867
Total species credits	-	**1767**

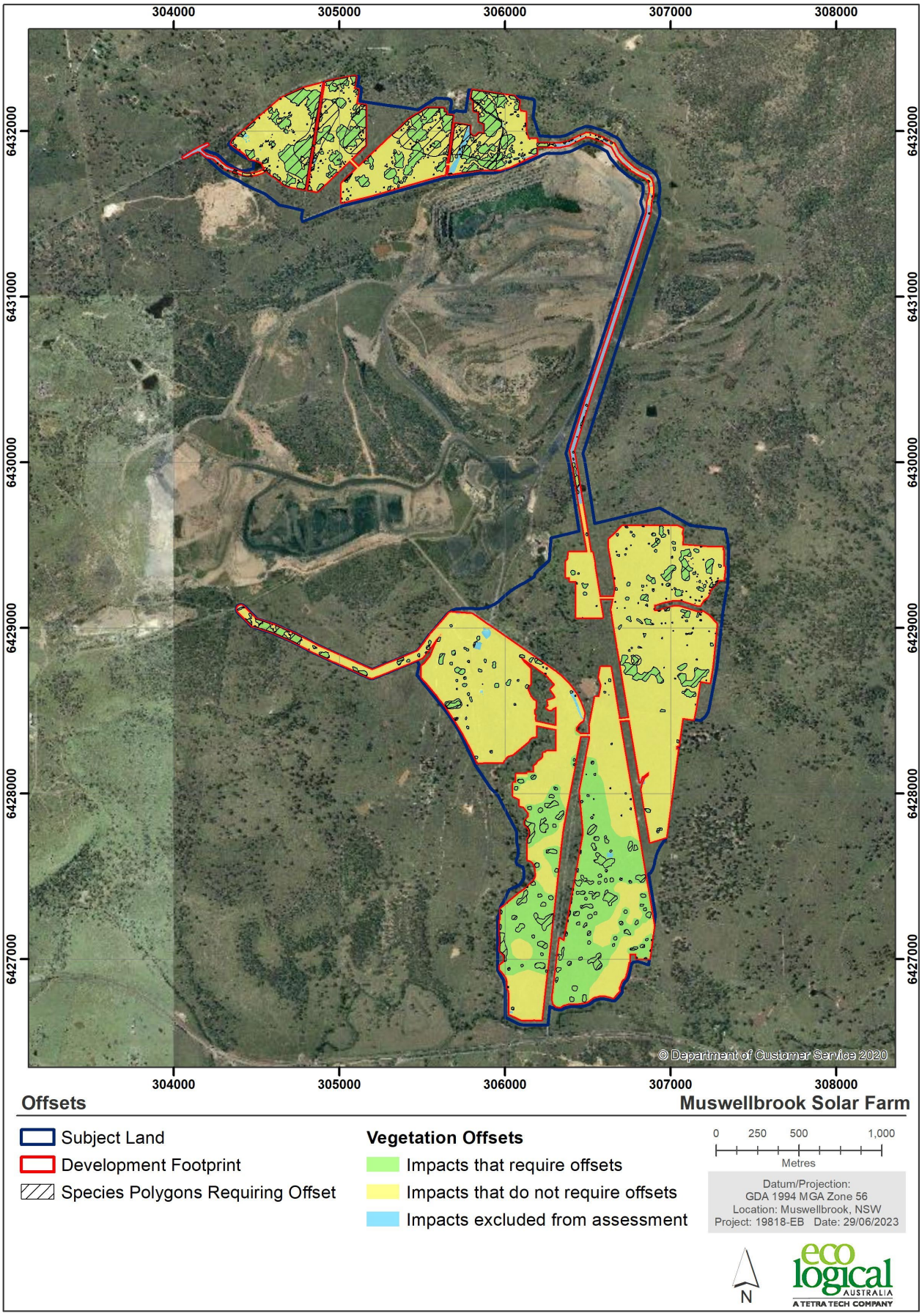


Figure 6.11 **Impacts requiring offsets, impacts not requiring offset and impacts excluded from assessment**

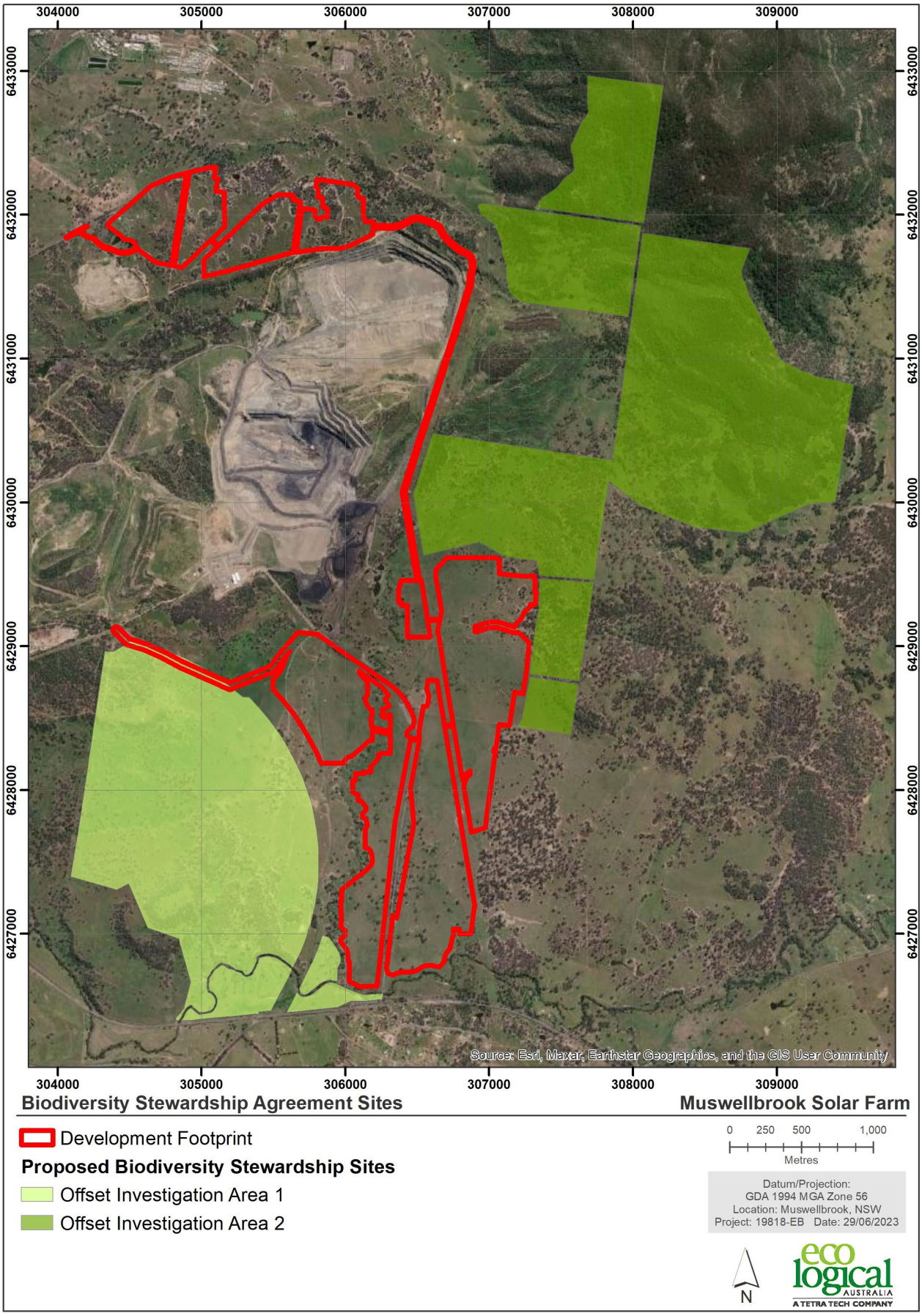


Figure 6.12 **Proposed stewardship sites under investigation**

6.1.6 Mitigation measures

Table 6.10 summarises the mitigation measures and recommendations that will be implemented in addition to the biodiversity offset strategy to further minimise residual impacts to biodiversity values.

Table 6.10 Biodiversity mitigation measures

ID	Mitigation measures
BIO1	A biodiversity management plan (BMP) will be prepared for the project. The BMP will document the measures to avoid and minimise direct and indirect impacts to ecological values and natural assets.
BIO2	Where possible, undertake clearing works outside of known seasonal breeding events for candidate fauna species known to inhabit the locality i.e. Squirrel Glider, Brush-tailed Phascogale, Southern Myotis and Large-eared Pied-bat.
BIO3	Pre-clearance surveys will be undertaken prior to tree clearing. A qualified ecologist/licenced wildlife handler will supervise tree removal in accordance with best practise methods.
BIO4	A procedure will be developed for the relocation of habitat features (e.g. fallen timber, hollow logs) to adjacent retained habitat. Any trees that are removed that have salvageable hollows/hollow trunks/fissures should be retained as ground fauna habitat and/or used as replacement hollows and attached to trees within the adjacent retained vegetation
BIO5	Clearing protocols will be developed that identify vegetation to be retained, prevent inadvertent damage and reduce soil disturbance (e.g. removal of native vegetation by chainsaw instead of heavy machinery where only partial clearing is proposed). Use of appropriate machinery for vegetation removal adjacent to retained areas.
BIO6	Fencing (or other barriers as required) and signage will be placed around those areas of vegetation to be maintained to prevent any accidental construction damage and provide a permanent barrier between the development footprint and retained areas. The type of fencing during construction may be of a temporary nature and scale that is robust enough to withstand damage during this stage of work. Permanent fencing should be established at the interface of the development area and the retained land to prevent ongoing impacts to these areas during the operational stage of the development.
BIO7	Appropriate controls will be implemented to manage exposed soil surfaces and stockpiles to prevent sediment discharge into waterways.
BIO8	All works within proximity to the drainage lines will have adequate sediment and erosion controls (e.g. sediment barriers, sedimentation ponds). Revegetation will also commence as soon as is practicable to minimise risks of erosion.
BIO9	Suitable species will be used as ground cover species in any revegetation areas.
BIO10	Construction works will predominately be undertaken during daylight hours. Noise impacts will be managed.
BIO11	Construction works will generally be undertaken during daylight hours. Lights associated with operation will be directional to avoid unnecessarily shining light into adjacent retained vegetation where possible.
BIO12	Dust suppression measures will be implemented to limit dust on site. Revegetation will also be commenced as soon as practicable to minimise areas likely to create dust. Suitable species will be used as ground cover species in any revegetation areas.
BIO13	Temporary fencing to be installed when works are within 100 m of any threatened flora. Threatened flora to have a 10m exclusion zone around known locations. Temporary fencing also required to demarcate the exact easement of the transmission line during construction.
BIO14	All machinery will be cleaned prior to entering and exiting the construction site to minimise the transport of weeds to vegetated areas to be retained. Weeds that are present within the Subject land that are listed under the NSW *Biosecurity Act 2015* will be managed in accordance with a weed management plan.

Table 6.10 Biodiversity mitigation measures

ID	Mitigation measures
BIO15	All personnel working on the project will undertake an environmental induction as part of their site familiarisation. This will include: • site environmental procedures (vegetation management, sediment and erosion control, exclusion fencing and noxious weeds) • what to do in case of environmental emergency (e.g. chemical spills, fire, injured fauna) • key contacts in the case of an environmental emergency. All contractors should be inducted into the site to be briefed on sensitive environmental features (including threatened flora, TECs and fauna habitat) and responsibilities in avoiding any impacts to retained vegetation.

6.1.7 Conclusion

The mitigation actions recommended within the BDAR have been developed in parallel with, and have informed the evolution of, the project design. This process has ensured the avoidance and minimisation of biodiversity constraints as far as practicable.

ESCO will compensate for these residual impacts through the implementation of a biodiversity offset strategy.

The BDAR has also considered impacts on MNES. Significant Impact Criteria assessments concluded that two MNES are likely to be significantly impacted due to "reduction in the extent of the community" only:

- White Box – Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland due to the permanent removal of 61 ha of this CEEC
- Central Hunter Valley eucalypt forest and woodland due to the permanent removal of 32 ha of this CEEC.

Similarly, an assessment on the impacts to aquatic habitats have been undertaken in accordance with the NSW *Fisheries Management Act 1994* (FM Act).

6.2 Aboriginal heritage

6.2.1 Introduction

An Aboriginal Cultural Heritage Assessment (ACHA) report has been prepared for the project by EMM (2023a) and is provided in Appendix E.

The ACHA has been prepared in accordance with the following:

- *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH 2011)
- *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010a)
- *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010b).

The relevant SEARs and how they are addressed are summarised in Attachment A and Section 1.1 of the ACHA (Appendix E).

A summary of the Aboriginal consultation, existing environment, impact assessment and mitigation measures are provided in this section.

6.2.2 Consultation

i Stage 1 — notification and registration of Aboriginal parties

The aim of Stage 1 was to identify the Aboriginal parties who wished to be consulted about the project.

Relevant government agencies were contacted and asked to provide a list of Aboriginal parties to contact in relation to the project, including Heritage NSW, Hunter Local Land Services, Muswellbrook Council, NTS Corp, Wanaruah LALC and Office of the Registrar NSW *Aboriginal Land Rights Act 1983*, and National Native Title Service Services Corporation Ltd.

An advertisement was placed in the Muswellbrook Chronicle on 8 July 2022 detailing the project name, proponent, location, description and a request for Aboriginal knowledge holders to register interest in the project.

Eighteen Aboriginal parties subsequently registered their interest in the project (i.e. registered Aboriginal parties (RAPs)), and are listed in Table 6.11.

Table 6.11 List of registered Aboriginal parties for the project

Organisation	Contact
Nunawanna Aboriginal Corporation	Colin Ahoy
Kamilaroi Yankuntjatjara	Paul Khan
Ungooroo Aboriginal Corporation	Alan Paget
Didge Ngunawal Aboriginal Corporation	Paul Carroll
Konanggo Aboriginal Cultural Heritage Services	Robert Young
Paulette Ryan and Luke Hickey	Paulette Ryan
Widescope Indigenous Group	Steven Hickey
DFTV Enterprises Indigenous Corporation	Derrick Vale
Murrabidgee Mullangari Aboriginal Corporation	Darleen Johnson
Tocomwall Pty Ltd	Scott Franks
Men's Shack Indigenous Corp	Rod Hickey
AGA Services	Ashley Sampson
Cacatua Culture Consultants	George Sampson
A1 Indigenous Services	Carolyn Hickey
Upper Hunter Wonnarua Council Inc	Rhoda Perry
Wanaruah LALC	Dee-Anne Douglas
Wurrumay Pty Ltd	Vicky Slater
Wonnarua Nation Aboriginal Corporation	Laurie Perry

ii Stages 2 and 3 – presentation of information and gathering cultural information

EMM issued a letter to all relevant RAPs which included an overview of the project, the proposed assessment methods and the consultation process.

ESCO, Idemitsu and EMM held an on-site consultation meeting with RAPs on 12 September 2022 to discuss the project, the assessment approach and identify any key issues.

A field survey was then undertaken between 24 October and 28 October 2022 and test excavations occurred between 14 November 2022 and 25 November 2022 with EMM archaeologists and representatives of seven of the RAPs.

iii Stage 4 – review of draft Aboriginal cultural heritage assessment

A draft version of the ACHA, which included all background information, results, draft significance assessments and draft management recommendations, was issued to all RAPs for review.

A meeting was held on 14 March 2023 to provide a summary of the results of the ACHA, outline the impact assessment and discuss management measures presented in the draft ACHA report. A summary of the key discussion points and outcomes is presented in Section 2.4 of the ACHA report (Appendix E).

6.2.3 Existing environment

The environmental characteristics of an area influenced the way Aboriginal people used the landscape. Understanding these environmental factors assists with predicting where Aboriginal sites are likely to occur. Additionally, natural and cultural (human-made) site formation processes that occur after the deposition of archaeological material influence the way archaeological material is distributed and preserved across a landscape.

i Landscape

The project area is characterised by low undulating hills to weakly developed sedimentary rock cut river valleys typical of the Central Lowlands.

ii Topography

The project area is situated at relatively low-lying natural elevations (between 160 m and 260 m above the Australian Height Datum (AHD)in the north). The closest elevated terrain is Bells Mountain (2 km north-east; maximum elevation of 690 m AHD) and Skellatar Hill (approximately 1 km west; maximum elevation of 333 m AHD). There is an overall fall in topography in a westerly direction toward the Hunter River, where the elevation on the flood plain adjacent to the river lies at approximately 150 m AHD.

iii Hydrology

Hydrological features are the most likely indicator of archaeological potential within the project area. Access to water, and the natural resources associated with it, would have influenced the distribution of habitation throughout the area.

The southern boundary of the project area is bounded by Muscle Creek, an ephemeral tributary of the Hunter River (Strahler 5th order creek). Both Muscle Creek and Sandy Creek, northwest of the project area, flow west to join the Hunter River. A small unnamed tributary of Muscle Creek runs in the southern portion of the project area (Strahler 4th order). Many ephemeral waterways and drainage lines intersect the landscape, feeding into Muscle Creek and Sandy Creek. Multiple dams have been constructed to capture water runoff including mine water.

iv Geology and soils

The primary geology of the region comprises Quaternary alluvial deposits and the Branxton Formation, which includes: sandstone, siltstone, mudstone, chert, coal and shale.

Soils within the project area consist of six landscapes described in Table 3.2 of Appendix E. These soil landscapes indicate that the soil profile can be fairly deep close to Muscle Creek to the south of the project area. However, most of the soils across the project area are reflective of duplex soils common across NSW and have been subject to varying levels of erosion which may have impacted the ability to retain in situ cultural materials. Coupled with the high degree of past disturbance throughout the project area, the potential for significant buried cultural materials within these soil landscapes is considered limited.

v Land use and disturbance

Most of the original native vegetation, with the exception of small areas generally within riparian corridors, has been cleared from the project footprint as a result of the intensive agricultural activities that have occurred across the valley surrounding the project area since it was initially occupied.

The northern portion of the project area and internal powerline route is dominated by working open cut mining areas, former underground mines, rehabilitated land, disused and grassed over open cuts, and only a small amount of land that has been avoided by major mining activities. The southern section remains in use as open paddocks utilised for grazing livestock with pockets of native vegetation.

vi Ethnography

The project area is on the traditional lands of the Wonnarua people (sometimes called Wanaruah, Wanarruwa and by other variations), who occupied an area of over 3,000 km^2 including the Hunter River and all its tributaries from near Maitland to the apex of the Liverpool Ranges.

Regional studies of the Hunter Valley suggest that Aboriginal people had inhabited the area by ~7,000 years ago. Some excavations of the Warkworth Sands hint at an older occupation, with >14,000 years ago being most probable based on available data.

vii Archaeological context

A search of the AHIMS register identified 515 Aboriginal sites in the region surrounding the project area (between ~5–15 km on each side). At least 21 sites are within 200 m of the project area; the majority of these are poorly defined stone artefact sites, and one culturally modified tree. There were six previously recorded AHIMS sites within the project area.

viii Field survey and test excavation

A field survey of the project area was conducted over a one-week period by EMM archaeologists and RAP representatives.

There were six previously recorded AHIMS sites within the project area:

- #37-2-0139 – Low density artefact – Could not be re-identified due to ground cover.
- #37-2-1841 – Low density artefact scatter – Could not be re-identified, inaccessible and very heavily disturbed.
- #37-2-1845 – Isolated stone artefact – Re-identified.
- #37-2-2030 – Isolated Aboriginal object – Erroneously recorded, not in project area.

- #37-2-2031 – Isolated Aboriginal object – Erroneously recorded, not in project area.
- #37-2-5957 – Low density artefact scatter – Could not be re-identified due to ground cover.

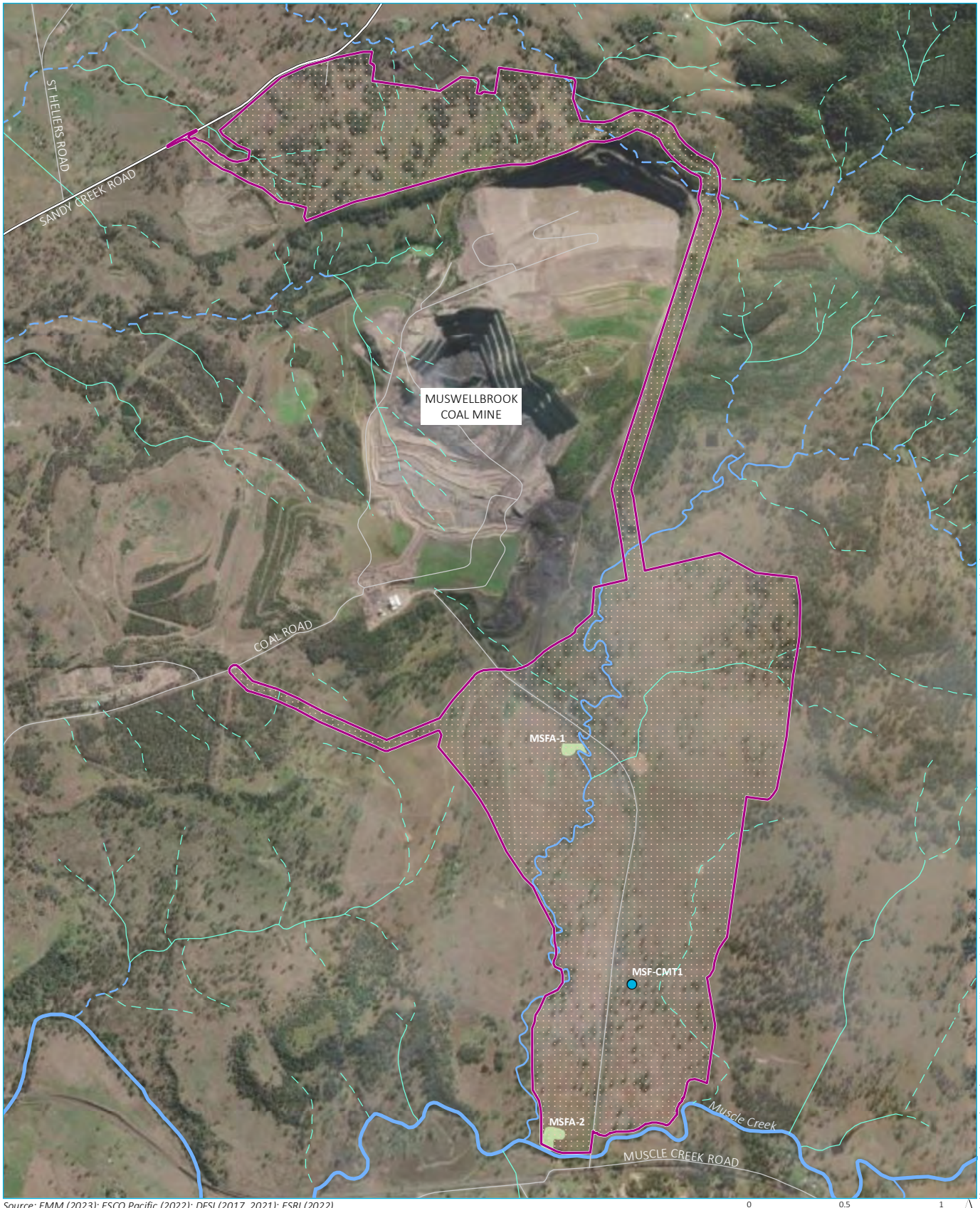
Eleven Aboriginal sites were documented during the field survey, including three artefact scatters, seven isolated stone artefacts and one potential culturally modified tree.

Test excavations were conducted over a two-week period with EMM archaeologists and RAP representatives. A total of 122 test pits were excavated across the project area. Eleven of the test pits contained artefacts with a total of 52 stone artefacts recovered.

Based on the findings of the desktop assessment, survey and test excavations, the project area can be considered to encompass four Aboriginal sites, places and/or objects. These sites, and their cultural significance, is summarised on Table 6.12 and shown on Figure 6.13.

Table 6.12 Significance assessment of Aboriginal objects and/or sites within the project area

Site	Site type	Brief description	Site status	Significance				
				Scientific	Aesthetic	Historical	Cultural	Overall
MSF-BS1 (including isolated finds and artefact scatters identified during survey and AHIMS sites #37-2-0841, #37-2-1845, and elements of #37-2-0139)	Artefact Scatter	A stone artefact background scatter across the entire project area within which artefact densities of <0.2/m^2 may be expected and reflecting ephemeral and/or transient use of the region for at least 5 ka.	Valid	Low	-	-	Low	Low
MSF-FA1	Artefact Scatter	An area of past foci and activity characterised by moderate densities of sub-surface artefacts ranging from 17–>21/m^2, and which reflect long term and/or repeat visitation and occupation by people over at least the last 5 ka.	Valid	Moderate	Low	-	Moderate	Moderate
MSF-FA2	Artefact Scatter	An area of past foci and activity characterised by moderate densities of sub-surface artefacts ranging from 17–>21/m^2, and which reflect long term and/or repeat visitation and occupation by people over at least the last 5 ka.	Valid	Moderate	Low	-	Moderate	Moderate
MSF-CMT1	Culturally Modified Tree	A potential modified tree on a flat plain surrounded by thick grasses and brush.	Tentative	-	Low	-	Mod	Mod



Source: EMM (2023); ESCO Pacific (2022); DFSI (2017, 2021); ESRI (2022)

0 0.5 1 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_AC\AC012_ArchaeologicalResources_20230705_04.mxd 5/07/2023

KEY

- Project area
- Background scatter
- Area of past foci
- Surveyed Aboriginal site

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order

Existing environment

- Major road
- Minor road

Archaeological resources

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.13

EMM
creating opportunities

6.2.4 Potential impacts

Impacts to Aboriginal sites and objects are summarised in Table 6.13. Overall, the project would potentially result in the loss of one identified Aboriginal site and/or place (MSF-CMT1), and the partial loss of ~0.92 ha of denser cultural material (MSF-FA1 and MSF-FA2), With these exceptions, the remainder of the works would be in areas that are likely to contain a very low density of stone objects – sites that are common across the Hunter Valley and across much of the eastern coastline. Based on this, some adverse impacts to the local cultural record would result from the project and contribute to the cumulative loss of the archaeological record of the region.

Table 6.13 Potential impacts to Aboriginal sites and objects

Site name	Type of harm (direct, indirect, none)	Location and/or activity causing harm	Degree of harm (total, partial, none)	Consequence of harm (total, partial, none)
MSF-BS1	Direct	Within solar panel footprint, laydown area, shared access road, facility area and buffer	Partial	Partial loss of value
MSF-FA1	Direct	Within solar panel footprint	Partial	Partial loss of value
MSF-FA2	Direct	Within solar panel footprint	Partial	Partial loss of value
MSF-CMT1	Direct	Within solar panel footprint	Total	Total loss of value

6.2.5 Mitigation measures

Table 6.14 summarises the mitigation measures and recommendations applicable to Aboriginal heritage.

Table 6.14 Aboriginal heritage mitigation measures

ID	Mitigation measures
AH1	Prior to commencement of ground disturbance, an Aboriginal Cultural Heritage Management Plan (ACHMP) will be developed in consultation with DPE, the RAPs and Heritage NSW.
AH2	A heritage interpretation strategy is to be prepared in conjunction with other interpretive requirements for the broader Muswellbrook Clean Industries Precinct. The heritage interpretation strategy is to be prepared by a heritage specialist and made available for consultation and feedback with the Aboriginal participants with demonstrated Wonnarua ancestry and/or connection.
AH3	Archival recording of all identified Aboriginal objects, sites and places; and archaeological excavation and mitigation of areas of significant buried cultural material (MSF-FA1 and MSF-FA2) prior to the commencement of construction. The methodology for the recording and salvage will be finalised as part of the ACHMP.
AH4	If not previously completed and where necessary, provide descriptions and methods for undertaking further investigation and assessment of MSF-CMT1 – currently assigned a tentative classification – to gain a comprehensive understanding of this site for subsequent management through construction of the project.

6.2.6 Conclusion

Four Aboriginal sites and/or objects are within the project area. This includes a potential cultural modified tree, two areas of past foci (moderate density stone artefact sites), and a general low density background scatter of artefacts across the entire project area. These four sites have incorporated, ratified and/or combined a number of earlier site recordings within the project area. Of these sites, all would be potentially directly affected by the project.

Recommendations include the development of an ACHMP to provide a framework for post approval activities, as well as direction on its content; and the development of an Interpretation Strategy and Plan to provide acknowledgement and other visual/educational opportunities for the Aboriginal and broader local community.

6.3 Landscape and visual

6.3.1 Introduction

A landscape and visual impact assessment (LVIA) has been prepared for the project by EMM (2023b) and is provided in Appendix F. The LVIA has been prepared in accordance with the relevant SEARs, guidelines and policies, and in consultation with the relevant government agencies.

This LVIA was prepared with reference to the methods outlined in:

- *Large-Scale Solar Energy Guideline* (DPE 2022a) (Solar Guideline)
- *Technical Supplement – Landscape and Visual Impact Assessment* (DPE 2022b).

The Solar Guideline outlines a visual assessment framework for large scale solar energy development that identifies impacts on landscape character and values, the amenity of landholders and communities, along with the adequacy of the measures that are proposed to mitigate these impacts, as key assessment issues.

This LVIA also references techniques and methods outlined in the following publications:

- *Guidelines for Landscape and Visual Impact Assessment Third Edition* (Landscape Institute & Institute of Environmental Management and Assessment 2013) (the GLVIA)
- *Wind Energy: Visual Assessment Bulletin AB 01 For State Significant Wind Energy Development* (DPE 2016b) (the VA Bulletin)
- *The Dark Sky Planning Guideline* (DPE 2016c).

The VA Bulletin specifically relates to assessment of visual impacts of wind farms in NSW; however, a number of the methods for describing visual sensitivity and landscape character are considered to be relevant to this assessment. These elements from the VA Bulletin have been adapted and included in this assessment.

The project is approximately 200 km south-east of Siding Spring Observatory. Therefore, *The Dark Sky Planning Guideline* is applicable to this LVIA.

The assessment method used in the LVIA consists of three main elements:

1. Preliminary visual impact assessment which identifies locations with potential for visual impacts and determines which viewpoints need further assessment.
2. Landscape character assessment which details the current condition of the landscape and its capacity to absorb change.
3. Visual impact assessment which provides a detailed assessment of the impact of the project on the visual amenity of the area.

6.3.2 Existing environment

i Local context

The project is sited adjacent to the Muswellbrook Coal Mine on land primarily owned by Idemitsu, the mine operator. Muswellbrook is situated along the New England Highway between Singleton and Aberdeen. Land surrounding the project area contains infrastructure and landforms associated with the Muswellbrook Coal Mine. Muswellbrook township is approximately 2.5 km west of the project area and contains residential and industrial land uses. The surrounding area also contains rural residences and properties used for grazing and environmental conservation.

Land immediately adjoining the project area is predominantly zoned RU1 Primary Production and C3 Environmental Management which currently host predominantly agricultural land uses such as cattle grazing.

There is also a small area in the east of the site zoned SP2 Infrastructure associated with the Muswellbrook Bypass road project. Beyond that there is land zoned R1 General Residential to the south the project area near Muscle Creek Road and further west in Muswellbrook township. There are several high voltage electricity transmission lines within and near the project area. Two existing substations are located around 1 km north and 1 km east of the project respectively.

Key land uses in the broader region include residential, industrial activities, coal mining, electricity generation and transmission as well as agriculture including livestock grazing, equine activities and viticulture. The region hosts a number of major developments including several operational coal mines, the former Liddell Power Station and the operational Bayswater Power Station. Renewable energy is a growing land use in the region with several projects in planning including the Bowmans Creek Windfarm, the Muswellbrook Battery Energy Storage project and the Maxwell and Hunter River Solar Farms.

ii Landscape character

The landscape character assessment details the current condition of the landscape and assesses its capacity to absorb change. The landscape surrounding the project area has been categorised into four landscape character zones (LCZ). These are based on the dominant landform and landscape features that create distinct character areas. The landscape character assessment is summarised in Table 6.15.

Table 6.15 Landscape character assessment

Landscape character zone	Sensitivity	Magnitude	Landscape character impact
Agricultural plains	**Low** • The landscape is highly modified with clearing of native vegetation and presence of cropping, agricultural structures, dwellings, roadways and railway. • The landscape elements that contribute to its quality will remain the same. • The project is not predicted to impact any key landscape features.	**Low** • Views of the project are likely to be limited by the topography surrounding the project. • The project will not occupy any portion of this LCZ. • The project elements may be visible from some locations within this LCZ, however, the viewing distance and visual change is considered minor in relation to this LCZ.	**Low**

Table 6.15 Landscape character assessment

Landscape character zone	Sensitivity	Magnitude	Landscape character impact
Ridges	**Moderate** • The ridges are vegetated and have low capacity to absorb change. • The landscape elements that contribute to its quality will remain the same. • The project is not predicted to impact any key landscape features.	**Low** • Views of the project are likely to be limited by the topography surrounding the project. • The northern project area will occupy a small portion of this LCZ. • The project elements may be visible from some locations within this LCZ, however, access to these areas is restricted.	**Moderate – Low**
Vegetated valley	**Moderate** • A substantial portion of the land within the project area has been cleared for grazing and other uses. There are still a significant number of trees along the valleys. As such it is considered to have some capacity to absorb change.	**Moderate** • The southern project area is located within this LCZ and will replace existing vegetation within the project area. • Views of the project from within this LCZ are limited due to the absence of dwellings near the project area and the presence of trees around the project area. • When viewed from outside the LCZ, the solar infrastructure may be visible from the Woodland Ridge community and ridges immediately adjacent to the project. • When viewed from a distance, the project is not expected to be visible.	**Moderate**
Urban slopes	**Low** • The landscape is highly modified from its natural state. • Human modification of the landscape defines this LCZ with dwellings, commercial buildings, roadways and supporting infrastructure. The LCZ has a high capacity to absorb change. • The landscape elements that contribute to its quality will remain the same. • The project is not predicted to impact any key landscape features.	**Low** • When viewed from within the LCZ, views toward the project are expected to occupy a small proportion of the horizontal and vertical fields of view. These will be limited and screened by buildings and trees. • The project infrastructure is not expected to be visible from this LCZ, with the exception of some views from the Woodland Ridge development.	**Low**

6.3.3 Potential impacts

i Construction impacts

Site establishment and construction activities associated with the project are considered temporary and the visual impacts from these activities include:

- Traffic and vehicle movements:
  - Vehicle movements will be a daily occurrence during the construction stage of the project. Most traffic into the project area is expected to be from the south along Muscle Creek Road and from the north along Sandy Creek Road.
- Temporary laydown area:
  - Laydown areas will be necessary for the construction of the project. These are located centrally in the south project area and near the Sandy Creek entrance in the north project area. The visual impacts of these areas is expected to be negligible due to the location along the valley and away from any roadways and residences.
- Installation of solar panels and BESS:
  - The installation of the solar panels and supporting infrastructure is expected to be completed within 18 months.
  - The installation of the BESS and supporting infrastructure is expected to be completed within 13 months.
- Installation of transmission poles and overhead wires:
  - The proposed 33 kV transmission line is located centrally to the project footprint and will connect the north and south solar arrays along existing transmission corridors. The addition of poles and cabling will therefore cause minimal visual impacts.
  - A 132 kV transmission line is proposed to connect to the electrical grid west of the project site. The transmission lines will use poles to support the cables. The location of this connection is central to the project and therefore it will have minimal visual impact to surrounding residences.

Motorists travelling along the local road network may experience views of the construction activity. The activity visible from public roads will be vehicles entering the access roads and the installation of the solar arrays. It is assumed the focus of these motorists will be in line with their direction of travel along the road corridors, minimising their views into the project footprint.

As the project site establishment works and construction activities are considered temporary, landscaping is not proposed to mitigate visual impacts during the construction stage of the project.

During the construction period, construction activity is expected to be limited to normal construction hours. There is therefore no lighting anticipated for construction. During the construction period (approximately 31 months) there may be some night lighting used for security at the laydown and construction yards. This lighting is expected to be confined to a small area and because of the undulating topography and existing vegetation, impacts from construction lighting are expected to be negligible.

ii Operation impacts

a Visual assessment

The operation impacts are visual impacts that extend from the construction phases through the life of the project. To assess these impacts, specific viewpoints are used to represent what people can see from that location and its immediate surrounds.

The preliminary visual impact assessment selected 17 viewpoints for assessment, of which nine were assessed as requiring detailed assessment. Nine representative viewpoints were selected from locations near residences and main roadways near the project. The viewpoints include assessments for selected residences that have potential for visual impacts. The viewpoints were selected in part from ongoing discussions with residents. Other viewpoints were selected to represent views from public roads.

Photographs from these representative viewpoints were captured and used as part of the viewpoint analysis. The photographs are used to represent and examine the human experience of the visual changes that may occur from the project.

Table 6.16 lists the viewpoints that are considered as part of this assessment and provides the rationale for selecting each photograph location. The locations of the viewpoints illustrated on Figure 6.14.

Table 6.16 Assessed viewpoints, receptors and rational for selection

Assessment location	Preliminary viewpoint reference	Viewpoint type(s)	Representative receptors	Distance to development (m)*	Rationale for selection
VP-1	PVP-1	Residential Transport/ infrastructure	R172, R65, R171 Motorists	720	This represents the typical view from Sandy Creek Road approaching the project from the west.
VP-2	PVP-2	Residential Transport/ infrastructure	R1, R2, R3, R4, R5, R31, R32, R39 Motorists	795	This viewpoint represents views from the residences along Sandy Creek Road and the eastern portion of St Heliers Correctional Centre. Motorists travelling westward on the road will also have this view.
VP-3	PVP-3	Residential	R40, R41	640	Residence is located on a hill overlooking the northern solar array and will need assessment individually.
VP-4	PVP-4	Residential Institutional	R37, R35, R36, R33, R34, R62, R63	1,1330	The viewpoint is at the St Heliers Correctional Centre administration. It is located on a hilltop with views into the northern solar array.
VP-5	PVP5	Residential Transport/ infrastructure	R71, R70, R69, R74, R75 Motorists Rail	2,485	This view is from the New England Highway, adjacent to the rail line. Travellers heading south will have this view.
VP-6	PVP-10	Residential Transport/ infrastructure	R7, R8, R9, R21, R22, Motorists	180	This viewpoint is on an elevated position looking north over the rail line. Three residences share this view.

Table 6.16 Assessed viewpoints, receptors and rational for selection

Assessment location	Preliminary viewpoint reference	Viewpoint type(s)	Representative receptors	Distance to development (m)*	Rationale for selection
VP-7	PVP-11	Residential Transport/ infrastructure	R10, R11, R12, R13, R14, R15, R16, R17, R18, R96, R97, R98, R99, R280, R284 Motorists	495	This is located at the intersection of Woodland Ridge Road and Babbler Crescent. There are also five residences nearby with similar views.
VP-8	PVP-12	Residential Transport/ infrastructure	R128, R129, R136, R137, R130, R133, R131, R132, R135, R134	1,030	This view is from a residence in a slightly elevated position. The surrounding residences will also have similar views.
VP-9	PVP-13	Residential Transport/ infrastructure	R147, R148, R149, R151 Motorists	1,310	This viewpoint is at the intersection of the New England Highway and Muscle Creek Road. Motorist turning onto Muscle Creek Road will have this view. There are residences south of the viewpoint who will have similar views.

Note * The distances shown in the table are taken from the nearest project elements.

A summary of the viewpoint analysis is provided in Table 6.17. A panoramic image of the existing view and a photomontage of the project were prepared for each viewpoint (see Appendix F).

The visual assessment determined that, of the viewpoints assessed, infrastructure may be visible to varying degrees from eight of the nine viewpoints. Based on variable elevation and undulation in the landscape, the presence of vegetation, and the size of the power generation infrastructure, the impact assessment predicts:

- a very low visual impact from Viewpoints 1,2, 5 and 9
- a low visual impact from Viewpoints 3, 4, 6, 7 and 8
- there were no viewpoint locations with a moderate or high impact rating.

In addition to the viewpoint assessments, each resident within 4 km of the project area is listed with the potential visual impacts. The assessment for residences predicts:

- no impact to low visual impact for all residences
- no residences with a moderate or high impact rating.

Table 6.17 Summary of results of visual impacts at each viewpoint

Viewpoint	Distance to project boundary (m)	Representative receptors	Residential or public	Project infrastructure visible based on ZVI/ photo-montage	Magnitude of change	Visual sensitivity	Visual impact rating	Significant impact	Mitigation proposed	Visual impact rating after mitigation	Potential for cumulative impacts
VP-1	720	R172, R65, R171 Motorists	Public/ residential	No	Nil	Low	**Nil to very low**	No	None	**Nil to very low**	None anticipated
VP-2	795	R1, R2, R3, R4, R5, R31, R32, R39 Motorists	Public/ residential	Yes	Very low	Low	**Very low**	No	None	**Very low**	Potential impacts from Bells Mountain Pumped Hydro
VP-3	640	R40, R41	Residential	Yes	Low	Moderate	**Low**	No	None	**Low**	Potential impacts from Bells Mountain Pumped Hydro
VP-4	1,330	R37, R35, R36, R33, R34, R62, R63	Residential	Yes	Low	Low	**Low**	No	None	**Low**	None anticipated
VP-5	2,485	R71, R70, R69, R74, R75 Motorists Rail	Public/ residential	Yes	Very low	Low	**Very low**	No	None	**Very low**	None anticipated
VP-6	180	R7, R8, R9, R21, R22, Motorists	Public/ residential	Yes	Moderate	Low	**Low**	No	None	**Low**	Potential impacts from Muswellbrook Bypass
VP-7	495	R10, R11, R12, R13, R14, R15, R16, R17, R18, R96, R97, R98, R99, R280, R284 Motorists	Public/ residential	Yes	Very low	Low	**Low**	No	None	**Low**	Potential impacts from Muswellbrook Bypass

Table 6.17 Summary of results of visual impacts at each viewpoint

Viewpoint	Distance to project boundary (m)	Representative receptors	Residential or public	Project infrastructure visible based on ZVI/ photo-montage	Magnitude of change	Visual sensitivity	Visual impact rating	Significant impact	Mitigation proposed	Visual impact rating after mitigation	Potential for cumulative impacts
VP-8	1,030	R128, R129, R136, R137, R130, R133, R131, R132, R135, R134	Residential	Yes	Low	Low	**Low**	No	None	**Low**	Potential impacts from Muswellbrook Bypass
VP-9	1,310	R147, R148, R149, R151 Motorists	Public/ residential	Yes	Very low	Low	**Very low**	No	None	**Very low**	Potential impacts from Muswellbrook Bypass

b Night time lighting assessment

Lights have the potential to alter the night time landscape character of the region. Potential sources of light sources include:

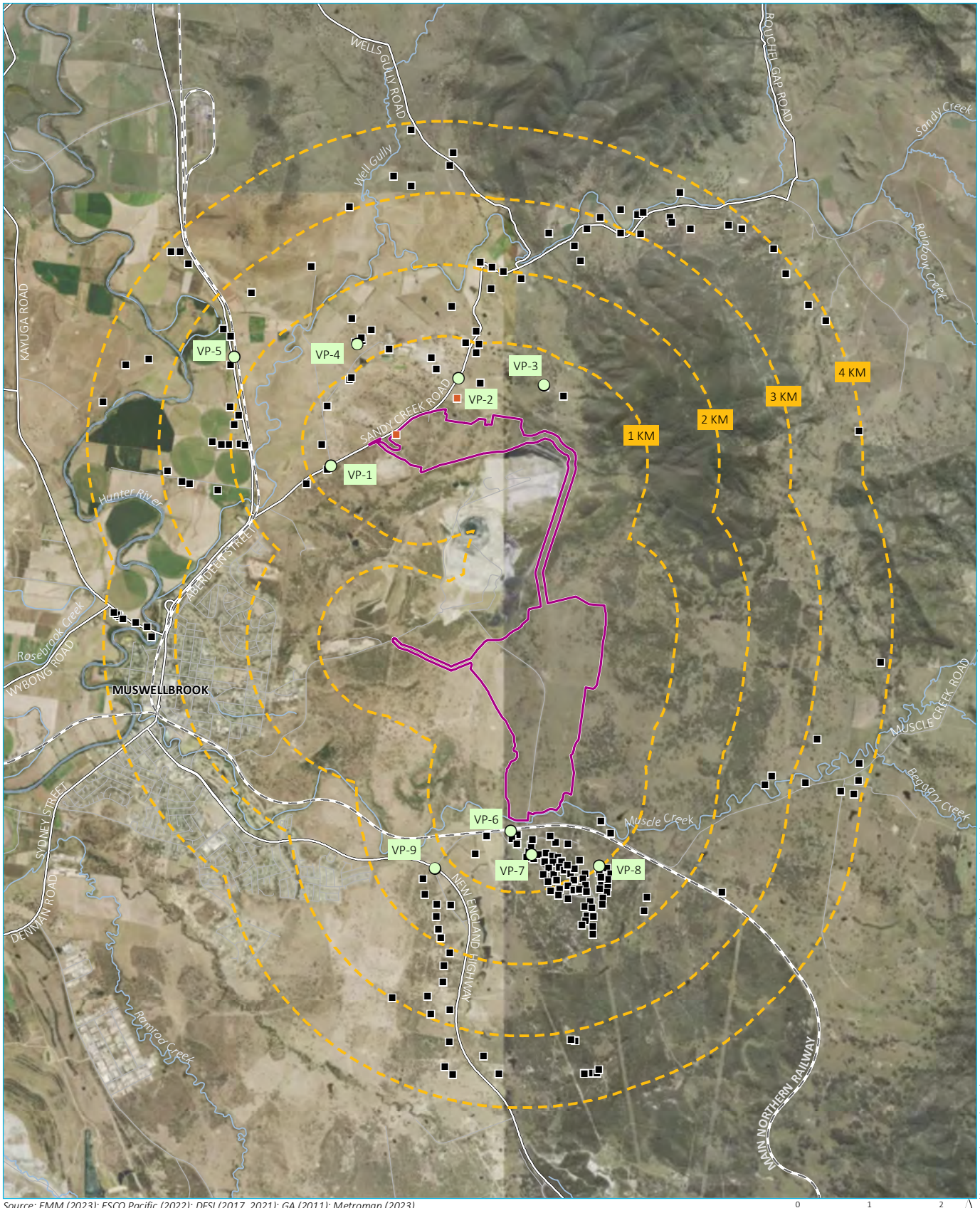
- lighting for safety and security on project infrastructure
- lighting for safety and security on ancillary structures.

Visual impacts from night lighting would likely be experienced by people who are outside in the landscape. The impact of night lighting is unlikely to be experienced from inside dwellings since internal lights reflect off windows and limit views of the exterior at night. The highest impact is expected to be on people who enjoy the outdoors at night, specifically night-sky enthusiasts, photographers and star gazers.

The project infrastructure that may need lighting at night includes the switchyard area and BESS location. The project infrastructure has been sited to minimise visibility from existing residences and public viewpoints. It is unlikely that the proposed lighting will create a noticeable impact on the existing night time lighting.

In addition to project infrastructure, night lighting may be required on ancillary buildings, compounds, and roadways. These include permanent O&M buildings, temporary construction compounds and permanent compounds.

At this stage of the project, the location and type of lighting required on these ancillary elements is yet to be confirmed. It is assumed that low-level lighting for security, maintenance, and emergency purposes.



Source: EMM (2023); ESCO Pacific (2022); DFSI (2017, 2021); GA (2011); Metromap (2023)

0 1 2 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_VIA\VIA009_Viewpoints_20230705_02.mxd 5/07/2023

KEY

- Project area
- Viewpoint location
- Associated dwellings
- Dwellings not associated with the project within 5 km
- Rail line
- Major road
- Minor road
- Named watercourse
- Named waterbody
- Project buffer

Viewpoint locations and receptors

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.14

EMM
creating opportunities

c Glint and glare assessment

A glint and glare analysis using specialised software (ForgeSolar) was performed to measure the possibility of glare from the solar arrays and the project infrastructure.

The software calculates the minutes of potential glare predicted at each location every day through the course of a year. The results indicate the number of minutes predicted at each location along with the type of glare expected. The classifications of glare from the software are:

- Green glare – glare is present with only a low potential for temporary after-image or flash blindness.
- Yellow glare – glare has a moderate potential for temporary after-image or flash blindness.
- Red glare – glare with high potential for permanent eye damage.

The glare analysis produced by the software does not account for physical obstructions between the solar arrays and the residences and motorists. This includes the presence of buildings, trees and other structures. It also assumes the weather is sunny each day for the duration of daylight hours. Therefore, a worst-case scenario is calculated.

Glare impacts were assessed from surrounding residence locations and along New England Highway, the railway, Muscle Creek Road and Sandy Creek Road.

A separate glare assessment for the BESS and operations structures has not been done. It is assumed that since the BESS is centrally located within the southern solar array and the solar panels reach a height of 4 m, any glint and glare from the BESS components would be shielded or represented by the glint and glare from the solar panels.

Based on the glare analysis, there is potential for glint and glare related impacts at 16 residences and along the roads and rails adjacent to the project. Table 6.18 summarises the locations and times that glare is expected at each location. This includes the time of year, time of day, and the maximum duration of each occurrence predicted at each location. It is important to note that the times indicated in the table are a 'worst-case scenario' providing a time period within which the glare might occur. It also does not account for any trees or built structures that may obstruct the glare.

Table 6.18 Glare analysis results

Location	Location name assigned by software	Glare from solar arrays			Glare timing (colour of cells indicates type of glare)		
		Green glare (minutes per year)	Yellow glare (minutes per year)	Red glare (minutes per year)	Time of year	Time of day	Max duration of glare per occurrence (minutes)
R21	OP 1	0	0	0			
R8	OP 2	0	0	0			
R7	OP 3	0	0	0			
R9	OP 4	0	0	0			
R97	OP 5	0	0	0			
R96	OP 6	0	0	0			
R10	OP 7	0	0	0			

Table 6.18 Glare analysis results

Location	Location name assigned by software	Glare from solar arrays			Glare timing (colour of cells indicates type of glare)		
		Green glare (minutes per year)	Yellow glare (minutes per year)	Red glare (minutes per year)	Time of year	Time of day	Max duration of glare per occurrence (minutes)
R99	OP 8	574	0	0	Mid-May to mid-July	4:30 pm – 5:00 pm	15
R98	OP 9	185	0	0	June	4:30 pm – 5:00 pm	10
R282	OP 10	958	0	0	May to mid-August	4:30 pm – 5:30 pm	12
R2	OP 11	77	0	0	December to January	6:00 pm – 7:00 pm	5
R1	OP 12	256	0	0	November to January	5:00 am – 5:30 am	5
						6:00 pm – 7:00 pm	5
R22	OP 13	414	0	0	Mid-May to mid-July	6:30 am – 7:30 am	10
R14	OP 14	0	0	0			
R17	OP 15	0	0	0			
R285	OP 16	797	0	0	May to July	4:30 pm – 5:30 pm	15
R111	OP 17	0	0	0			
R128	OP 18	353	0	0	June to mid-July	4:30 pm – 5:00 pm	15
R129	OP 19	551	0	0	Mid-May to mid-July	4:30 pm – 5:30 pm	12
R136	OP 20	0	0	0			
R19	OP 21	770	0	0	Mid-April to August	4:00 pm – 5:30 pm	10
R20	OP 22	1811	0	0	Mid-April to August	4:00 pm – 5:30 pm	10
R32	OP 23	0	0	0			
R35	OP 24	311	0	0	Mid-November to January	5:00 am – 5:30 am	8
R40	OP 25	3091	0	0	Mid-October to February	5:30 pm – 7:00 pm	25
R41	OP 26	6366	69	0	October to mid-March	5:30 pm – 7:00 pm	22
					December	6:00 pm – 6:30 pm	5
R3	OP 27	0	0	0			
R5	OP 28	0	0	0			
R65	OP 29	0	0	0			
R64	OP 30	334	0	0	Mid-October to mid-February	5:00 am – 6:00 am	5

Table 6.18 Glare analysis results

Location	Location name assigned by software	Glare from solar arrays			Glare timing (colour of cells indicates type of glare)		
		Green glare (minutes per year)	Yellow glare (minutes per year)	Red glare (minutes per year)	Time of year	Time of day	Max duration of glare per occurrence (minutes)
R62	OP 31	768	0	0	Mid-October to mid-February	5:00 am – 6:00 am	8
Lonhro Place	OP 32	0	0	0			
Henry Dangar Drive	OP 33	2931	0	0	Mid-April to mid-August	6:00 am – 8:00 am	20
R147	OP 34	1614	0	0	Mid-May to July	6:00 am – 8:00 am	18
R151	OP 35	0	0	0			
R149	OP 36	0	0	0			
R152	OP 37	0	0	0			
New England Highway north of Muswellbrook	ROUTE: New England Highway – North	952	0	0	November – January	5:00 am – 6:00 am	10
New England Highway south of Muswellbrook	ROUTE: New England Highway – South	3970	53	0	April to mid-September	6:00 am – 8:00 am	20
					June – mid July	7:00 am	5
Railway north of Muswellbrook	ROUTE: Railway-North	1024	0	0	November to mid-February	5:00 am – 6:00 am	10
Railway south of Muswellbrook	ROUTE: Railway-South	5376	2317	0	Mid-April to August	6:00 am – 7:30 am	22
					Mid-April to August	4:00 pm – 5:30 pm	30
					May to mid-August	6:30 am – 7:30 am	30
					June to mid-August	4:00 pm – 5:30 pm	30
Sandy Creek Road	ROUTE: Sandy Creek Road	641	0	0	Mid-October to mid-February	5:00 am – 6:00 am	5
					Mid-November to mid-January	6:00 pm – 7:00 pm	5
Muscle Creek Road	ROUTE: Muscle Creek Road	5036	1186	0	Mid-April to mid-August	6:30 am – 8:00 am	25
					Mid-April to August	4:00 pm – 5:30 pm	25
					Mid-May to mid-July	7:00 am – 8:00 am	20
					June to mid-July	4:30 pm – 5:30 pm	20

Note: Duration of "glare from solar arrays" may include duplicate times of glare from multiple solar array areas.

The glare analysis indicated the worst impacted locations are along Muscle Creek Road and the railway adjacent to the southern boundary of the project.

- Motorists along Muscle Creek Road are predicted to experience green glare from mid-May through August. It is likely to occur in the morning between 6:30 am and 8:00 am and in the evening between 4:00 am and 5:30 pm. The longest duration of green glare is predicted to last 25 minutes along portions of the road. Yellow glare is predicted along the road from Mid-May through Mid-July. It is likely to occur in the morning between 7:00 and 8:00 am and in the evening between 4:30 am and 5:30 pm. The maximum duration predicted is 20 minutes of yellow glare.
    - The glare along Muscle Creek Road is mitigated by the trees that exist between the proposed solar arrays and the road. There are trees along Muscle Creek and along the roadway that forms a significant screen.
- Travellers along the railway south of the project are expected to experience green and yellow glare. Green glare is expected from mid-April through August. It is likely to occur in the morning between 6:00 am and 7:30 am and in the evening between 4:00 am and 5:30 pm. The longest duration of green glare is predicted to last 22 minutes in the morning and 30 minutes in the evening. Yellow glare is predicted along the rail from May through Mid-August. It is likely to occur in the morning between 6:30 am and 7:30 am and in the evening between 4:00 am and 5:30 pm. The maximum duration predicted is 30 minutes of yellow glare.
    - The glare along the rail is mitigated by the trees that exist between the proposed solar arrays and the railway. There are trees along Muscle Creek, along the roadway, and between the railway and roadway. These form a significant screen for the glare.
- Other instances of yellow glare include:
    - New England Highway, south of the site. Expected duration is 5 minutes per occurrence.
    - R41. Expected duration is 5 minutes per occurrence.

Based on the glint and glare analysis, the glare resulting from the project is predicted to be within acceptable limits, and no mitigation is required.

6.3.4 Mitigation measures

Table 6.19 outlines the mitigation measures to be implemented in relation to the potential landscape and visual impacts from the project.

Table 6.19 Landscape and visual mitigation measures

ID	Mitigation measure
VIS1	Design standards like AS 4282 Control of obtrusive effects of outdoor lighting, National Light Pollution Guidelines for Wildlife (2020), and the Dark Sky Planning Guideline (2016) will be applied during the design of project elements.

6.3.5 Conclusion

The visual assessment determined that, of the viewpoints assessed, infrastructure may be visible to varying degrees from eight of the nine viewpoints. Based on variable elevation and undulation in the landscape, the presence of vegetation, and the size of the power generation infrastructure, the impact assessment predicts:

- a very low visual impact from Viewpoints 1,2, 5 and 9
- a low visual impact from Viewpoints 3, 4, 6, 7 and 8
- there were no viewpoint locations with a moderate impact rating
- there were no viewpoint locations with a high impact rating.

Not mitigation is required for these low impacts.

A glint and glare analysis was performed to measure the possibility of glare from the solar arrays and the project infrastructure. The results indicate the potential for green and yellow glare along the road and rail, however there is low potential for glare because of the screening provided by existing trees.

Night lighting is not expected to impact receptors as all night lighting would be inwardly focused and shielded so it does not result in light spill impacts to neighbouring properties or the Dark Sky Planning Guideline.

6.4 Social

6.4.1 Introduction

A social impact assessment (SIA) has been prepared for the project by EMM (2023c) and is provided in Appendix G. The SIA has been prepared in accordance with Social Impact Assessment Guideline (DPE 2023a). The relevant SEARs and how they are addressed are summarised in Appendix A and Section 1.3 of the SIA (Appendix G).

6.4.2 Existing environment

The project area is within the Muswellbrook LGA, in the traditional country of the Wonnarua people. It is located adjacent to the Muswellbrook Coal Mine, approximately 2.5 km east of Muswellbrook township. While the development footprint is localised, direct and indirect impacts may be farther reaching. As such, the project impacts and opportunities have been considered at various spatial scales (or areas of social influence): the local area and nearby townships, and the regional area.

The local area and nearby townships consist of the communities that are likely to experience direct social impacts from the project (i.e. impacts related to local social infrastructure and services, road infrastructure, amenity, workforce, local business and industry, local housing and accommodation, and community health and wellbeing).

The regional study area includes the geographic areas likely to experience fewer direct and more indirect social impacts of the project. Indirect impacts are associated with use of infrastructure, supply chains, roads, transportation of goods, materials and equipment, the movement of workers (some of which may operate on a drive-in-drive-out (DIDO) basis and cumulative impacts arising from other projects in the area.

The communities have been mapped to the Australian Bureau of Statistics (ABS) statistical geographic areas (Table 6.20) and the local area, nearby townships and regional area are illustrated in Figure 6.15.

Table 6.20 Area of social influence

SIA study area	Geographic area	ABS data category	Referred to in report as:
Local study area	Muscle Creek	Muscle Creek SAL	Local area
	Muswellbrook	Muswellbrook SA2	
Nearby townships	Singleton	Singleton SA2	Nearby townships
	Denman	Denman SAL	
	Aberdeen	Aberdeen SAL	
	Scone	Scone SA2	
Regional study area	Muswellbrook	Muswellbrook LGA	Regional area
	Singleton	Singleton LGA	
Area of reference	Hunter Valley	Hunter Valley excluding Newcastle SA4	Area of reference
State of New South Wales	State of New South Wales	New South Wales STE	NSW

Muswellbrook's community of over 12,000 residents are nostalgic for the past but are pragmatic, welcome newcomers and enjoy outdoor recreational activities. Muswellbrook offers a modest range of educational, medical, sporting facilities and community services such as St Heliers Correction Centre. Coal mining remains a key contributor to Muswellbrook's' economy while agricultural production, horse breeding and tourism offer some diversification. Muswellbrook is experiencing a period of change with the imminent closure of NSW's largest coal-fired power stations and the early closure of several coal mines in the region.

Economic drivers and opportunities in Muswellbrook LGA include:

- mining support industries
- agriculture and horse breeding
- tourism
- renewable energy.

Other key townships are Denman (25 km south-west of the project area), Aberdeen (7.5 km north of the project area) and Scone (20 km north of the project area). Singleton is a larger rural agricultural centre offering a range of infrastructure and services approximately 40 km south-east of the project area.

Chapter 4 of the SIA provides a full summary of the existing social conditions in the area of social influence for the project with reference to the specific and relevant social indicators that align to the following key themes:

- population and demography
- vulnerabilities and vulnerable groups
- labour market and income
- local business and industry
- educational attainment and qualifications

- housing and short term accommodation
- community health and wellbeing
- social infrastructure and services.

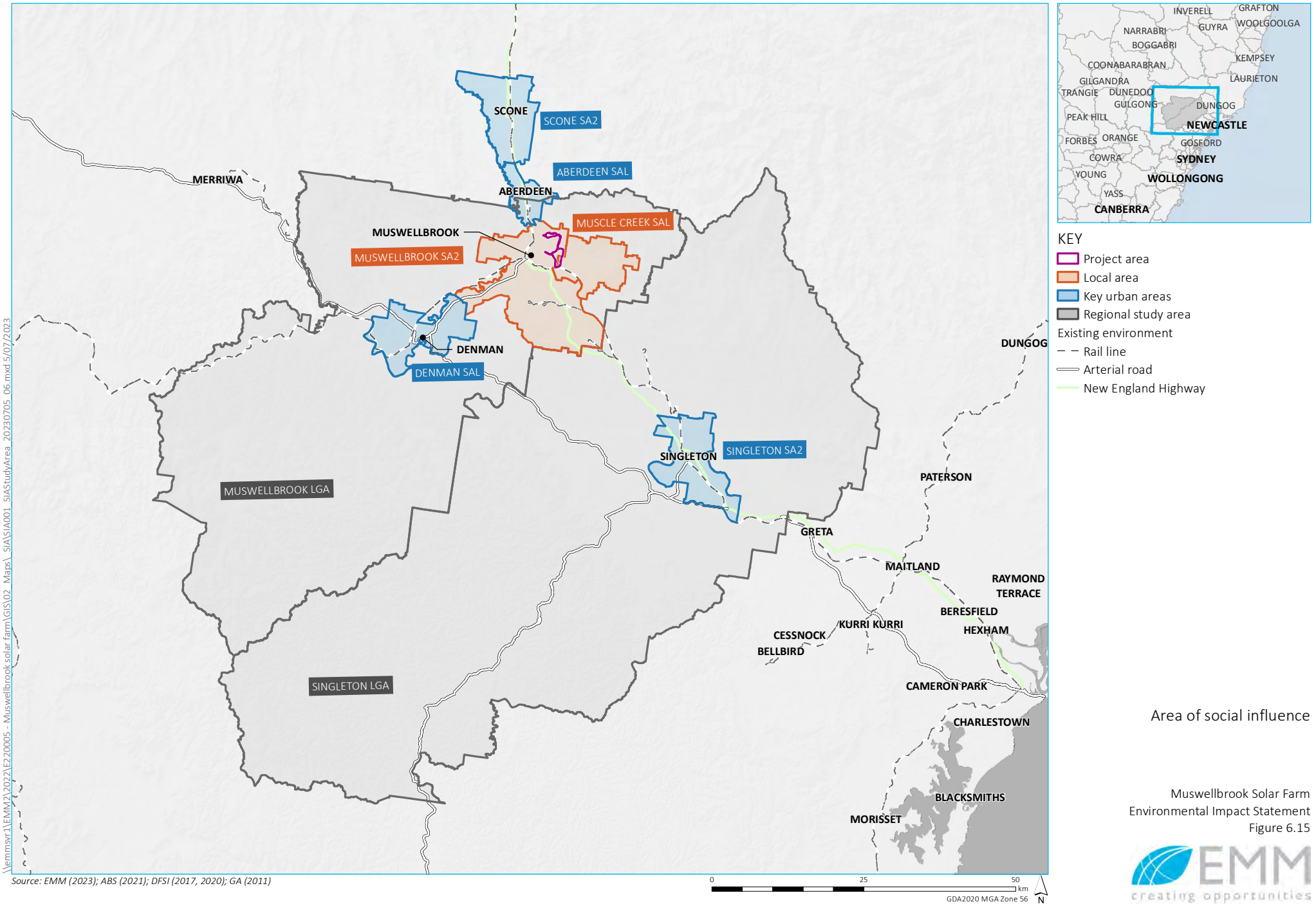
6.4.3 Potential impacts and benefits

Assessment of social impacts considers a range of factors and potentially competing interests. The impact assessment is reflective of this and has:

- assessed some aspects of the project as both negative and positive as they relate to different groups of people
- included potential impacts and benefits on local communities and the broader region
- considered potential impacts on vulnerable sectors of affected communities
- considered community access to services such as housing and health care.

Social impacts have been assessed on a worst-case scenario initially and then the residual impact is assessed on the basis that proposed mitigation or enhancement measures are effectively implemented. The assessment uses the terms unmitigated and mitigated when referring to negative impacts and un-enhanced or enhanced when referring to positive impacts (benefits).

The social impact identification and risk assessment methodology is provided in Chapter 2 of the SIA, and a detailed discussion of all identified potential impacts is provided in Chapter 6 of the SIA.



\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_SIA\SIA001_SIAStudyArea_20230705_06.mxd 5/07/2023

Source: EMM (2023); ABS (2021); DFSI (2017, 2020); GA (2011)

Area of social influence

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.15

EMM
creating opportunities

Table 6.21 Summary of social impacts and benefits

Social impact theme	Impact/benefit	Affected parties	Duration	Extent	Unmitigated/ unenhanced	Mitigated/ enhanced	Proposed mitigation and management, responsibility, and potential partners
Transition	Contribution to improving intergenerational equity.	The broader community.	Life of project	Local community and broader community.	Medium (Benefit)	Medium (Benefit)	As an indirect social benefit contributed to by the project enhancement measures are not required. However, to enable more community benefits to be experienced locally, the project could implement a local employment and training strategy that provides training for the local construction workforce to build skills to contribute to future renewable energy projects in the region. The project could also implement a local procurement strategy including engaging with local businesses and provides support to businesses to invest in service offerings to the renewable energy sector.
	Improved confidence in sustained economic opportunities.	Local residents and Council.	Life of project	Local community and broader community.	Medium (Benefit)	Medium (Benefit)	As an indirect social benefit contributed to by the project enhancement measures are not required, however there may be an opportunity to maximise economic benefits for regional communities through prioritising employment and training opportunities for local residents and structuring procurement processes which enable businesses throughout the region to participate in the supply chain. The project could also engage with the community to promote the energy transition and opportunities for community participation.
	Concerns regarding waste management during decommissioning and rehabilitation.	Local residents and Council.	Life of project	Muswellbrook Shire LGA.	Medium	Medium	The project should educate the local community regarding the rehabilitation process and final land form.
Locality impacts	Changes to the visual character impacting amenity	Local residents and visitors.	Construction Operation	Local area.	Medium	Medium	Since views and the scenic quality of the surrounding landscape is valued by local community members, additional mitigation is required. Whilst the VIA found that the visual impact was low, surrounding residents may wish to apply mitigations such as screening tailored to their individual property.

Table 6.21 Summary of social impacts and benefits

Social impact theme	Impact/benefit	Affected parties	Duration	Extent	Unmitigated/ unenhanced	Mitigated/ enhanced	Proposed mitigation and management, responsibility, and potential partners
	Generation of noise affecting quality of life for nearby residents.	Nearby neighbours, residents of the local and regional area.	Construction	Local area, haulage routes.	Medium	Medium	Due to a concern for nearby animals as well as people, further mitigations may be required to meet community expectations. The project will establish a publicly available complaints management process including a feedback mechanism as to how the complaint was resolved. The project will also provide regular briefings and meetings for local stakeholders including nearby neighbours and landowners.
	Perceived reduction in agricultural productivity.	Host landowner.	Construction and operation	Muswellbrook community.	Low	Low	Landowners and the project proponent may investigate opportunity to implement Agrisolar. Research demonstrates the productivity benefits of sheep on solar farms.
	Increased traffic congestion and commute times during construction.	Road users.	Construction	Local area, particularly closest to the site. Haulage routes.	Medium	Medium	There is also an opportunity for minibuses to be utilised to transport project construction workers to and from the project site daily. This would also decrease worker fatigue. Encouraging carpooling is also an option to decrease the amount of traffic on local roads.
	Perceived public safety risks due to increased traffic.	Road users and pedestrians.	Construction	Local area, particularly closest to the site.	Medium	Medium	In addition to the mitigations recommended in the TIA, it is proposed that the project engages with the local community to explain the mitigation measures to reduce the perceived public safety risk due to increased traffic from the project.
Local employment and procurement	Local employment and training.	Potential local labour force and their families. Local businesses.	Construction	Local and regional area.	Medium (Benefit)	High (Benefit)	A potential benefit enhancement for the project is to partner with local organisations to implement an Indigenous and non-indigenous prison employment program. An indigenous employment program for the broader indigenous population should also be considered. A local employment strategy which focuses on the recruitment of local workers should also be considered.

Table 6.21 Summary of social impacts and benefits

Social impact theme	Impact/benefit	Affected parties	Duration	Extent	Unmitigated/ unenhanced	Mitigated/ enhanced	Proposed mitigation and management, responsibility, and potential partners
	Local procurement opportunities.	Potential local labour force and their families. Local businesses.	Construction	Local and regional area.	Medium (Benefit)	High (Benefit)	A local procurement strategy should be considered by the project to ensure early and regular engagement with local businesses and the Muswellbrook Chamber of Commerce to establish relationships with the project. Local businesses are often smaller and require more lead time to prepare for tenders and to potentially recruit people for their business. Further, it is recommended that the project encourages the project workforce, particularly during the construction phase, to support and contribute to the local and regional community through local spending.
Housing and services	Reduced availability of rental housing and short-term accommodation for residents.	Residents of the local and regional area, project workforce.	Construction	Local area. Key urban areas. Regional area (commutable distance).	High	Medium	Maximise recruitment of local residents for the construction workforce where possible. Innovative housing solutions such as refurbishment of existing unoccupied dwellings in exchange for rent could reduce the demand for short-term accommodation given the significant availability of this dwelling type in Muswellbrook. Encourage non-local workers to be accommodated in surrounding towns to further reduce the impact on Muswellbrook.
	Reduced access to services for residents due to increased competition for social services.	Local residents. Residents of key townships.	Construction	Local area.	Low	Low	It is proposed that the project engages with Muswellbrook Shire Council to identify potential service limitations and implement measures such as provision of on-site first aid facilities to reduce competition for the GP services most proximal to the site. The provision of mental health services for the construction workforce should also be considered.

Table 6.21 Summary of social impacts and benefits

Social impact theme	Impact/benefit	Affected parties	Duration	Extent	Unmitigated/ unenhanced	Mitigated/ enhanced	Proposed mitigation and management, responsibility, and potential partners
Environmental and cultural values	Perceived water quality and water security impacts.	Residents receiving water from the Hunter River.	Construction	Local area, regional area.	Medium	Low	An overarching and adaptive soil and water management plan (SWMP) will be prepared for the project in consultation with NSW government agencies. Provision of complaint resolution processes and project information on surface water and groundwater to interested members of the community should be provided with easy access. However, since the project site is using existing mine water licenses and is expected to require less water than the mines, there are no further mitigations required for water security.
	Perceived increased fire safety risk associated with the project.	Muswellbrook residents and emergency services.	Operation	Muswellbrook Shire LGA.	Medium	Medium	Alongside the measures proposed by the Bush Fire Strategic Study, the project will engage with local residents to understand the risk and mitigation measures that will be implemented. Further, allowing sheep on solar farm land can also reduce fire risk by keeping the surrounding pasture down.
	Potential for impacts to unknown items or sites of Aboriginal cultural significance.	Local Aboriginal groups.	Life of project	Local and regional area.	Low	Low	The effectiveness of mitigation measures will be dependent upon thorough and ongoing stakeholder engagement with the local Aboriginal community. The effective implementation of the proposed ACHMP, as outlined in the ACHA, is key to effective mitigation of the disturbance to culturally important places, sites, or artefacts.

6.4.4 Mitigation measures

Table 6.22 outlines the mitigation measures to be implemented in relation to the potential social impacts from the project.

ESCO has developed an Accommodation and Employment Strategy (Appendix P) which includes a monitoring and evaluation framework to ensure the strategy remains effective. This strategy will be regularly monitored and updated annually and at major project milestones.

Table 6.22 Social mitigation measures

ID	Mitigation measure
SOC1	ESCO will develop and adopt a monitoring and management framework to monitor and measure the effectiveness of the proposed management measures.
SOC2	A project community and stakeholder engagement strategy will be maintained to guide engagement with the community and ensure mechanisms for both information dissemination and feedback collection are incorporated.
SOC3	A local procurement strategy will be implemented and include consideration of: • engagement with local businesses and provision of support to businesses to invest in service offerings to the renewable energy sector • employment of local workers where possible • an indigenous employment program for the broader indigenous population • a local employment and training strategy • partnership with local organisations to implement and Indigenous and non-Indigenous prison employment program • engagement with the Muswellbrook Chamber of Commerce • encouragement of local spending by the project workforce.
SOC4	An Accommodation and Employment Strategy has been developed and includes consideration of innovative housing solutions such as refurbishment of existing unoccupied dwellings in exchange for rent given the significant availability of this dwelling type in Muswellbrook. The external workforce would be encouraged to consider residing in surrounding towns to further reduce the impact on Muswellbrook. The Accommodation and Employment Strategy will be regularly monitored and updated.
SOC5	ESCO will engage with Muswellbrook Shire Council to identify potential service limitations and implement measures such as provision of on-site first aid facilities to reduce competition for the GP services most proximal to the site. The provision of mental health services for the construction workforce should also be considered.
SOC6	A complaints procedure will be developed and implemented to provide opportunities for stakeholders to raise complaints and provide feedback. The procedure will facilitate the timely response to stakeholder complaints and enable the monitoring and reporting of grievances and ESCO response.
SOC7	ESCO will consider opportunities to support the co-location of livestock grazing within the development footprint

6.4.5 Conclusion

The outcomes of the SIA indicate that the project will have various social impacts and benefits, particularly in the local area but also in the key townships and regional study area.

The expected impacts and benefits for the local and regional area fall within the themes of transition, locality impacts, local employment and procurement, housing and services, and environmental and cultural values. The project will result in various social benefits for the local community. By comparison, the project impacts are relatively few and can generally be managed through mitigation recommended in other reports supporting the EIS. No impacts were assessed as having a high mitigated significance.

The local community acknowledges the transition to renewable energy and is generally supportive of the project.

6.5 Land and soils

6.5.1 Introduction

A land use, soils and erosion assessment (LUSEA) has been prepared for the project by EMM (2023d) and is provided in Appendix H. The LUSEA identifies and assesses potential land capability, soil erosion and sedimentation impacts associated with project construction and operation. The relevant SEARs and how they are addressed are summarised in Section 1.2.1 of the LUSEA and Appendix A.

An agricultural impact assessment has been prepared for the project by Minesoils (Minesoils 2023) and is provided in Appendix I. This report addresses the impact on agricultural resources and agricultural productivity.

The agricultural assessment has been undertaken in accordance with the Solar Guidelines (DPE 2022a) which includes requirements to undertake a soil survey and verify land and soil capability (LSC) in accordance with Land and Soil Capability Assessment Scheme (LSC Scheme) (OEH 2012). A Level 2 – Reduced agriculture impact assessment was completed.

6.5.2 Existing environment

i Land use and zoning

Land use on and around the project area is predominantly grazing native vegetation and grazing modified pastures. Whilst generally cleared of native woodland and forest, the majority of the site remains well vegetated with highly disturbed grassland. Some scattered trees remain in paddocks and in narrow, disconnected patches along creek lines. The Muswellbrook Coal mine is located adjacent to the project area.

The Australian Land Use and Management (ALUM) classification is a system for classifying land based on primary, secondary and tertiary classes which are broadly structured by the potential degree of modification and the impact to the 'natural state', essentially native land cover. Under the ALUM classification and mapping, the project area is predominantly mapped as ALUM 2.1.0, grazing native vegetation, and ALUM 3.2.0, grazing modified pastures (Figure 6.16). There are small areas of ALUM 5.7.0, transport and communication associated with the existing roads and a former coal rail spur line, and ALUM 5.8.0, mining associated with the mining pit.

The project area is zoned RU1 Primary Production, SP2 Infrastructure and C3 Environmental Management under the Muswellbrook LEP (refer Figure 2.3).

a Agricultural land use

The southern area of the project area is primarily used for cattle grazing and is characterised by degraded native grasslands and modified pastures with widely scattered remnant paddock trees. The northern area predominantly comprises regenerating even-aged regrowth Ironbark with occasional mature trees, sparsely scattered shrubs and degraded native grasslands. General agricultural improvements are present including dams, cattle yards, stock fences and gates, sheds, water pumps, and unsealed access tracks. Similar agricultural improvements (e.g. stock fences and existing access tracks) are widespread throughout the locality which reflects the historical and current development of the local lands for livestock grazing.

No sensitive agricultural activities such as intensive plant or intensive livestock agriculture are being undertaken within the project area or its immediate surrounds.

The estimated productivity of grazing land within the project area has been calculated based on NSW Department of Primary Industries (2019) Gross Margin Budgets for Livestock and is shown in Table 6.23.

Table 6.23 Estimated productivity of grazing land within the project area

Enterprise	Estimated gross margin ($/ha/year)	Grazing land (ha)	Project area gross margin ($/year)
Feeder steers	173.81	481.9	83,759.04
Growing-out Steers 240–460 kg	412.04	481.9	198,562.08

ii Geology

The site geology is available on the Muswellbrook 1:25,0000 geological map (Summerhayes 1983) and occurs on or in proximity to the five primary geologies including the Branxton Formation, Rowan Formation, Skeletar Formation, Mulbring Siltstone, and Alluvial valley deposits.

The site is divided roughly in half between east and west by the Aberdeen Fault. The majority of the project area is located on the Branxton Formation and Mulbring Siltstone with areas of alluvial valley deposits associated with the localised drainage lines.

iii Soil landscapes

The mapping of the primary soil and land resources within the project area is summarised in Table 6.24 and shown on Figure 6.17.

Australian Soil Classification (ASC) (DPIE 2021c) state-wide mapping identifies that the site encompasses two soil orders; Sodosols and Kurosols, with some natric Kurosols present (Figure 6.17). These soils have potentially high erosion risk (particularly gully and tunnel erosion) and are the highest risk of generating turbid runoff.

Minesoils (2023) soil survey indicated four primary soil units present in the project area. The two main soil units within the project area were characterised by Chromosols (in the southern project area) and Tenosols (in the northern project area). Chromosols present as not sodic or strongly acidic. Tenosols cover a diverse range of soil types with samples taken presenting characteristics including non-sodic, moderate acidity with a moderate permeability and moderate drainage capacity. Dermosols and Sodosols were limited to the lower slopes and low lying flats in the south and a small pocket in the north near Sandy Creek Road, respectively.

Acid sulfate soils are unlikely to be present in the vicinity of the project. There was no evidence of acid sulfate soil indicators such as soil gleying, odour, marine sediments and organic materials recorded during the site survey.

Table 6.24 Soil and land resource mapping within the project area

Soil Landscape	Type	Landscape characteristics	Limitations and degradation	Area (ha)
Cressfield Road (cfz)	Erosional	Soils present on broad rounded crests and side slopes. Typical consists of sandstone, conglomerate, siltstone, shale, tuff, coal and claystone. Soils comprise of sodosols, chromosols and kurosols at 50 to 150 cm depth.	Moderate sheet, topsoil and occasionally subsoil erosion is widespread, especially in disturbed areas or with high stocking rates. Drainage lines and lower slopes exhibit past and present minor to moderate gully erosion.	136.37

Table 6.24 Soil and land resource mapping within the project area

Soil Landscape	Type	Landscape characteristics	Limitations and degradation	Area (ha)
Cressfield Road variant A (cfza)	Erosional	Located within steeper sections of topography.	Moderate sheet erosion. Topsoil and occasionally subsoil erosion is widespread, especially on disturbed areas or with high stocking rates. Drainage lines and lower slopes exhibit localised minor to moderate gully erosion.	17.06
Dochra (dot)	Erosional	This is a typical soil landscape around Muswellbrook, with significant erosion problems. The landscape comprises of siltstones and mudstones. The soils are typically sodosols, dermosols and kurosols at 50 to 100 cm depth. The mapping includes areas of made land (rehabilitated mine spoil).	Sheet erosion is extensive on many hillslopes in cleared areas, whilst most drainage lines in cleared areas are subject to significant gully erosion. Many subsoils are highly dispersible and erodible.	108.03
Donalds Gully (dnz)	Transferral	Located in drainage plains and alluvial fans, the landscape includes a mixture of alluvium and colluvium derived from the Permian Wittingham Coal measures. The soils includes sodosols and kurosols between 50 to 150 cm depth.	Minor sheet erosion is extensive. Occurrences of moderate sheet and gully erosion is rare. Localised saline outbreaks are present, e.g., near Lake Liddell and west of Castle Rock.	195.59
Foy Brook (fyz)	Alluvial	Quaternary alluvium located within broad tributaries of the Hunter River draining Permian sediments. Along Muscle Creek includes solodic soils and yellow podzolic soils at 100 mm to 500 cm depth.	Streambank erosion is common and occurs especially on the outside of meander bends. Flood scour and sediment deposition occur on some inset floodplain surfaces.	3.26
Little Grasstree Hill (lgw)	Erosional	Rolling low hills to rolling hills on Permian siltstones, sandstone and conglemerate of the Maitland Group in the central area of the Hunter Region.	Sheet erosion is extensive on many hillslopes in cleared areas, Gully and rill erosion is also present on slopes and drainage depressions where clearing has occurred. Many subsoils are dispersible and erodible.	1.71
Goorangoola (gon)	Erosional	Rolling hills on carboniferous sediments in the central part of the Hunter Region.	Sheet erosion is evident on cleared and over-grazed slopes, and minor discontinuous gully erosion where drainage is concentrated on lower slopes. Terracettes have been observed on cleared upper slopes. Feral goats have been observed in some areas.	3.51

Table 6.24 Soil and land resource mapping within the project area

Soil Landscape	Type	Landscape characteristics	Limitations and degradation	Area (ha)
Disturbed terrain (xxz)	NA	Extensively disturbed areas where the original features of the soil and landscape have been extensively modified.	Disturbed areas where soil or rock is exposed are prone to erosion and removal of sediment off-site. Gravel quarries usually have little in the way of erosion control and this has resulted in significant erosion problems in some areas, with adjacent waterways and farm dams becoming filled with sediment. In some instances, rubbish pit sites appear to have had toxic effects on surrounding vegetation. Limitations not recorded.	16.31

iv Inherent soil fertility

NSW regional mapping provides an estimation of the inherent fertility of soils in NSW (DPIE 2020d, DPIE 2021d). Inherent soil fertility is used as a general indication of a soil's capacity to retain and release nutrients and soil water for use by vegetation and is a function of the interrelationship between physical, chemical and biological components in the soil.

The project area is dominated by soils with moderately low fertility. There are some very small areas of moderate and moderately high fertility soils present within the project area.

Table 6.25 Inherent soil fertility

Inherent soil fertility	ASC	Description
Moderately low	Foy Brook (Dermosols)	Soils with high fertility in their virgin state but this fertility is significantly reduced after only a few years of cultivation.
Moderate	Goorangoola (Kurosols)	Soils have low to moderate fertilities and usually require fertiliser and/or have some physical restrictions for arable use.
Moderately high	Cressfield Road and Donalds Gully (Sodosols), Cressfield Road variant a (cfza) (Kurosols), Dochra and Little Grasstree Hill (natric Kurosols)	Soils with low fertilities that, generally, will only support vegetation suited to grazing with large inputs of fertiliser required to improve the soils and make them suitable for arable purposes.

v Land and soil capability

The Land and Soil Capability Assessment Scheme (OEH 2012) ('LSC Scheme') assesses the inherent physical capacity of the land to sustain a range of land uses (and management practices) in the long term without leading to degradation of soil, land, air and water resources. Land is classified between an LSC class of 1 (best, highest capability land) and 8 (worst, lowest capability land). The overall LSC class of the land is based on the most limiting feature/hazard.

The NSW regional based maps of LSC (DPIE 2021e) indicate the project area consist of land capable of a variety of land uses and characterised by LSC Classes 3, 4, 5 and 6 representing land with high to low capability.

Verification of LSC was undertaken by Minesoils (2023) across 20 soil test sites in the project area in accordance with the LSC Guideline (OEH 2012, OEH 2013) (Figure 6.18). The majority of land in the project area is moderate capability land (Class 4) with portions of low capability lands (Class 6) and even smaller portions of moderate to low capability lands (Class 5) (Table 6.26).

Table 6.26 Verification of LSC in the project area

Class	Area (ha)	Description
4	396.1	Moderate to high limitations for high-impact land uses that will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology. The key limitations of this class within the project area include water-logging, structural decline, water erosion and soil depth.
5	25.2	High limitations for high-impact land uses and will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation. The key limitation of this class within the project area is soil acidity.
6	60.6	Very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation. The key limitations of this class within the project area include water-logging, and soil depth.

vi Strategic agricultural land

Strategic agricultural land includes land with unique natural resource characteristics is known as biophysical strategic agricultural land (BSAL), and clusters of significant agricultural industries are known as critical industry clusters (CICs).

There is no BSAL or CICs mapped within the project area. The nearest BSAL is located approximately 0.5 km southwest of the project area in association with Muscle Creek (Figure 2.7).

vii Erosion

An assessment of erosion hazard in the project area was completed in accordance with the process outlined in Landcom (2004) which considers the overall project erosion hazard based on slope and rainfall erosivity (R-Factor) and subsequent determination of soil loss classes (SLC). The SLC dictates specific erosion management as mitigation measures as detailed in Landcom (2004).

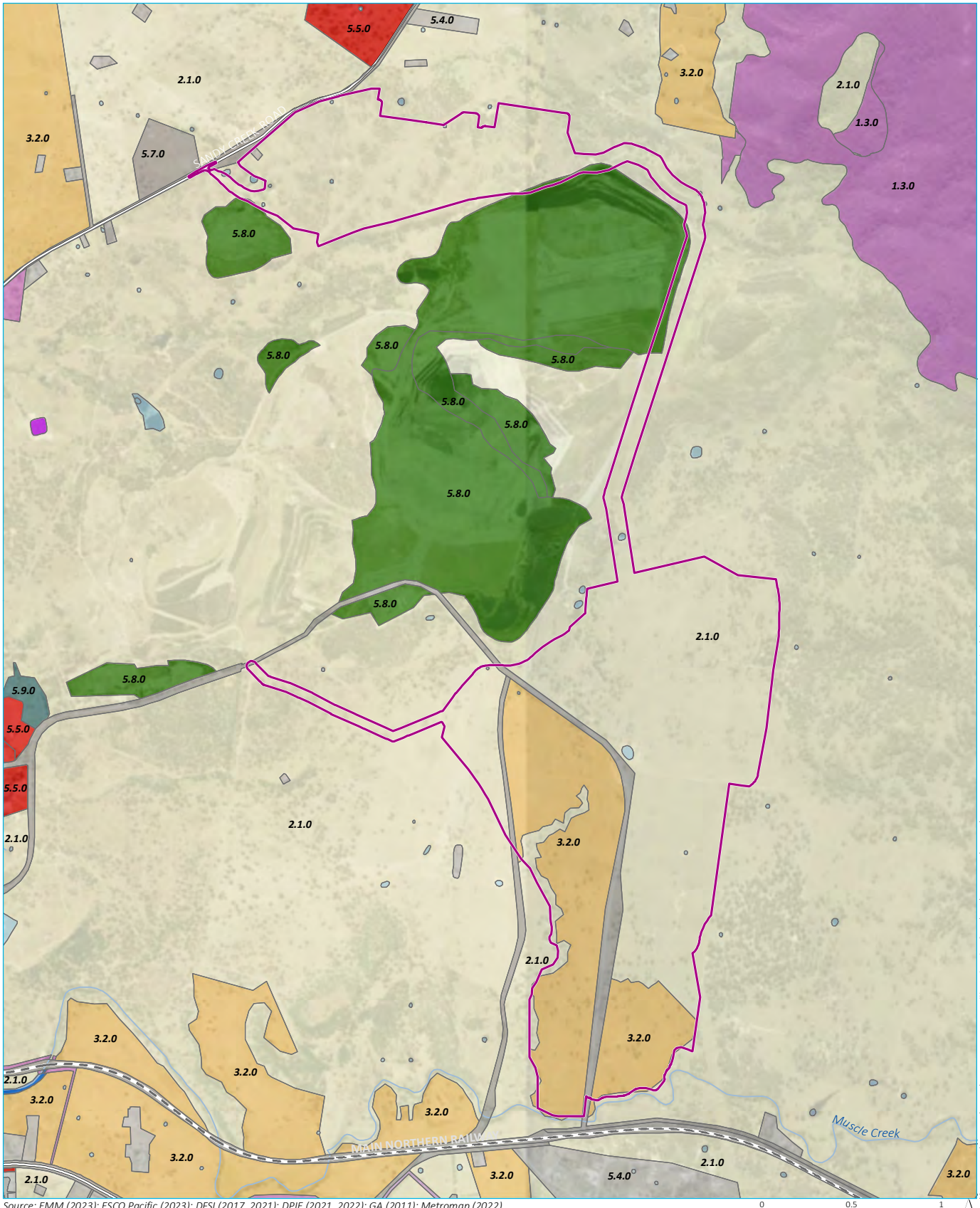
Slopes and associated erosion hazard for the key project elements are provided in Table 6.27 and shown on Figure 6.19. The calculated minimum and maximum soil loss classes are also summarised here. The project generally has a low to high erosion hazard based on mean slope. The majority of the project area has low to moderate erosion hazard. The area of erosion hazard across the project area is summarised as:

- low to moderate erosion hazard: 464.5 ha (96.4%)
- high to very high erosion hazard: 17.3 ha (3.6%)
- extreme erosion hazard: 0.004 ha (0.0009%).

Lands with SLCs ≥4 (where project slopes >15–39 %) trigger increased erosion and sediment control management requirements as stipulated in Section 4.4.2 of Landcom (2004).

Table 6.27 Slope ranges and erosion hazard for key project elements

Project element	Slope (min %)	Slope (max %)	Slope (mean %)	Standard deviation	Erosion hazard	SLC (min)	SLC (max)
Internal connection route (33kV)	0.1	277.2	23.4	28.9	Low to High	1	7
132 kV transmission line to 95M	0.2	96.3	13.3	8.4	Low to High	1	7
BESS	0.0	32.5	3.0	4.1	Low to High	1	6
Switching station	0.1	24.6	4.6	5.3	Low to High	1	5
Transformer substation	0.3	5.6	2.2	1.1	Low	1	2
Solar Farm collector station	1.3	25.0	8.1	6.7	Low to High	1	5
Operation and maintenance area	0.7	2.2	1.3	0.3	Low	1	1
Car park	1.3	7.9	3.4	1.1	Low	1	2
Laydown A	0.3	22.3	4.3	3.5	Low to High	1	3
Laydown B	2.4	18.3	7.3	1.9	Low to High	1	4
BESS collection station	1.9	8.7	4.2	1.8	Low	1	2
Northern array	0.1	51.4	8.7	2.7	Low to High	1	7
Southern array	0.0	60.1	3.7	2.9	Low to High	1	6



Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); DPIE (2021, 2022); GA (2011); Metromap (2022)

0 0.5 1 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_LSEA\LSEA005_ALUM_20230705_02.mxd 5/07/2023

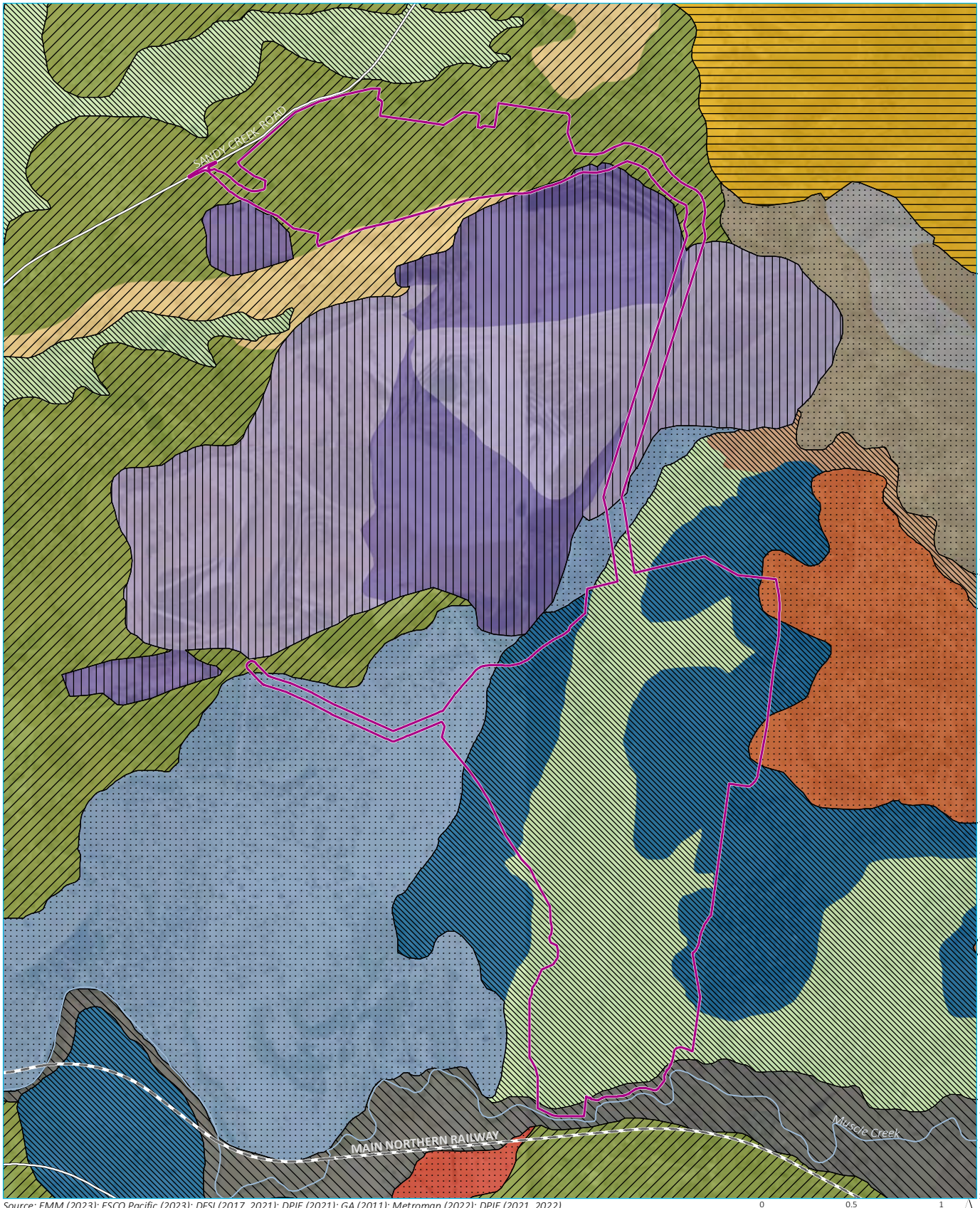
KEY

- Project area
- Existing environment
- Rail line
- Major road
- Named watercourse
- Land use mapping (secondary)
- 1.2.0 Managed resource protection
- 1.3.0 Other minimal use
- 2.1.0 Grazing native vegetation
- 3.2.0 Grazing modified pastures
- 5.4.0 Residential and farm infrastructure
- 5.5.0 Services
- 5.6.0 Utilities
- 5.7.0 Transport and communication
- 5.8.0 Mining
- 5.9.0 Waste treatment and disposal
- 6.2.0 Reservoir/dam
- 6.3.0 River

Land use

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.16

EMM creating opportunities



Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); DPIE (2021); GA (2011); Metromap (2022); DPIE (2021, 2022)

0 0.5 1 km

GDA2020 MGA Zone 56

N

KEY

Project area

Australian soil classification (order)
- Dermosols (DE)
- Kurosols (natric) (KUn)
- Kurosols (KU)
- Rudosols (RU)
- Sodosols (SO)
- Not assessed

Soil land resource
- Cressfield Road (cfz)
- Cressfield Road variant a (cfza)
- Disturbed Terrain (xxz)
- Disturbed Terrain variant a (xxza)
- Dochra (dot)
- Donalds Gully (dnz)
- Foy Brook (fyz)
- Foy Pinnacle (fpy)
- Goorangoola (gon)
- Isis (isz)
- Kangaroo Ridge (kaw)
- Little Grasstree Hill (lgw)
- Lovedale (lvv)
- Singleton (sgw)
- Waverly (waj)

Existing environment
- Rail line
- Major road
- Named watercourse

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_LSEA\LSEA003_ModelledASCandSLR_20230705_02.mxd 5/07/2023

Modelled ASC mapping and SLR units

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.17

EMM
creating opportunities

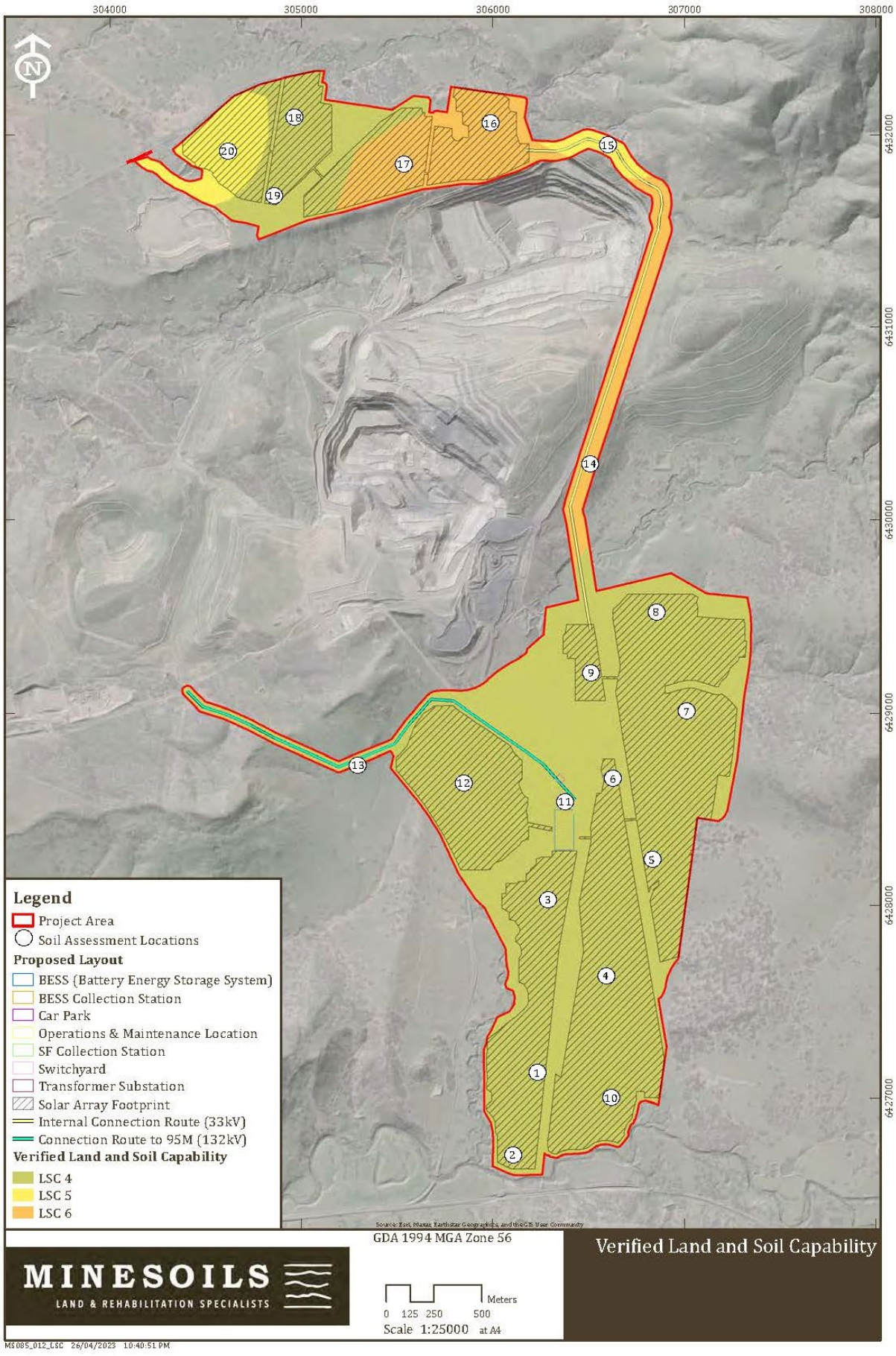
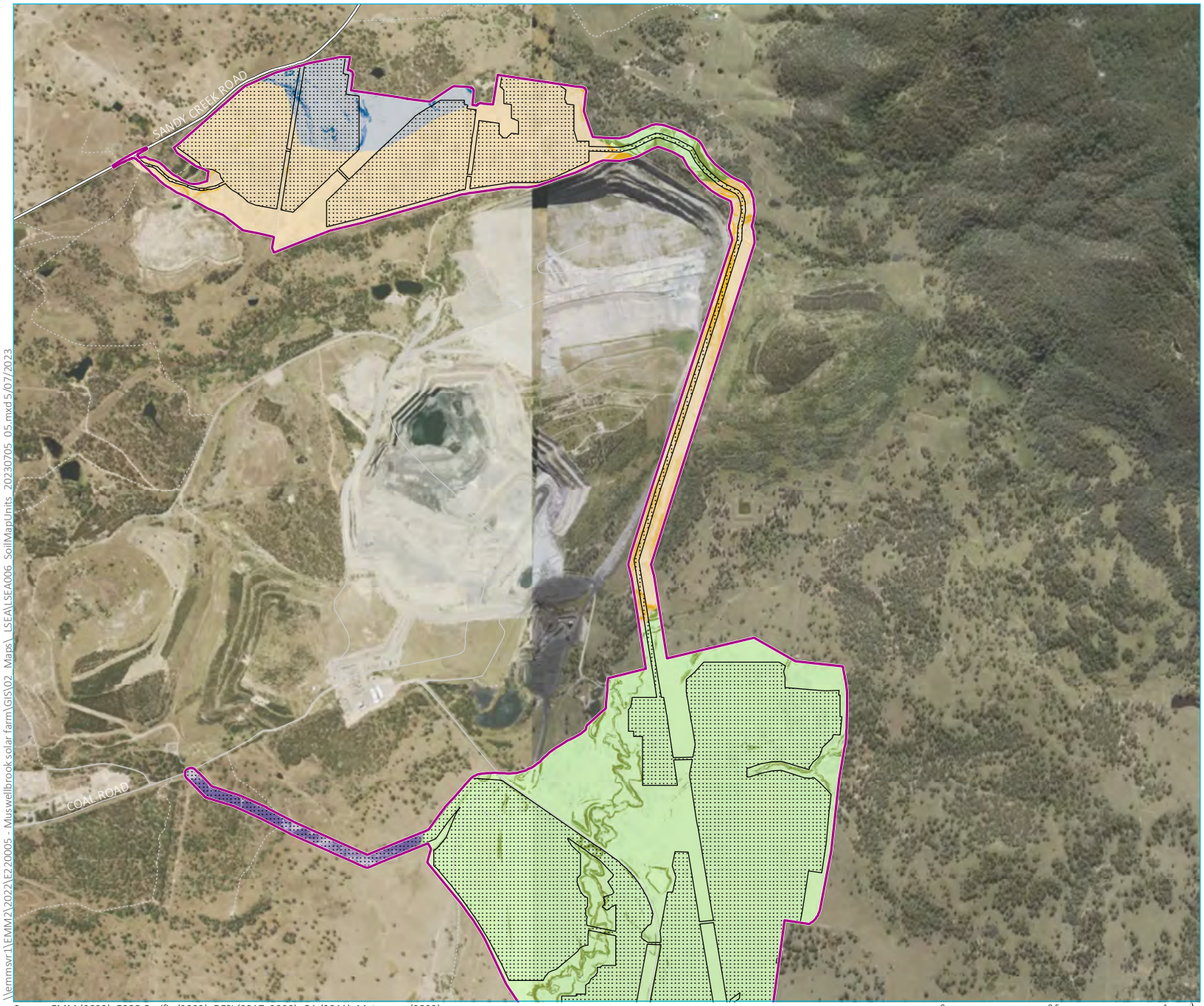


Figure 6.18 Verified LSC



KEY

- Project area
- Disturbance footprint

SMU 1
- SLC 1-3 | Very low to low-moderate
- SLC 4 | Moderate
- SLC 5-6 | High and very high

SMU 2
- SLC 1-2 | Very low to low
- SLC 3 | Low-moderate
- SLC 4 | Moderate
- SLC 5-6 | High

SMU 3
- SLC 1-3 | Very low to low-moderate
- SLC 4 | Moderate
- SLC 5-6 | High and very high

SMU 4
- SLC 1-3 | Very low to low-moderate
- SLC 4 | Moderate
- SLC 5-6 | High and very high
- SLC 7 | Extreme

Existing environment
- Rail line
- Major road
- Minor road
- Vehicular track

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02 Maps\ LSEA\LSEA006 SoilMapUnits 20230705 05.mxd 5/07/2023

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2020); GA (2011); Metromap (2022)

0 0.5 1 km

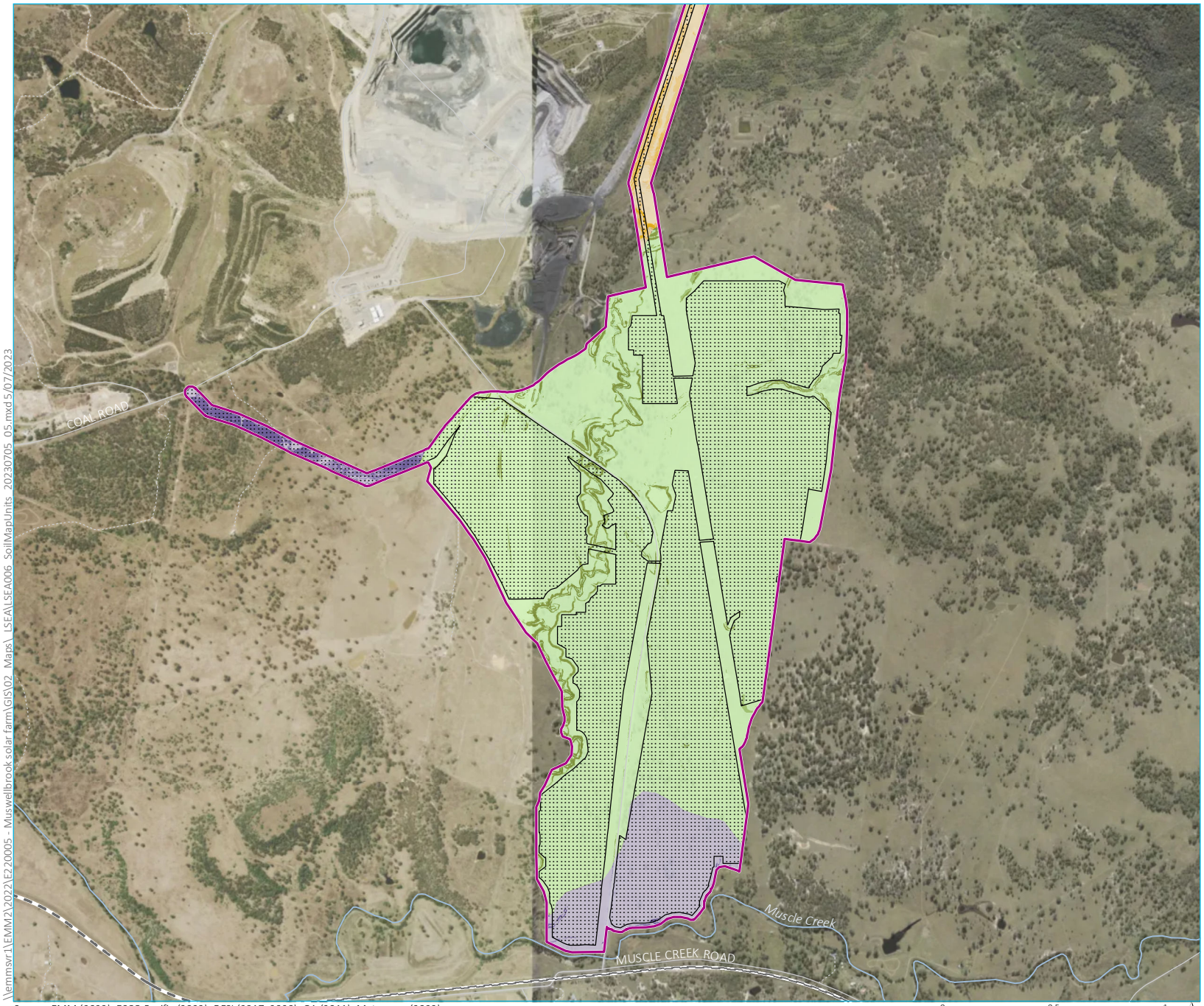
GDA2020 MGA Zone 56

N

Project SLC erosion hazard

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.19

EMM creating opportunities



KEY

- Project area
- Disturbance footprint

SMU 1

- SLC 1-3 | Very low to low-moderate
- SLC 4 | Moderate
- SLC 5-6 | High and very high

SMU 2

- SLC 1-2 | Very low to low
- SLC 3 | Low-moderate
- SLC 4 | Moderate
- SLC 5-6 | High

SMU 3

- SLC 1-3 | Very low to low-moderate
- SLC 4 | Moderate
- SLC 5-6 | High and very high

Existing environment

- Rail line
- Minor road
- Vehicular track
- Named watercourse

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_LSEA\LSEA006_SoilMapUnits_20230705_05.mxd 5/07/2023

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2020); GA (2011); Metromap (2022)

0 0.5 1 km

GDA2020 MGA Zone 56

N

Project SLC erosion hazard

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.19

EMM
creating opportunities

6.5.3 Potential impacts

i Construction impacts

Potential construction erosion and sediment control impacts include:

- off-site discharge of sediment and turbid run-off from the erosion of exposed soils particularly dispersive subsoils
- degradation of stock drinking water
- infilling of waterway pools
- diversion of waterway flow due to sediment deposition and associated bed and bank erosion
- erosion and subsequent sedimentation of creeks and waterways due to inappropriately designed and constructed creek and watercourse crossing
- mud tracking from vehicles and machinery to public roads
- increased potential for rill and gully erosion due to modification of flow conditions from sheet flow to concentrated flow from constructed landforms (roads, tracks, hardstands), water diversion and drains
- incision and widening of downstream drainage lines due to modification of the run-off hydrograph due to an increase in impermeable surface such as roads, hardstands, roofs and solar arrays
- tunnel erosion under or beside foundations for solar arrays, towers, light poles etc and along cable trenches due to dispersive soils
- dust emissions from unsealed roads, hardstands and exposed soils.

ii Operation impacts

Potential operational erosion and sediment control impacts include:

- offsite discharge of sediment and turbid run-off from on-going erosion from drainage, landform and infrastructure design not cognisant of dispersive subsoils
- increased maintenance costs for on-going stabilisation of landforms, roads, drains and cable trenches
- operation and maintenance of sediment control structures due to on-going erosion
- tunnel erosion under or beside foundations for solar arrays, towers, light poles etc and along cable trenches due to dispersive soils
- dust emissions from unsealed roads, hardstands and exposed soils.

iii Changes to land and soil capability

Due to the nature of the project which will require only localised and sporadic landform modification including soil stripping (for excavation works and leveling), impacts on LSC are expected to be minor.

Following the end of life for the project, disturbance areas will be re-graded (where required) and stockpiled topsoil and subsoil be respread over disturbed areas and rehabilitated with either native vegetation or improved pastures depending on the intended final land use. This strategy, along with good soil management practices will facilitate the rehabilitation in returning the land to an equivalent LSC class.

Therefore, it is anticipated there will be no permanent impacts on LSC classes within the project area as a result of the project.

iv Agricultural productivity impacts

For the purposes of determining impacts on agricultural productivity, it has been assumed that the project will remove an area of approximately 482 ha from agricultural use for the duration of the project. It is anticipated that the pre-existing land use will be re-established at the time of decommissioning, unless otherwise agreed with the landowner and/or regulatory authorities.

Current agricultural land use adjacent to the project area and in the broader project locality will not change as a result of the project, and there will be no fragmentation or displacement of existing agricultural industries.

The related economic activity arising from project area enterprises is referred to as the secondary productivity. The value of secondary productivity can be calculated using an economic multiplier. Agricultural economic multipliers provide annual estimates of the employment and output effects of trade in agricultural products on the economy. When expressed as multipliers, these effects reflect the amount of economic activity and jobs generated by agricultural exports.

There are a range of upstream and downstream employment roles associated with agricultural production in the project locality and wider region. These include:

- agronomy services
- input providers (chemical, fertilisers, etc.)
- machinery sales and mechanical support
- grain and livestock transport
- production marketing
- fencing, harvest and other contractors.

Upstream activities for the current project area enterprises include contractors, farm input and service providers. Downstream activities for the current landowners' enterprises include distribution and processing (value adding).

The impacts on agriculture as a result of the project are determined to be minimal, temporary, and limited to the project area. These impacts can be summarised as the following:

- temporary removal of 482 ha from agricultural land use within the project area
- temporary removal of potential agricultural primary productivity to the estimated value of $83,759 to $198,562 per annum per year of project life
- temporary removal of potential agricultural secondary productivity to the estimated value of $182,494 to $432,627 per annum per year of project life
- temporary impacts on soil resources within the project area where surface disturbance occurs.

The economic benefits of the project are considered further in Section 6.14.

6.5.4 Mitigation measures

Table 6.28 provides a summary of the mitigation measures for land, soil and erosion impacts for the project.

A rehabilitation strategy has been developed for the project and is available in Chapter 7 of Appendix H.

Table 6.28 Land, soil and erosion mitigation measures

Reference	Mitigation measure
Soil quality	
LS1	Prepare and implement a soil stripping and management plan (SSMP) that includes an inventory of soils to be stripped and stockpiled, including soil types, stripping areas, depths and volumes, and includes a topsoil and subsoil stripping and stockpiling procedure.
LS2	Preserve as much topsoil and subsoil as practicable for in-situ replacement post-disturbance.
LS3	Segregate topsoil and subsoil as much as practicable.
LS4	Segregate soil types as much as practicable.
LS5	Protect stockpiles from erosion using polymers or cover crops etc.
LS6	Where soil requires amelioration, apply the ameliorant prior to and during stripping. This will maximise mixing of the ameliorants.
LS7	Address any amelioration requirements in stockpiled subsoil and topsoil prior to reinstatement.
LS8	Implement weed and biosecurity management practices as outlined in the construction environmental management plan (CEMP).
LS9	Minimise the extent and duration of disturbed soil. Stabilise exposed soil with polymers, vegetation, gravel or similar as soon as practicable.
LS10	Avoid unnecessary soil compaction as much as practicable.
LS11	If potentially contaminated soil is identified, ensure the soil is segregated and is managed in accordance with applicable guidelines.
Dust	
LS12	To minimise dust during construction, use water trucks as required and minimise vehicle speeds and movements where possible. Stabilise pavements with polymer or cement wherever practicable.
Erosion and sediment	
LS13	Avoid disturbance of dispersive soils wherever practicable. Where this is not practicable, treat dispersive soil with ameliorants at a suitable rate.
LS14	Ensure drainage is designed to: • maintain sheet flow conditions • maintain unlined flow velocities ≤ 0.3 m/s • avoid ponding • avoid concentrated flows • minimise slope gradient and slope length.
LS15	Ensure access roads have a crowned profile, where appropriate, with minimum cross fall of 4% either side of the crown to minimise the formation of corrugations.
LS16	Use outfall drainage, where appropriate, to convey upslope drainage across roads and tracks instead of infall drainage and table drains. Infall drainage and table drains should be used where the slope and height of the outer fill present an erosion risk.

Table 6.28 Land, soil and erosion mitigation measures

Reference	Mitigation measure
LS17	Install Type A or B sediment basins to capture and treat turbid runoff. Ensure sediment basins have a flow-activated flocculant system installed.
LS18	If there are catchments where the calculated soil loss exceeds 150 t/ha/yr but it is not possible to construct a sediment basin due to boundary or flood height limitations, install Type 2 and Type 3 sediment control measures to compensate for the inability to install sediment basins.
LS19	Divert clean runoff away from areas of ground disturbance wherever practicable.
LS20	In areas of high erosion risk, such as drains, trenches or areas of dispersive soil, install rock/soil matrices and/or apply ameliorant as applicable.
LS21	Install energy dissipaters at drain outlets to ensure flow velocities are maintained within acceptable limits for the soil type. Stilling pond and roughness type dissipators are recommended.
LS22	Design and construct the BESS diversion drain to mimic the natural geomorphology of the existing drainage line including bed slope, sinuosity, pool/riflle sequences, flow velocity and flood terraces.
LS23	Limit cut and fill batter gradients to ≤ 3:1 to allow the placement of topsoil and vegetative stabilisation
LS23	Revegetate exposed areas. For areas steeper than 4:1, direct seed with a straw-based bonded fibre matrix hydromulch.
LS24	Maintain groundcover (vegetation, gravel etc) around solar panels during operation, particularly on panel drip lines.
LS25	Schedule earthworks (including watercourse disturbance) to avoid high rainfall periods wherever practical. Where this is not practicable, apply polymers or physical covers to exposed soil to achieve C-Factors of 0.01.
LS26	Avoid handling saturated soil wherever practicable (e.g. after rain).
LS27	Implement a water movement permit system during construction to minimise the potential for accidental turbid water discharge during pumping and dewatering activities, as applicable.
LS28	Ensure that the effectiveness of sediment and erosion control infrastructure and procedures are regularly monitored by a suitably trained person.
Water crossings	
LS29	Install water course crossings as early as possible in the construction program.
LS30	Design and construct water course crossings as per the recommendations in *Why do fish need to cross the road? Fish passage requirements for waterway crossings* NSW Fisheries 2003.
LS31	Ensure water course crossing have necessary inlet, outlet, bank and headwall erosion protection.
Agriculture	
AG01	Investigate opportunities to implement Agrisolar to reduce area of land removed from agricultural service. If Agrisolar is implemented, it must be at a suitable stocking rate.
AG02	Agriculture land use will be re-established over the entire 482 ha project area at the time of decommissioning (unless otherwise agreed with the landowner and/or regulatory authorities).
AG03	Stock fences, dams and access tracks to be reinstated in consultation with the landholder to accommodate a final land use of grazing.
AG04	A Biodiversity Management Plan will be prepared for the project. The plan will include measures to manage pest species and biosecurity.

6.5.5 Conclusion

There is no biophysical strategic agricultural land (BSAL) mapped within the project area. Soils in the study area are of moderate capability with portions of moderate to low capability, and low capability land. The project area is dominated by soils with moderately low fertility, and there are some very small areas of moderate and moderately high fertility soils. The land and soil capability of agricultural lands in the study area are unlikely to change as a result of the project from their current capability and will be managed through the implementation of appropriate mitigation measures.

Erosion hazard ranges from low to high throughout the project area. Most of the project area has a very low to moderate erosion hazard (464.5 ha), with small areas of high (17.3 ha) to extreme (0.0004 ha) erosion hazard. This hazard can be minimised to an acceptable level via adoption of appropriate drainage, erosion and sediment control practices, management measures for which will be incorporated in the construction environmental management plan (CEMP) for the project.

The impacts on agriculture as a result of the project are determined to be minimal, temporary, and limited to the project area. It is anticipated that by implementing effective land management procedures during construction and operation and implementing effective decommissioning and rehabilitation at the end of project life, the project will have no permanent negative impacts on agricultural resources or enterprises.

6.6 Water resources

6.6.1 Introduction

A water resources impact assessment (WRIA) has been prepared for the project by EMM (2023e) and is provided in Appendix J. The relevant SEARs and how they are addressed are summarised in Section 3.1 of the WRIA, and Appendix A.

6.6.2 Existing environment

i Water sharing plans

The following water sharing plans (WSPs) relevant to this project are:

- *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Source 2022* (Surface Water WSP) – the Muswellbrook Water Source applies to surface water and groundwater contained in unconsolidated sediment (alluvium), both mapped and unmapped, in the vicinity of the site.

- *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016* (Groundwater WSP) – the site includes both the Sydney Basin-North Coast Groundwater Source and New England Fold Belt Coast Groundwater Source mapped groundwater resources. Historical dewatering from the Muswellbrook Coal Mine has been located within the Sydney Basin-North Coast Groundwater Source.

Muswellbrook Coal Mine holds existing groundwater entitlements under the WM Act within the Sydney Basin-North Coast Groundwater Source.

ii Hydrology

The project site is in the Upper Hunter Valley region in the catchment of the Hunter River, which is located approximately 3 km to the west. The total Hunter River catchment covers an area of approximately 21,367 km^2. The two sub-catchments of interest within the vicinity of the project include Sandy Creek and Muscle Creek which are both ephemeral tributaries of the Hunter River. Both watercourses flow in a westerly direction and join the Hunter River in the township of Muswellbrook. No flow gauging data is available for these watercourses downstream of the project, however stream flow gauging at regional scale is available along the Hunter River downstream.

Muscle Creek is a fifth order stream with several unnamed tributaries through the southern project area. Sandy Creek is a sixth order stream with multiple unnamed tributaries through the northern project area.

The NSW River Styles Database (DPIE 2020e) provides an overview of geomorphic watercourse character, behaviour, condition and recovery potential targeting third and higher order watercourses throughout NSW. Two watercourses within the project area have been mapped in this database:

- A tributary of Muscle Creek on the western side of the southern project area. Mapped as having a gravel channel bed, this watercourse is partially confined within the valley controlled by terracing and a discontinuous floodplain to the east. The condition and future fragility of this watercourse is mapped as moderate however it has a high potential for recovery from impact. A number of smaller watercourses within the project extent also feed into this system.

- A tributary of Sandy Creek and its tributaries to the north of the project area. This watercourse has been modified due to the clean water diversion constructed by Muswellbrook Coal however the lower reaches are of importance to the project as they form the receiving environment to the project area. The watercourse is considered to be confined within the valley due to bedrock being present within the margins. The watercourse channel is mapped as a gravel bed and has been classed as in poor condition. The watercourse is considered to have moderate fragility but also a moderate recovery potential from impact.

iii Flooding

Existing flooding characteristics for the site and surrounds have been established by flood modelling undertaken by BMT (2023). The study by BMT covered flooding behaviour in all waterways and drainage lines present within the project development footprint including specifically those unnamed watercourses (orders 1st to 4th) contributing to both Muscle and Sandy Creeks. The study assessed flood behaviour for the 10% and 1% annual exceedance probability (AEP) events as well as the Probable Maximum Flood (PMF) and is consistent with the assumptions considered for the adjacent Muswellbrook Bypass project.

The project development area in the north is within the Sandy Creek catchment. The existing flood characteristics within this area are limited to topographic drainage low points, draining to the north west where they contribute to Sandy Creek. Flow depths in the 1% event are relatively shallow at 0.1 to 0.2 m depth. There are a number of farm dams and storages developed as part of the mine in this area.

Within the southern portion of the project area, flooding is broad and shallow. The existing mine access road is raised between 2 to 4 m above the surrounding low lying area. The road embankment significantly influences the flood behaviour within the southern project area. Culverts, consisting of multi-barrel reinforced concrete pipes, are present along the mine access road and influence the conveyance of flood waters to Muscle Creek in a south-westerly direction. The culverts limit conveyance during large flood events resulting in flood waters flowing along the road embankment to the south. This results in flood waters fanning out across a wide plain area.

As flood waters proceed south via floodplain and watercourses, they contribute to Muscle Creek which flows east to west along the southern extent of the project area. Flow within Muscle Creek is predicted to be confined within its banks in the 1% AEP event.

iv Surface water quality

Surface water quality has been monitored monthly as part of the ongoing Muswellbrook Coal Mine operational site water management activities. The 2022 Muswellbrook Coal Mine Environmental Monitoring Report (MCC 2022) reports on pH levels at the six monitoring sites in both Muscle and Sandy Creeks to have ranged from 7.5 to 8.5 pH on average in 2022. The electrical conductivity (EC) has ranged from 936 to 7,230 microsiemens per centimetre (µs/cm) and the total suspended solids has ranged from 6.5 to 13 milligrams per litre (mg/L).

Following monitoring undertaken at Muscle Creek as part of the Muswellbrook Bypass Water Resources Impact Assessment (AECOM 2021) the surface water environment was described as slightly turbid with an average of 10.2 nephelometric turbidity units (NTU). The geochemical conditions found fairly pH neutral, slightly saline water conditions with an average conductivity of 1,293 µs/cm and a pH of 7.48 (AECOM 2021).

v Groundwater

Groundwater sources present within the project area include:

- The Sydney Basin-North Coast Groundwater Source which covers the north-west portion of the project. It is a porous rock source with low yields unless there is an interaction with a fracture zone (DPI Water 2016).
- The New England Fold Belt Coast Groundwater Source, covers the south-east portion of the project and is a fractured rock groundwater source. Yields within this source are likely to be more variable but generally still low, unless a highly fractured fault system is encountered or specifically targeted.
- The shallow 'upriver' alluvial aquifers associated with the Muswellbrook Water Source. These aquifers are characterised by their short travel times between surface and groundwater and high connectivity to parent streams. The source areas are mapped in some parts but also include any unmapped areas of alluvium material.

Historical underground mining activities at Muswellbrook Coal mine have become groundwater storages. During active mining, these underground areas served as a source of water (via extraction bores) but also were used as a water management device (via active injection).

Due to underground and open cut mining at Muswellbrook Coal, the regional groundwater table has been extensively modified with a cone of depression around the remaining open cut pits. This has modified the regional groundwater flow direction, with flow within the cone of depression generally occurring towards the open cut pits.

The Water Management Plan for the mine indicates that the regional deep groundwater level is approximately 210 mAHD with the water level within the existing open cuts below this height. Therefore, the management plan indicates that the final open cut voids will behave as an evaporative sink (MCC 2018).

Groundwater quality across the three groundwater sources can be variable however due to the historical mining activities in the area and the saline aquifers groundwater quality from the more productive sources (deeper aquifer) is likely to be poor.

a Groundwater dependent ecosystems

A range of terrestrial groundwater dependent ecosystems (GDEs) are mapped within and adjacent to the disturbance footprint based on the *Groundwater Dependant Ecosystems Atlas* (BoM 2022). These terrestrial GDEs have been mapped as having a low potential for groundwater dependence. As much of the vegetation has been cleared for either agricultural or mining activities, there is a limited diversity of terrestrial vegetation communities within and adjacent to the project area. The shallow groundwater aquifer can be highly variable and therefore may not be a sustainable resource for many GDE vegetation communities.

The Groundwater WSP does not identify any high priority GDEs within or adjacent to the project area.

6.6.3 Potential impacts

i Construction

a Water quality

The primary risks to water quality during construction will occur as a result of:

- soil erosion and transport of sediment into receiving watercourses (through bulk earthworks and other construction activities such as trenching)
- accidental spillage of fuel or other hazardous materials used to support construction activities
- poor or ineffective wastewater management practices (wastewater will be collected and transported offsite for disposal to avoid discharge of wastewater to receiving waters)
- entrainment of construction plant and/or materials in floodwaters.

Overall, potential impacts to water quality during construction are considered minor and manageable with proposed management measures in place.

The project proposes to use groundwater sourced from the underground mining area of Muswellbrook Coal Mine. Based on available groundwater quality data, the mine water is not suitable for discharge into the surface water environment based on default guideline values (DGVs) associated with the protection of aquatic ecosystems as detailed within ANZECC (2000) and ANZG (2018). The potential use of this water in the project though however is generally consistent with the guideline values considered in primary industries which is consistent with the activities currently undertaken on many of the land parcels of the project. The reuse of groundwater from the mine as a source of water for the project will be subject to the requirements and controls outlined within the environmental management plans developed following the project's approval, covering both the construction and operational phases. Based on the proposed use of the water, it is likely that water will either infiltrate, evaporate, or be significantly dispersed, when used.

The project may need to consider some form of chemical adjustment on the groundwater such that the use of the water is appropriate or compatible with the infrastructure of the project. Confirmation of this requirement will be detailed with the subsequent future stages of design on the project, with the relevant requirements and controls to be detailed within the environmental management plans, developed following the project's approval. It is expected that water quality utilised during construction and in operation will be generally in accordance with water quality guideline values applicable to primary industries (ANZECC 2000).

b Water quantity

During construction there is the potential for a temporary increase in site runoff as a result of clearing, earthworks, compaction of soils and installation of impervious surfaces, leading to additional runoff leaving the project site and impacting downstream properties and receptors. However, potential construction phase impacts to site runoff volumes and rates are considered minor and manageable with implementation of temporary water and soil management measures.

c Flooding

During construction, there is potential for inundation of site works, compounds, storage areas and plant/equipment if these are located within flood prone areas, which could lead to undesirable flooding impacts either offsite or within the project area. Flooding conditions may also present a safety hazard to construction workers.

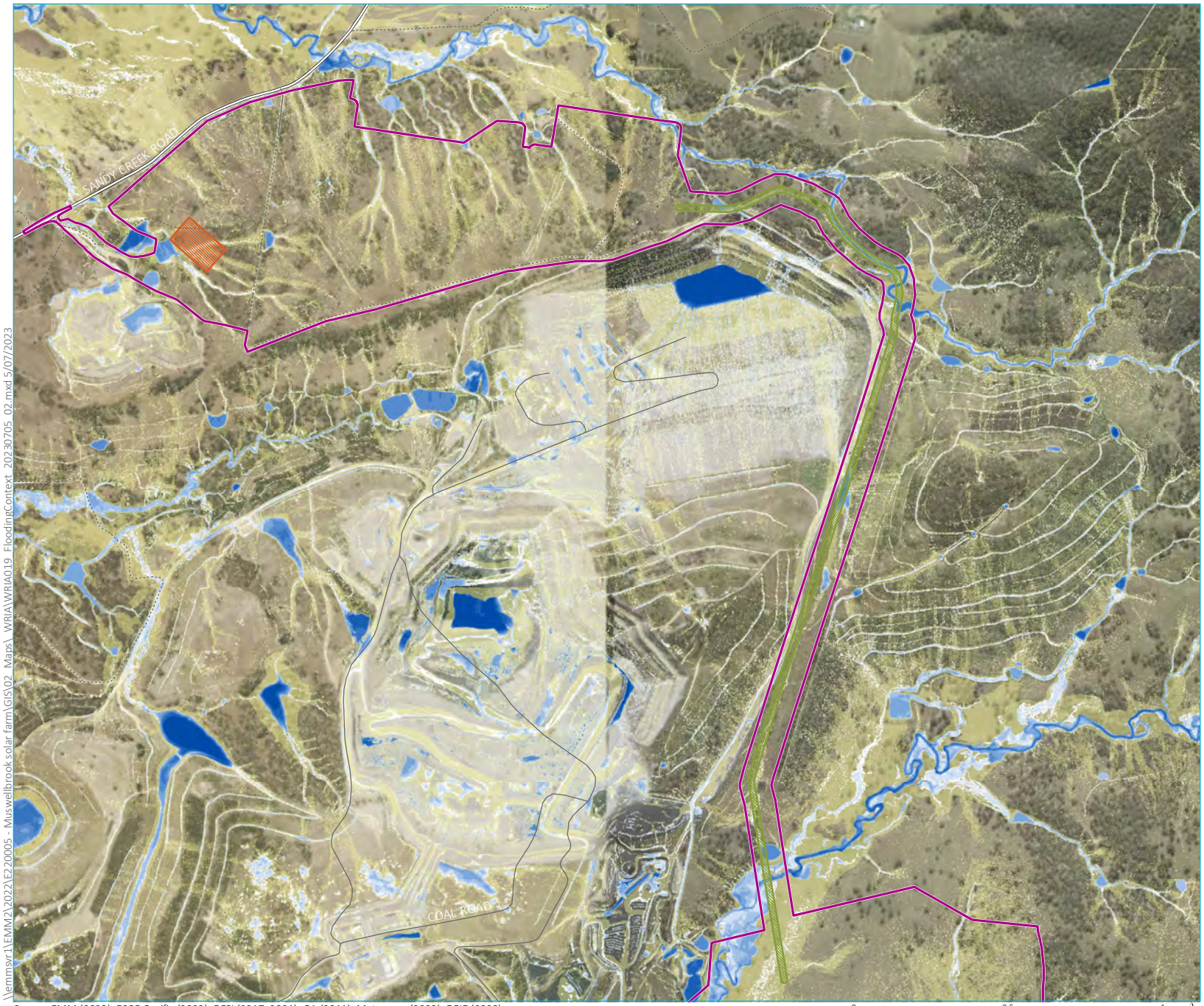
Figure 6.20 shows the proposed development footprint with existing flooding conditions (depth and extent) for the 1% AEP event. The mine access road is a key influence on flooding within the southern project area with concentrated flow paths occurring predominately on the northern and eastern side of the road contributing to Muscle Creek in the south.

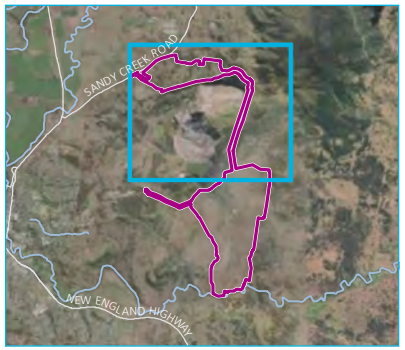
The facilities area is located within an existing drainage flow path. To improve the flood immunity of the area, a clean water diversion and bund arrangement is required which will reinstate a previous watercourse alignment as mapped by DPE Water (under *Water Management (General) Regulation 2018 hydroline spatial data 1.0*). The flood model considered the clean water diversion and bund arrangement as a scenario within the flood modelling undertaken for the project to understand the potential hydraulic change within downstream watercourses. Figure 6.21 shows the change in flood extent resulting from the diversion. The diversion and bund would reduce flood risk for the BESS area such that it would no longer be subject to flooding in a 1% AEP flood event. Further details of the diversion and bund are provided in Section 5.3.1 of the WRIA.

Flood extents within the northern portion of the project are limited to the flow paths present within the gullies which drain to the north. There is low potential for adverse flooding impacts either within or downstream of the project area for events up to, and including, the 1% AEP.

Residual flood risks can be adequately managed by suitable construction planning giving due consideration to flood risk, including for events larger than 1% AEP, which will occur as part of future detailed design. This includes:

- appropriate placement of temporary works, plant, materials and workforce facilities
- development of appropriate watercourse crossing designs and construction methods that consider local hydraulic conditions, minimise local flooding impacts, and are consistent with relevant guidelines
- development of a flood management plan (FMP) or similar to describe required site management and protocols in the event of flood events that could impact construction sites or access.





KEY

- Project area

Existing environment

- Major road
- Minor road
- Vehicular track
- PMF flood extent

Site layout

- Connection internal north to south buffer
- Laydown

Maximum water depth (m)

- < 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

INSET KEY

- Major road

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_WRIA\WRIA019_FloodingContext_20230705_02.mxd 5/07/2023

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2022); DPIE (2020)

0 0.5 1 km

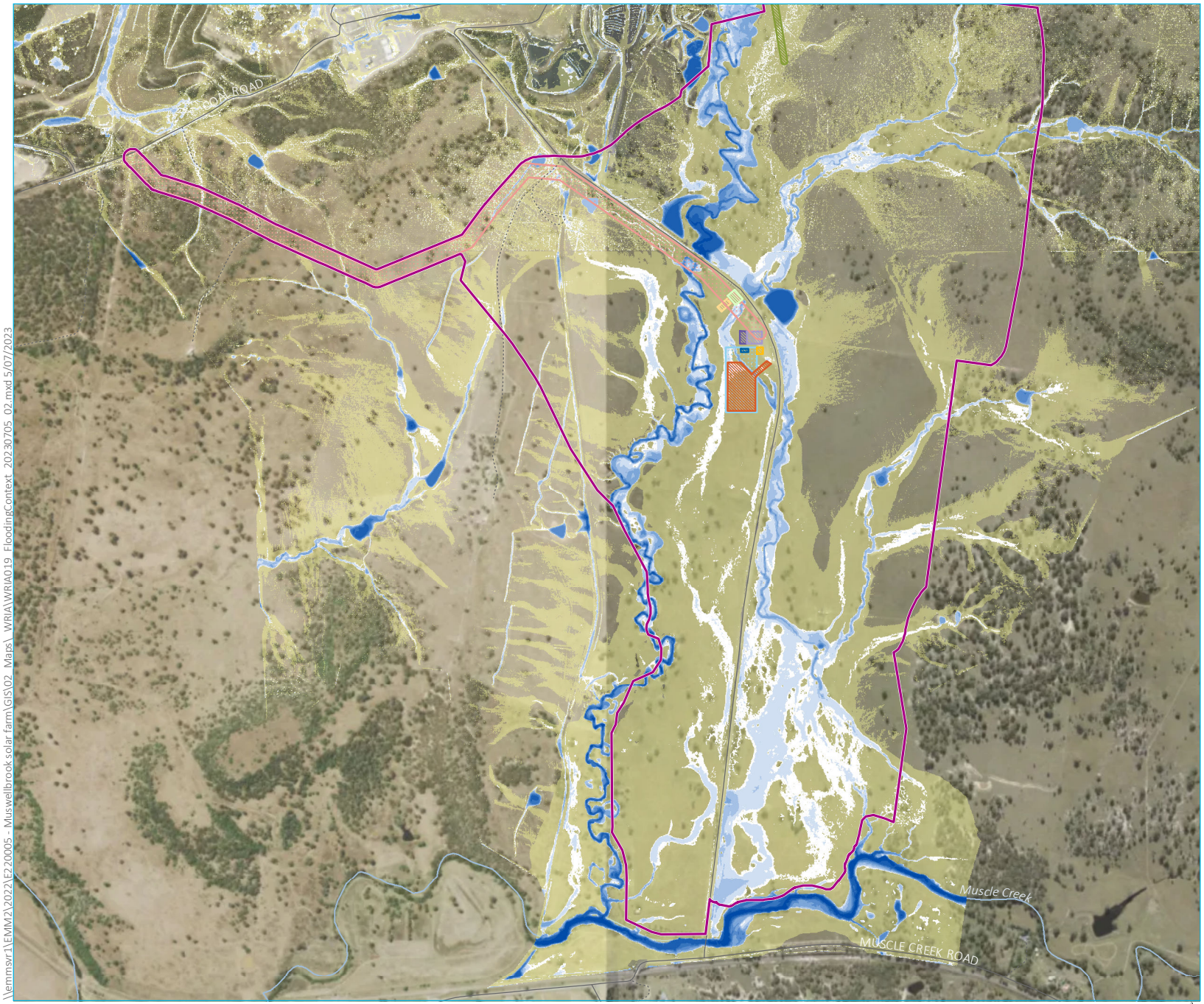
GDA2020 MGA Zone 56

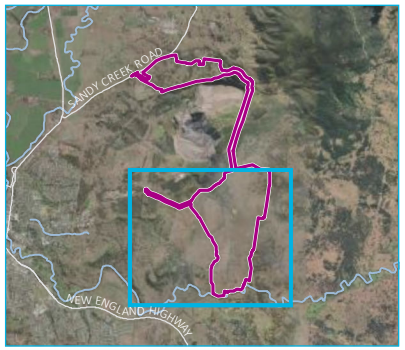
N

Flooding context for a 1% AEP flood event

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.20a

EMM
creating opportunities





KEY

- Project area

Existing environment

- Minor road
- Vehicular track
- Named watercourse
- PMF flood extent

Site layout

- BESS (Battery Energy Storage System)
- BESS collection station
- Car park
- Connection internal north to south buffer
- 132 kV connection to 95M buffer
- Laydown
- O&M
- SF collection station
- Switchyard
- Transformer substation

Maximum water depth (m)

- < 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

INSET KEY

- Major road

Flooding context for a 1% AEP flood event

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.20b

EMM
creating opportunities

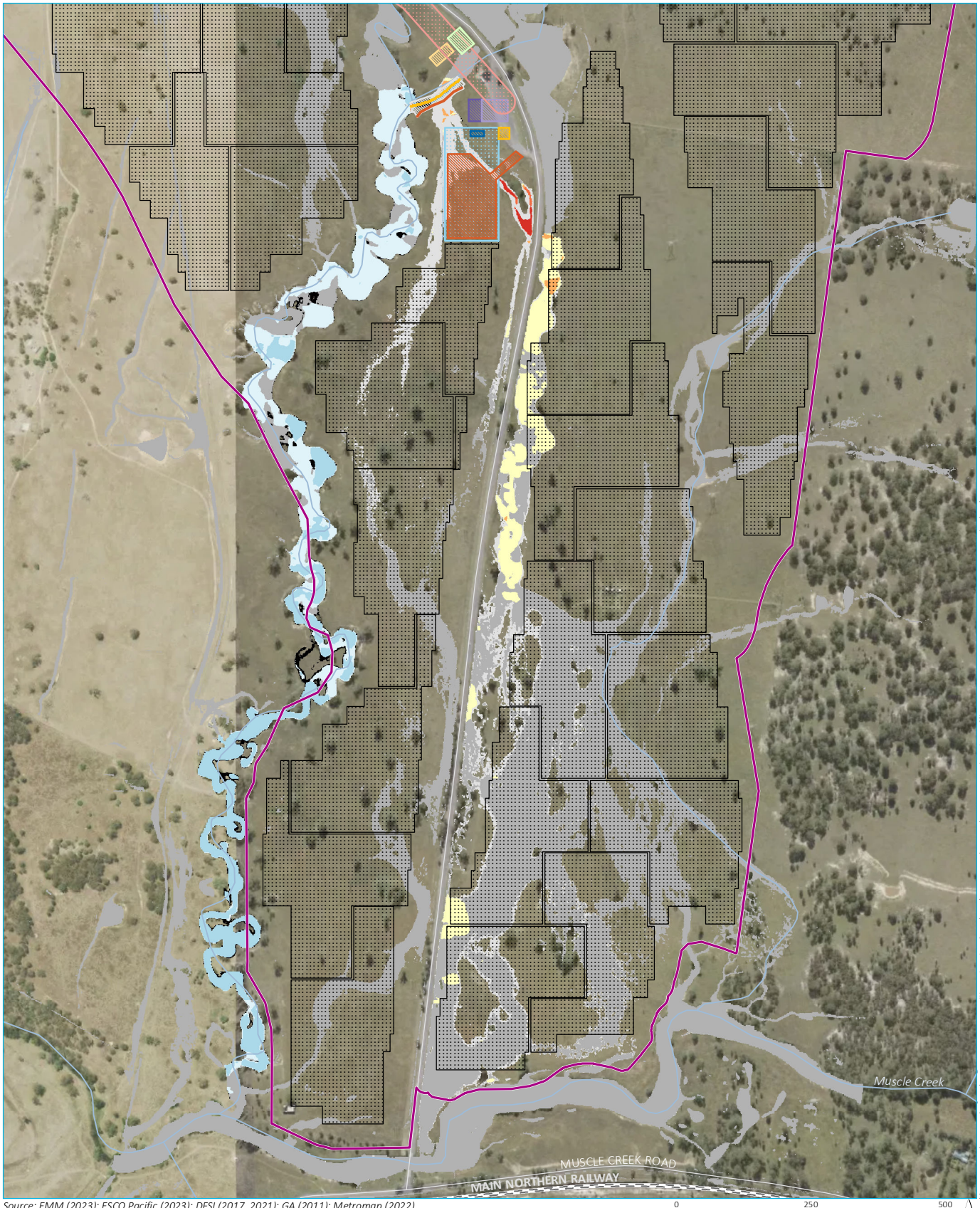
Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2022); DPIE (2020)

0 0.5 1 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_WRIA\WRIA019_FloodingContext_20230705_02.mxd 5/07/2023



Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2022)

0 250 500 m

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_LSEA\WRIA020_FloodingAffluxDrainageDiversion_20230705_04.mxd 5/07/2023

KEY

Project area

Solar array footprint

Diversion channel

Existing environment

- Rail line
- Minor road
- Watercourse/drainage line

Mitigation structure

- Open channel
- Flood diversion bund

Site layout

- BESS (Battery Energy Storage System)
- BESS collection station
- Car park
- 132 kV connection to 95M buffer
- Laydown
- O&M
- SF collection station
- Switchyard
- Transformer substation

Change in water depth (m)

- -1 - -0.5
- -0.5 - -0.25
- -0.25 - -0.1
- -0.1 - -0.05
- -0.05 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1

Change in extent

- Was wet now dry
- Was dry now wet

Flooding afflux from drainage diversion and flood protection bund in 1% AEP event

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.21

EMM
creating opportunities

d Watercourses and riparian corridors

Due to the need to mitigate flood impacts around the BESS area there is a predicted change to flow conditions within the non-minor tributary of Muscle Creek. The change is due to the introduction of an open channel and diversion bund north of the facilities area. This open channel may require some degree of interface with the receiving watercourse which may be determined to be instream works for the receiving watercourse.

The modelling prepared for the diversion indicates localised increases in flow velocity at the interface of between channel and watercourse of 1.5 to 3.0 m/s and depth changes within the receiving watercourse more broadly of 0.1 to 0.3 m. Flow velocity may be attenuated through in channel flow attenuation structures and placed rock. This will be specified during detailed design.

The number of required watercourse crossings has been minimised by the project through the utilisation of the existing access roads and tracks of the existing mining operations. Potential watercourse crossings that could be considered in construction or operation of the project are outlined in Table 6.29.

An above ground cable crossings is required over the tributary of Muscle Creek. This crossing will use poles to elevate the necessary cables off the ground and out of the zone of potential interaction with the watercourse, mitigating the need for any trenching in this location.

Where instream works are proposed (i.e. construction or upgrade of watercourse crossings), these works will be designed and constructed to consider local hydraulic conditions, minimise local flooding impacts, and consistent with relevant guidelines.

Table 6.29 Watercourse crossings

Area	Reach [Figure 3.1]	Stream order	Crossing
North project area	N2-2	1st order	1x existing bed level crossing to be formalised
	N2-3	1st order	1x existing bed level crossing to be formalised
South project area	S1-1	1st order	1x existing bed level crossing to be formalised
	S1-2	1st order	1x existing bed level crossing to be formalised
	S2-1	2nd order	1x existing bed level crossing to be formalised
	S2-2	4th order	Construction methodology to avoid requiring the use of an existing bed level crossing – no upgrade required

e Groundwater

The project will require excavation below existing surface levels to establish suitable foundation conditions for infrastructure, and for the installation of underground services. However, excavations will be shallow (up to a maximum of a few metres in depth) and localised. Groundwater is not expected to be intercepted by excavations.

ii Operation

a Water quality

The key risk to water quality during operation would occur as a result of poor site stabilisation, poor reestablishment of ground cover revegetation, or instream erosion due to failed channel lining within engineered diversions. The occurrence of these risks would lead to ongoing exposure of soils and potential erosion and mobilisation of sediment into receiving watercourses. Accidental spillage of fuel or other hazardous materials may also occur.

b Water quantity

The potential for surface water impacts downstream of the project associated with hydrologic changes due to increased runoff rates from PV modules and proposed new impervious surfaces is considered negligible. PV modules will shed runoff directly to the ground, which will be stabilised and vegetated to promote retention and infiltration similar to existing conditions. Overall, the project is expected to result in no measurable net change to overall site runoff potential, provided stabilisation and revegetation recommendations identified in the LSEA are implemented.

c Flooding

Shallow inundation of PV array areas will have negligible impact on broader flooding conditions and potential for adverse flooding impacts due to the minimal obstruction to floodwaters presented by spaced PV panel support posts. It is predicted that for a PMF event, floodwaters would engage the PV panels in only a few isolated locations based on the current development footprint.

The proposed use of the site is considered to be compatible with the flood hazard, in that the majority of the PV array and infrastructure areas and internal access roads are either free of mainstream flooding or subject to flood hazard that is generally safe for people, vehicles and buildings for events up to, and including, the 1% AEP.

Residual flood risks and the potential for adverse flooding impacts can be adequately managed by:

- Outside those areas requiring engineered drainage mitigation measures, finished ground levels of the project are to be constructed at grade and not materially higher than existing levels in areas subject to mainstream flooding risk. Where a change in ground level is proposed in areas, as part of future design stages or refinements, assessment of the change should be quantified and as part of the FMP to confirm offsite flooding impacts do not occur.
- Development of appropriate watercourse crossing designs and construction methods that consider local hydraulic conditions, minimise local flooding impacts, and are consistent with relevant guidelines.
- Development of a suitable operational FMP to describe required site management and protocols in the event of flood events that could impact operation of the project.

d Watercourses and riparian corridors

Adverse impacts to watercourses and riparian corridors will be avoided due to the development footprint considering the vegetated riparian zone (VRZ) widths recommended in guidelines by DPE (2022c). There are some areas where the VRZ will be developed and a merits based approach was considered in the development of these areas. This is summarised in Table 6.30.

In addition to the proposed development within the VRZ zones of 1st and 2nd order watercourses, there are also areas within the project where the solar panel array footprint is partially within the outer 50% of the VRZ. These situations are considered minor and also acceptable with the adoption of the averaging rule (DPE 2022c).

Table 6.30 Areas of proposed development footprint within or adjacent to VRZ

Area	Reach [Figure 6.22]	Stream order	Merits assessment
North project area (Sandy Creek)	N1-2	1st order	• Limited riparian vegetation. • Downstream excluded development footprint area due to presence of *Diuris tricolor*.
	N1-3	1st order	• Limited channel bed. • Limited riparian vegetation. • Downstream farm dam.
	N1-5	1st order	• Limited encroachment. • Limited riparian vegetation. • Upstream excluded development footprint area due to presence of Diuris tricolor.
	N2-3	1st order	• Limited channel bed. • Limited riparian vegetation.
South project area (Muscle Creek)	S1-1	1st order	• No riparian vegetation. • Limited channel shape.
	S2-1	2nd order	• In-channel erosion due to stock and vehicle movements.

e Groundwater

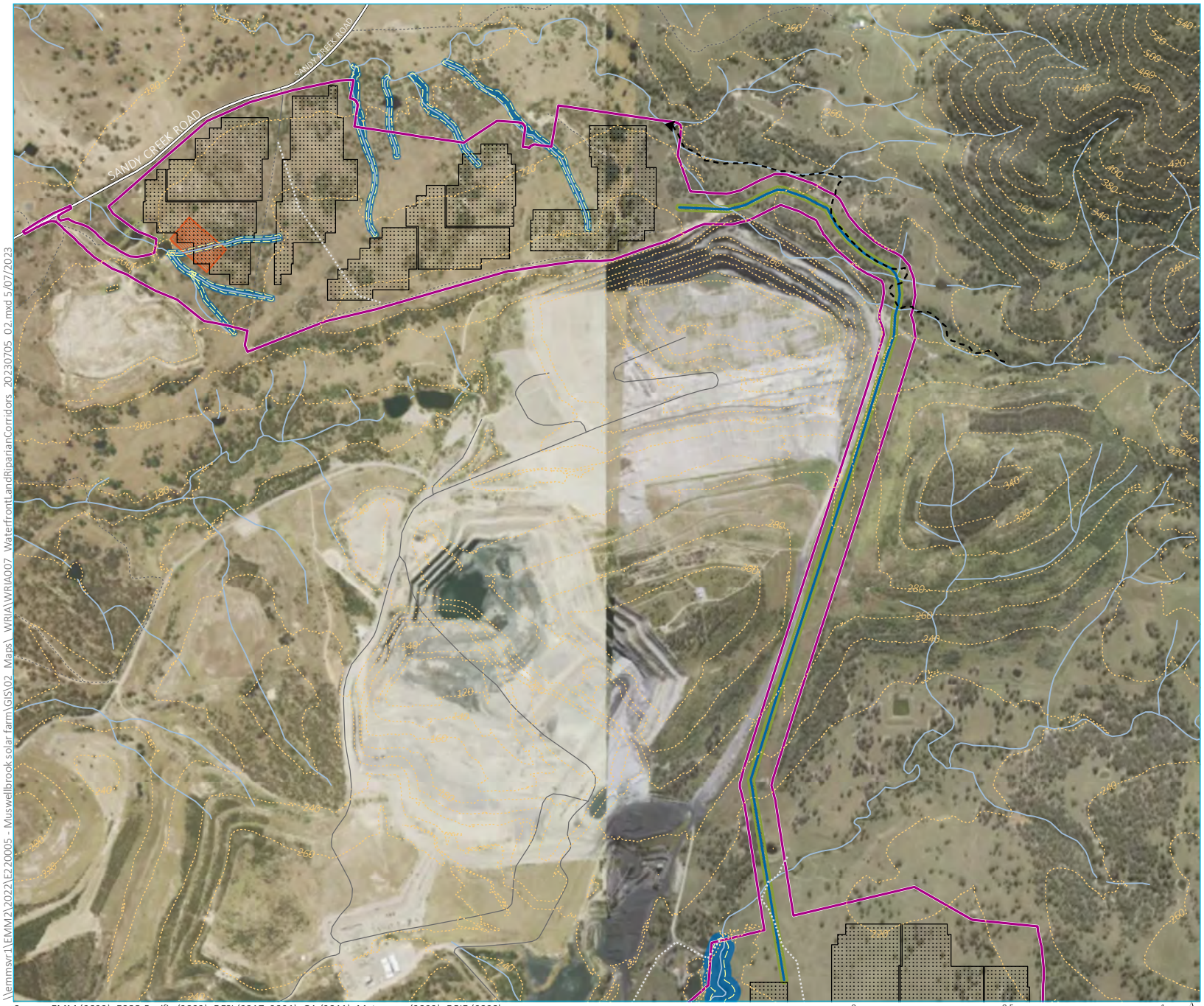
The introduction of impervious surfaces for selected site infrastructure will lead to a very small reduction in the infiltration of stormwater runoff to the underlying soils and recharge of groundwater. However, this will have negligible impact on groundwater levels or availability to existing users (including GDEs) owing to the very small, impacted area compared to the overall recharge area.

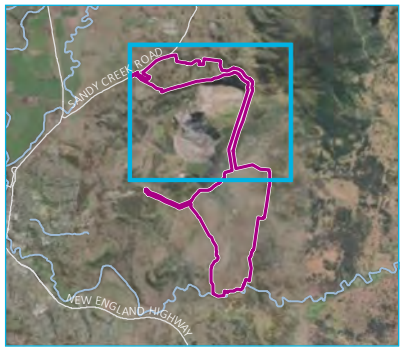
iii Water use

The project will utilise groundwater available from Muswellbrook Coal Mine to meet both construction and operational non-potable water demands. Groundwater from Muswellbrook Coal Mine is available within underground mining voids with the mine having existing dewatering pumping infrastructure available for use which are currently approved water supply works. The water access licences and allocated volumes associated with the groundwater are detailed in Section 3.3.3i.

Based on the predicted construction and operational water volumes (Section 3.3.3i), the project will have sufficient water.

Impacts to consumptive users accessing groundwater via existing registered bores are not anticipated. Similarly, the availability of groundwater to terrestrial and aquatic GDEs mapped in the vicinity of the project, including high priority GDEs under the Surface Water WSP, is unlikely to be impacted.





KEY

- Project area
- Vegetated riparian zone (VRZ)
- Inner 50% of VRZ
- MCC clean water diversion

Site layout

- Internal connection route (33 kV)
- Connection internal north to south buffer
- Laydown
- Solar array footprint

Existing environment

- Major road
- Minor road
- Vehicular track
- Topographic contour (20 m interval)

INSET KEY

- Major road

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02 Maps\ WRIA\WRIA007 WaterfrontLandRiparianCorridors 20230705 02.mxd 5/07/2023

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2022); DPIE (2020)

0 0.5 1 km

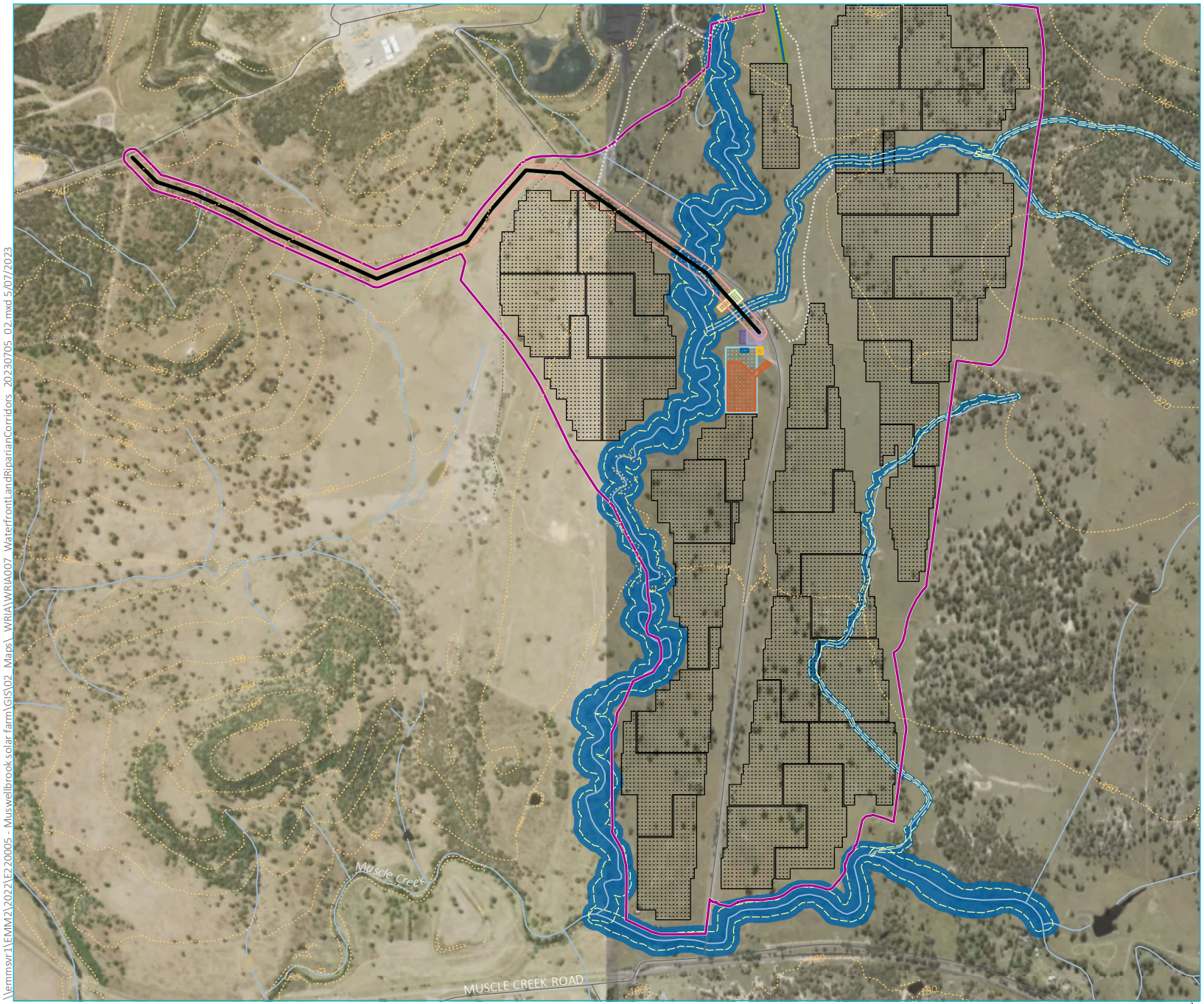
GDA2020 MGA Zone 56

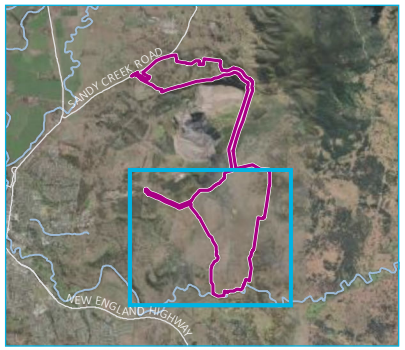
N

Waterfront land and riparian corridors

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.22a

EMM creating opportunities





KEY

- Project area
- Vegetated riparian zone (VRZ)
- Inner 50% of VRZ

Site layout

- 132kV connection to 95M
- Internal connection route (33 kV)
- BESS (Battery Energy Storage System)
- BESS Collection Station
- Car Park
- Connection internal north to south buffer
- 132 kV connection to 95M buffer
- Laydown
- O&M
- SF Collection Station
- Switchyard
- Transformer Substation
- Solar array footprint

Existing environment

- Minor road
- Vehicular track
- Topographic contour (20 m interval)

INSET KEY

- Major road

Waterfront land and riparian corridors

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.22b

Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2022); DPIE (2020)

0 0.5 1 km
GDA2020 MGA Zone 56

N

creating opportunities

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_WRIA\WRIA007_WaterfrontLandRiparianCorridors_20230705_02.mxd 5/07/2023

6.6.4 Mitigation measures

A summary of the proposed measures to manage and mitigate potential impacts to surface water and groundwater is provided in Table 6.31.

Table 6.31 Consolidated management and mitigation measures

ID	Management/mitigation measure
Stormwater management	
SW1	Prior to the commencement of construction, a Soil and Water Management Plan (SWMP) will be prepared, which will outline mitigation measures to be implemented during construction and operation of the project to address risks to surface water and groundwater. Mitigation measures will consist of appropriate siting of infrastructure, capture of stormwater runoff from buildings, erosion and sediment control (ESC) measures such as sediment fences and sediment basins, and continuation and maintenance of stabilised and vegetated surfaces, drainage and sediment and erosion control measures that will be retained for operations.
SW2	Specific stormwater management measures for the substation area will include: • diversion of clean runoff away from potentially oil-contaminated areas • bunding of potentially oil-contaminated areas • provision of stormwater treatment device(s) to remove oil/grease, hydrocarbons and sediment from runoff prior to discharge to the downstream drainage system.
Erosion and sediment control	
ES1	Implementation of erosion and sediment control measures and site rehabilitation and revegetation in accordance with best practice comprising *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004) and Volume 2A (DECC 2008) and *Best Practice Erosion and Sediment Control* (IECA 2008). The LUSEA describes a range of proposed measures for adoption. Proposed measures will be considered further and formalised as part of detailed design and will form part of the SWMP.
ES2	Progressive erosion and sediment control plans (PESCPs) will be developed for all discrete disturbance areas.
Flood risk management	
FLO1	Develop and implement a FMP to describe required site management and protocols in the event of flood events that could impact construction sites or access, including: • suitable early warning/prediction measures and communication protocols • site preparedness activities and procedures • triggers for closure, evacuation and recovery • emergency response and support.
FLO2	Construction site planning at detailed design stage to: • consider flood risk and adopt appropriate placement of temporary works, plant, materials and workforce facilities, that gives due consideration to overland flow paths and mainstream flood risk • ensure that temporary works minimise offsite flooding impacts as far as practical.
FLO3	Design and construction of permanent works to: • locate sensitive infrastructure (e.g. substation, BESS) on high ground above 1% AEP flood levels (or other suitable level of flood immunity as may be determined during detailed design), and avoid or otherwise divert local overland flow paths around infrastructure • ensure finished ground levels are constructed at-grade and not materially higher than existing levels in areas subject to existing mainstream flooding, in order to minimise potential offsite flooding impacts as far as practical. Where a change in ground level is proposed in areas, as part of future design stages or refinements, assessment of the change should be quantified and as part of the FMP to confirm offsite flooding impacts do not occur.
FLO4	Update FMP to describe required site management and protocols in the event of flood events that could impact ongoing operation of the site.

Table 6.31 Consolidated management and mitigation measures

ID	Management/mitigation measure
FLO5	Drainage diversion structure and other required clean water diversion outlets will: • be designed to minimise the construction footprint and proposed extent of disturbances to soil and vegetation within watercourse or waterfront land • protect against scour by attenuating concentrated flow and providing the necessary scour protection, for example, rock rip-rap and/or vegetation • stabilise and rehabilitate all disturbed areas including topsoiling, revegetation, mulching, weed control and maintenance in order to adequately restore the integrity of the riparian corridor.
FLO6	Watercourse crossings to be designed and constructed to: • the appropriate level of serviceability and flood immunity required for the project • local hydraulic conditions and minimise scour potential • minimise local flooding impacts • be consistent with relevant guidance comprising Guidelines for watercourse crossings on waterfront land (DoPI 2012), *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull, S. and Witheridge, G. 2003) and *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI 2013).

6.6.5 Conclusion

Potential water related impacts associated with the proposed Muswellbrook Solar Farm were assessed including impacts to:

- surface water quality, quantity, flooding and impacts to watercourses and riparian corridors
- groundwater levels, quality and impacts to existing users.

Overall, potential surface water and groundwater impacts during construction and operation are considered minor and can be adequately managed through the implementation of the mitigation measures.

6.7 Traffic and transport

6.7.1 Introduction

A traffic impact assessment (TIA) has been prepared for the project by EMM (2023f) and is provided in Appendix K. The TIA has been prepared in accordance with the NSW Government's *Guide to Traffic Generating Developments* (RTA 2002). The relevant SEARs and how they are addressed are summarised in Appendix A and Chapter 1.3 of the TIA.

6.7.2 Existing environment

i Site access

The project area is bounded by Muscle Creek to the south and Sandy Creek Road to the north. There will be two primary access points to the project area via Muscle Creek Road on the south side and Sandy Creek Road on the north side. There is existing access to the project area as part of the MCC operations via Muscle Creek Road and Sandy Creek Road.

ii Road network

An overview of the surrounding road network and traffic characteristics is presented in Figure 6.23.

Key roads in the vicinity of the project include:

- New England Highway – a State road which crosses the NSW border north of Tenterfield and forms a junction with the Pacific Highway at Hexham, Newcastle at the southern end. The New England Highway is a sealed road that generally runs north-south and is generally one lane each way. It is approximately 12.1 m wide, with 3.4 m travel lane each way and 2.1 m shoulders. The road has a 60 km/h speed limit in Muswellbrook and 100 km/h in rural sections of the highway. It is an approved 26 m long B-double route.

- Muscle Creek Road – a local road that starts at the New England Highway at the south-west and roughly follows Muscle Creek until the road terminates approximately 10 km away to the north-east. It is a sealed road that generally runs north-east to south-west with one lane in each direction. Muscle Creek Road is approximately 8.4 m width, with 3.6 m wide lanes and 0.6 m shoulders. It has a posted speed limit of 100 km/h. The road is an approved 26 m long B-double route up to the Muscle Creek Road/Access Road (south) intersection, and local traffic only to the east of the intersection.

- Sandy Creek Road – a local road that starts at New England Highway at the west and ends at McCullys Gap. It is a sealed road that broadly runs east-west with one lane in each direction. It is approximately 6.4 m width, with 3.2 m lanes each way. Shoulder width varies from 0 m in between intersections to 1 m near intersections. It has a posted speed limit of 100 km/h. The road is an approved B-double route for trucks up to 19 m long (with time restrictions) to Sandy Creek Road/Access Road (north) intersection, and local traffic only to the east of the intersection.

iii Key intersections

Key intersections along the haulage route have been identified for this traffic analysis and are labelled on Figure 6.23. The key intersections are:

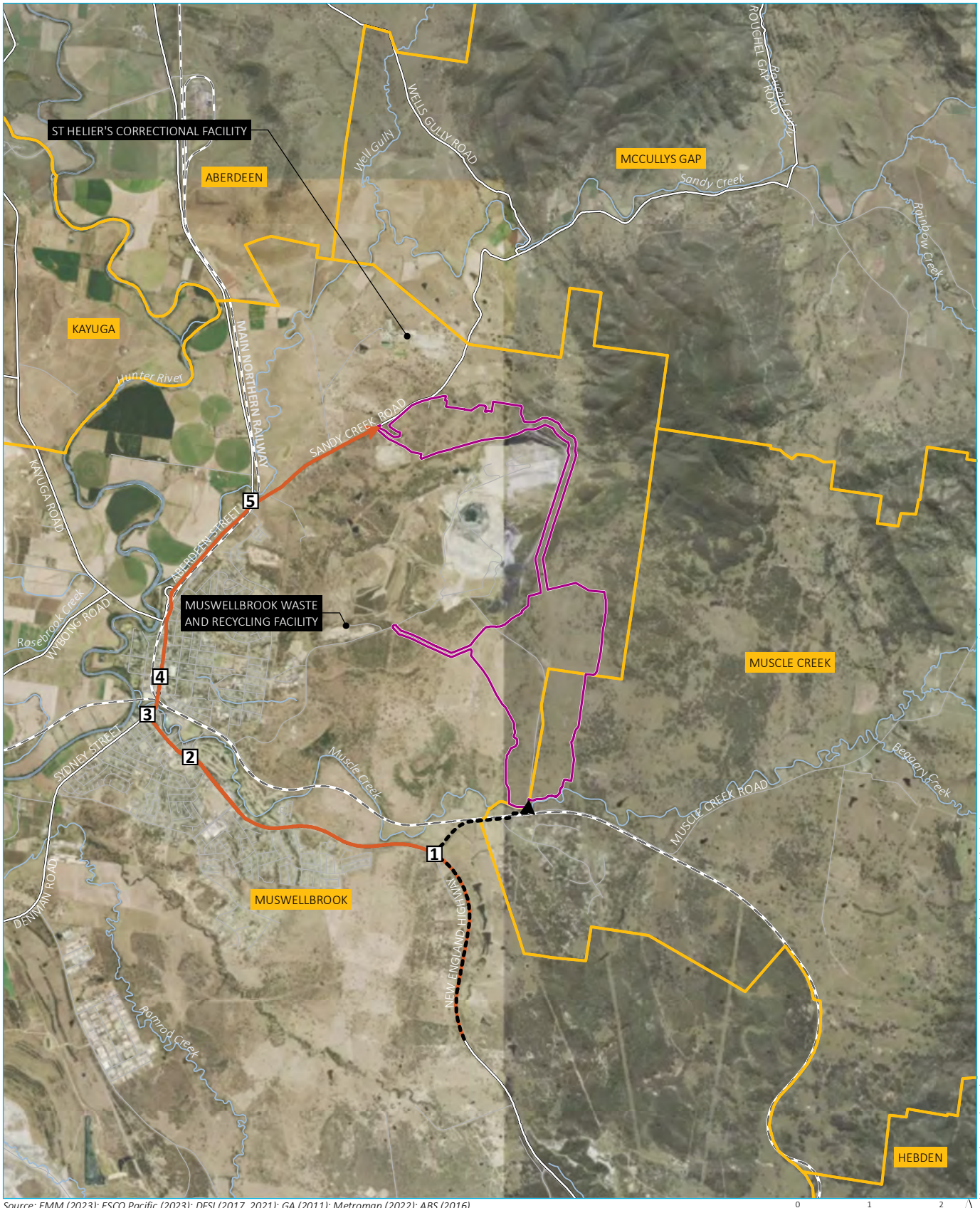
1. New England Highway/Muscle Creek Road – priority-controlled T-intersection (traffic on Muscle Creek Road gives way to New England Highway)

2. Maitland Street (New England Highway)/Bell Street (signalised) – signalised four-way intersection

3. Sydney Street/Maitland Street (signalised) – signalised three-way intersection

4. Bridge Street (New England Highway)/Brook Street (signalised) – signalised four-way intersection

5. Aberdeen Street (New England Highway)/Sandy Creek Road – priority-controlled T-intersection (traffic on Sandy Creek Road gives way to Aberdeen Street).



Source: EMM (2023); ESCO Pacific (2023); DFSI (2017, 2021); GA (2011); Metromap (2022); ABS (2016)

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_TIA\TIA002_LocalContext_20230705_02.mxd 5/07/2023

KEY

- Project area
- Key intersection

Main transport route

- Transport route to northern site access
- Transport route to southern site access

Existing environment

- Rail line
- Major road
- Minor road
- Named watercourse
- Named waterbody
- Suburb boundary

Road network and key intersections

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.23

EMM
creating opportunities

iv Existing traffic volumes

The key intersections were surveyed in September 2022. The AM and PM peak hours were identified as:

- AM: 8:00 am to 9:00 am
- PM: 3:30 pm to 4:30 pm.

The distribution of peak hour traffic volumes is shown in Figure 6.24.

v Crash data analysis

The crash history in the vicinity of the northern and southern site accesses was reviewed for the five years between 2016–2020. Seven crashes have been reported near Aberdeen Street (New England Highway)/Sandy Creek Road intersection and one crash at the New England Highway/Muscle Creek Road intersection. The total of eight crashes involved the following severity:

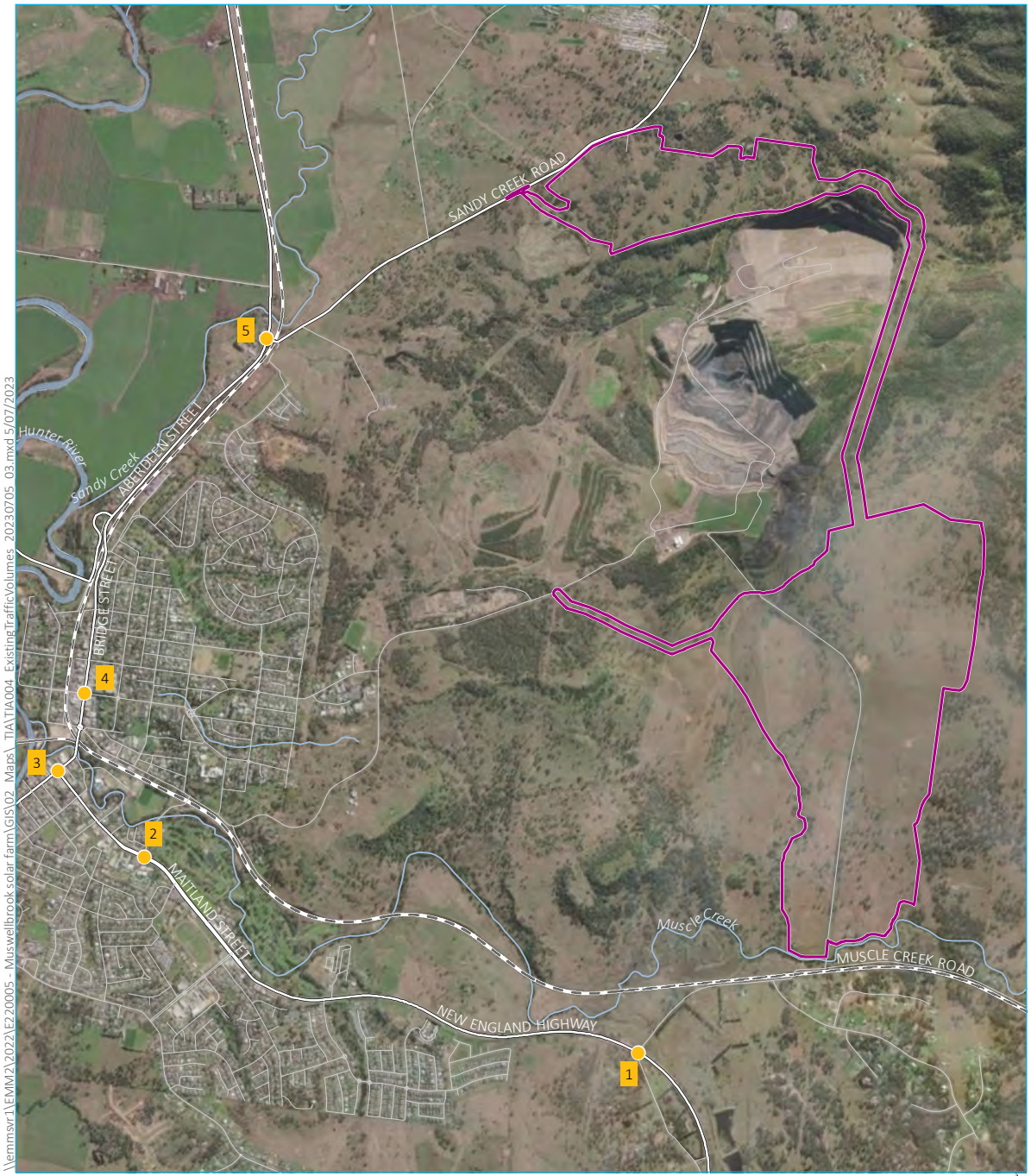
- one fatal
- one serious injury
- six moderate injuries
- none with minor/other injury.

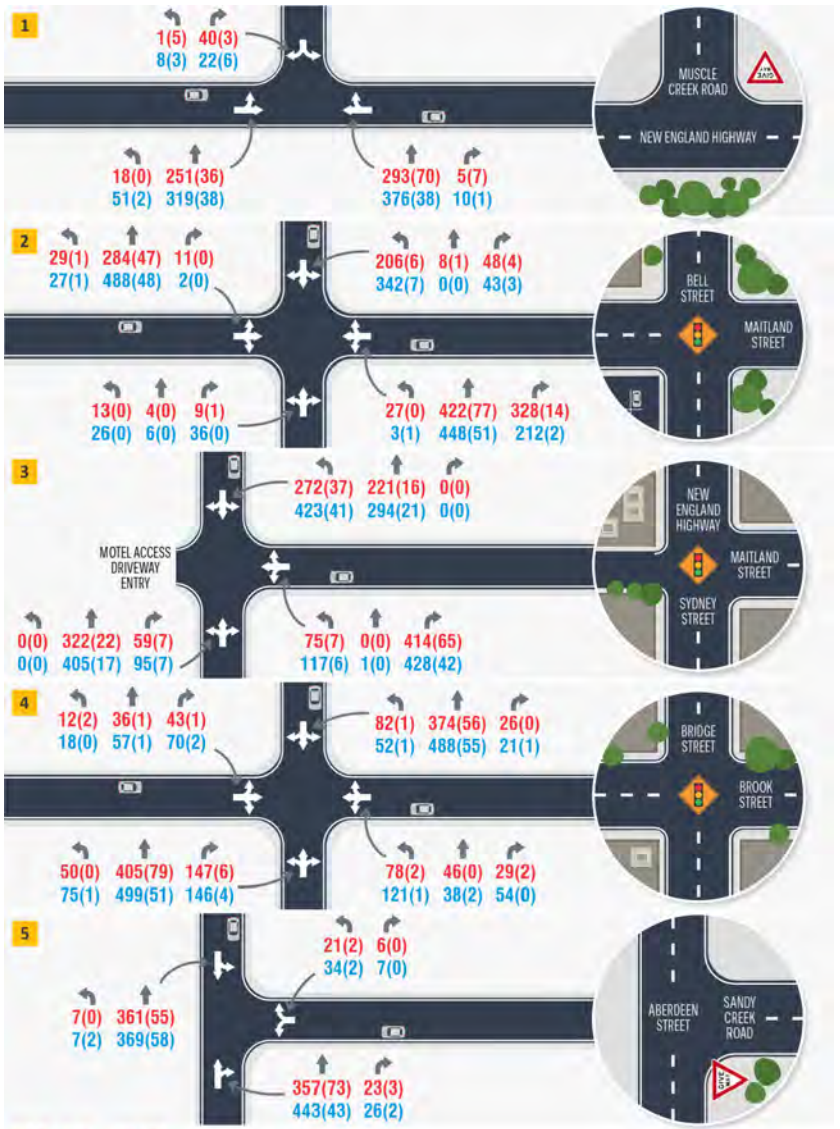
The fatal crash took place in 2018 and was a head on collision at the 2-way undivided New England Highway, approximately 100 m north of the Aberdeen Street (New England Highway)/Sandy Creek Road intersection. The majority of the other crashes were off road on bends and rear ends. The overall crash rate of eight crashes is considered low over the 5-year period, which indicates that there are no significant road safety issues at the locality.

vi Public transport

There are six bus routes operating in the Muswellbrook area that travel along New England Highway including services to Scone, Aberdeen and Denman operated by the private bus company Osborn's Transport. There are a number of schools in Muswellbrook and surrounding areas that are served by Osborn's Transport and Howard's Bus & Charter. School buses run on Sandy Creek Road between 7:30 am–8:30 am in the morning and 3:45 pm–4:45 pm in the afternoon.

Commuter trains stop at Muswellbrook train station. On a typical weekday, four services depart Muswellbrook on the Hunter Line towards Newcastle Interchange. Three services depart Muswellbrook on the Hunter Line towards Scone, while one service travelling in the same direction terminates at Muswellbrook. On a typical weekend, two services depart Muswellbrook on the Hunter Line towards Broadmeadow and Newcastle Interchange. Two services depart Muswellbrook on the Hunter Line towards Scone. There is a daily regional service operating in both directions between Sydney and Armidale that stops in Muswellbrook.





AM Peak Hour LV(HV)
PM Peak Hour LV(HV)

LV – Light Vehicles
HV – Heavy Vehicles

Existing traffic volumes in Muswellbrook

KEY

- Project area
- Key intersection
- Rail line
- Major road
- Minor road
- Named watercourse
- Named waterbody
- State forest

Source: EMM (2023); ESCO Pacific (2022); DFSI (2017, 2020); ESRI (2023); GA (2011)

0 1 2 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_TIA\TIA004_ExistingTrafficVolumes_20230705_03.mxd 5/07/2023

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.24

EMM
creating opportunities

vii Active transport

There are no dedicated footpaths or cycling infrastructure on either Muscle Creek Road or Sandy Creek Road. There are pedestrian footpaths on both sides of the New England Highway through Muswellbrook between Wilkins Street in the north and Bell Street in the south, and on one side of the highway from Bell Street to Hunt Place in the east.

Signalised pedestrian crossings are provided at several intersections along the New England Highway in Muswellbrook.

Bike paths are provided throughout Muswellbrook and along the New England Highway.

viii Future road improvements

The New England Highway bypass of Muswellbrook will divert traffic from the Muswellbrook town centre and run along the eastern side of Muswellbrook town centre. The construction of the bypass is expected to decrease traffic volumes by at least 20% along the New England Highway. Construction works are expected to start in 2023 and take around 3.5 years to complete. The bypass is expected to be operational in 2027.

ix Level crossing

A railway level crossing intersects the north-south railway line between Muswellbrook and Aberdeen, and Sandy Creek Road approximately 55 m east of the New England Highway/Sandy Creek Road intersection. For eastbound traffic on Sandy Creek Road, a 40 m long stretch of road is available to store vehicles while the railway level crossing is occupied by a train. The railway level crossing is situated to the north of the Muswellbrook town centre. Sandy Creek Road forms part of a potential route to access the northern section of the project area.

The majority of the trains timetabled to pass through the level crossing are coal trains serving the coal mines along the railway line. Each day there are between 53–59 trains passing through the level crossing and these trains are roughly spread out through all hours of the day. The timetable varies every day, but there are no substantial differences between weekdays and weekends.

6.7.3 Potential impacts

i Traffic generation and distribution

Construction traffic for the project will consist of light vehicles transporting construction staff, heavy vehicles for construction activities and deliveries, and one OSOM vehicle for delivery of the transformer.

The following daily construction vehicle movements are anticipated during the peak construction period of the solar farm:

- a maximum of 200 light vehicle trips per day (200 in and 200 out) during the construction works phase
- a maximum of 90 heavy vehicle trips per day (90 in and 90 out) during construction works phase
- an average of 24 heavy vehicle trips per day (24 in and 24 out) during the construction works phase.

The following assumptions have been made to anticipate peak hour construction vehicle movements during the peak construction period of the solar farm:

- a maximum of 167 light vehicle trips during the morning and evening peak hour (167 in and 167 out)
- a maximum of 13 heavy vehicle trips during these peak hours (13 in and 13 out) in both peak hours.

Passenger vehicles are expected to arrive at the site prior to commencement of construction shifts. Sixteen minibuses (included as light vehicles) would be used to take workers to and from the site. Peak heavy vehicle trips are expected to occur during civil and structural works, associated with the delivery of materials, plant and equipment. Deliveries of solar panels, batteries and enclosures are anticipated to occur in batches.

Eighty percent (80%) of light and heavy vehicles are anticipated to travel to the southern site access point via New England Highway and Muscle Creek Road, while 20% of all vehicles will travel to the northern site access point via the New England Highway and Sandy Creek Road as presented in Table 6.32.

Table 6.32 Estimated construction traffic movements

Description		Light vehicles	Heavy vehicles
Muscle Creek Road between New England Highway and southern site access			
AM peak movements	Eastbound	134	11
	Westbound	0	11
PM peak movements	Eastbound	0	11
	Westbound	134	11
Sandy Creek Road between Aberdeen Street and northern site access			
AM peak movements	Eastbound	33	2
	Westbound	0	2
PM peak movements	Eastbound	0	2
	Westbound	33	2

Muscle Creek Road is already an approved 25/26 m B-double route up to the southern site access due to its history of catering for coal truck movements. It is anticipated that the construction period heavy vehicle movements would be evenly distributed throughout the day to meet deliverables and allow for operational flexibility. These heavy vehicle movements are expected to have minimal impact on Muscle Creek Road and the surrounding road network.

While Sandy Creek Road is currently only approved for 19 m B-doubles and B-doubles are currently not permitted on Sandy Creek Road between 7:30–8:30 am and 3:45-4:45 pm on school days, National Heavy Vehicle Regulator (NVHR) approval will be required as it is anticipated that some 26 m B-doubles will access the northern site access during construction hours. A maximum of two heavy vehicles per hour will use Sandy Creek Road to access the northern site access. The heavy vehicle movements are expected to have minimal impact on Sandy Creek Road and the surrounding road network.

Workers for the project have been assumed to live in and/or commute from the following areas:

- 30% in Muswellbrook
- 50% in Singleton and further east towards Newcastle
- 10% in Denman
- 10% in Aberdeen/Scone.

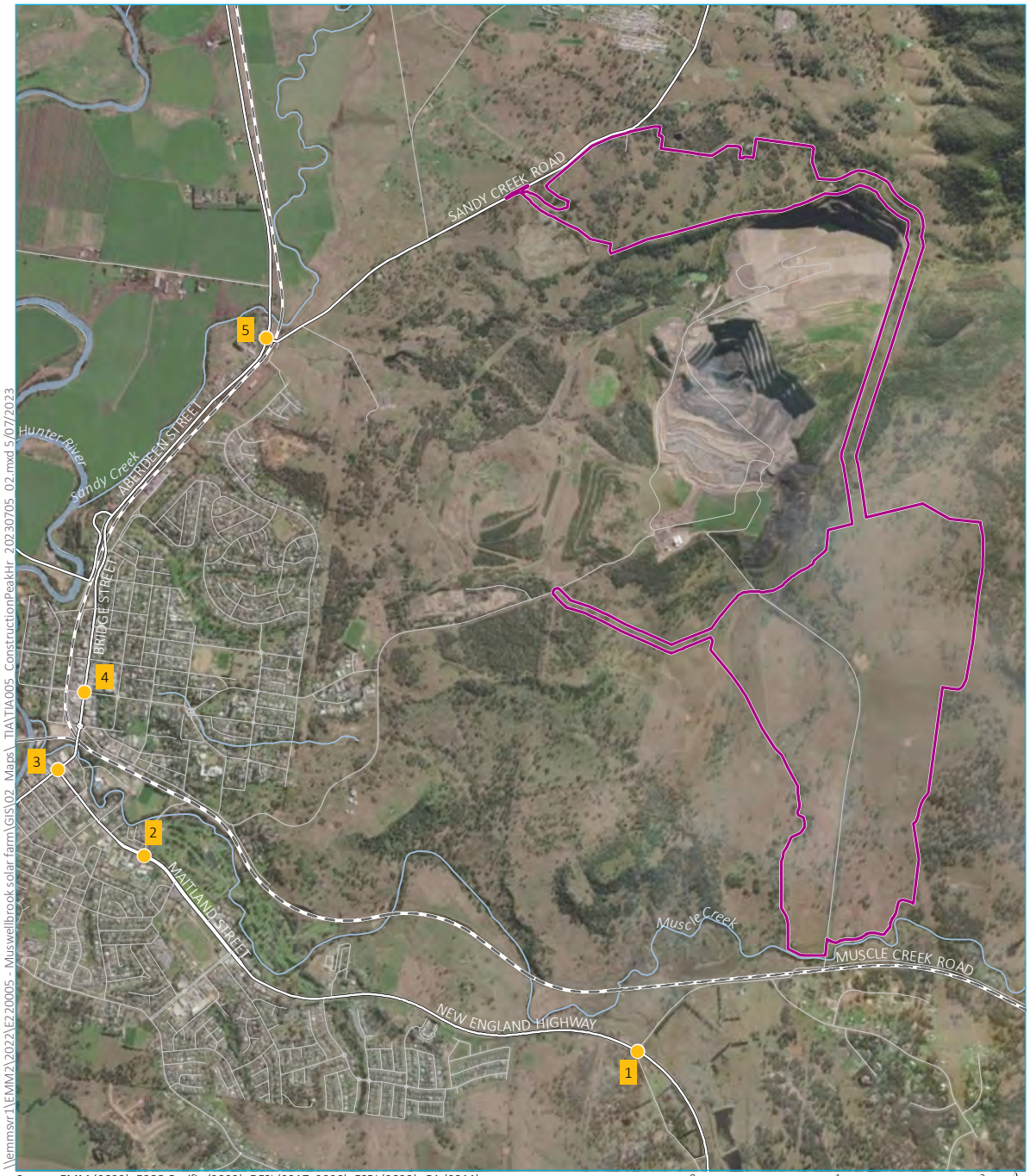
Heavy vehicle movements, particularly those associated with the delivery of materials and equipment will generally be evenly spread throughout construction hours. Most heavy vehicles are anticipated to be via Sydney/Newcastle and surrounding regional centres (90%). Some heavy vehicles will also originate from Scone and Aberdeen (10%). Most heavy vehicles travelling from Sydney and Newcastle are anticipated to travel to site via the New England Highway and Muscle Creek Road, an approved 26 m long B-double route.

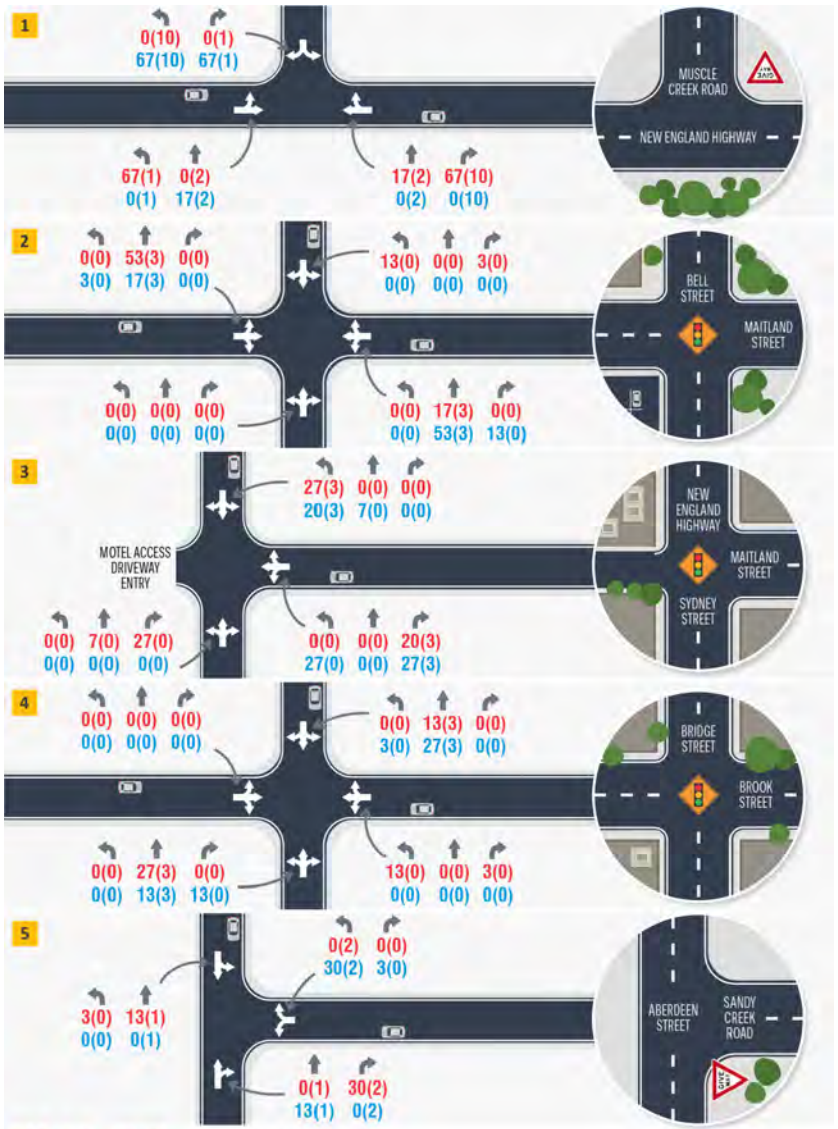
The expected project traffic volumes during the AM and PM peak hours are summarised in Figure 6.25, and the combined existing and construction traffic volumes are shown in Figure 6.26.

The operational traffic generation will be significantly lower than during project construction. Hence operational traffic impacts were not considered further by the TIA.

At the end of the project's operation, decommissioning will generate approximately half of the daily number of trips generated by construction traffic. These vehicles will be used to transport equipment away from the site.

As the decommissioning traffic volumes will also be significantly less than the project's construction traffic, the TIA assessed construction traffic only.





AM Peak Hour LV(HV)
PM Peak Hour LV(HV)

LV – Light Vehicles
HV – Heavy Vehicles

KEY

- Project area
- Key intersection
- Rail line
- Major road
- Minor road
- Named watercourse
- Named waterbody
- State forest

Source: EMM (2023); ESCO Pacific (2022); DFSI (2017, 2020); ESRI (2023); GA (2011)

0 1 2 km

GDA2020 MGA Zone 56

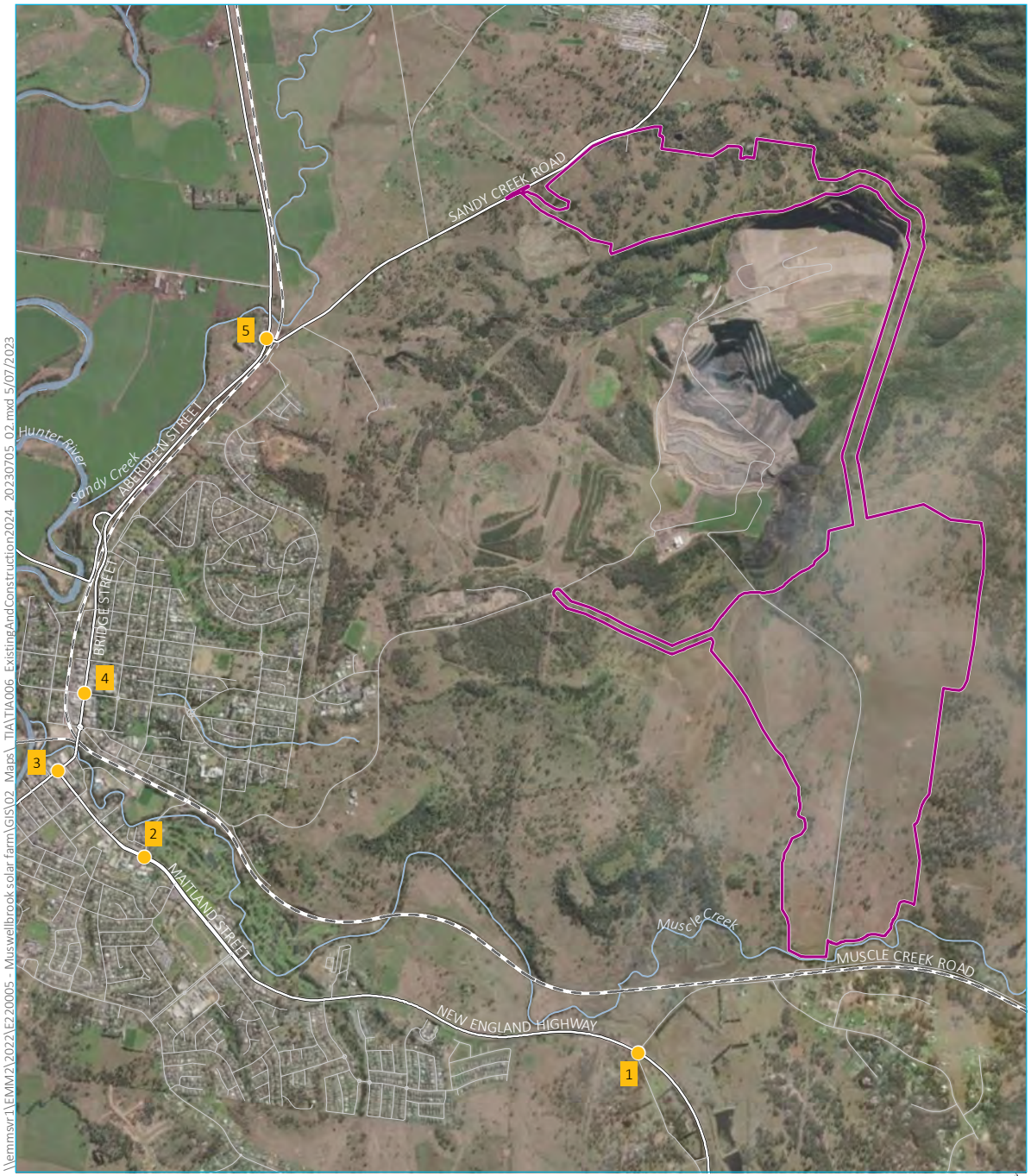
N

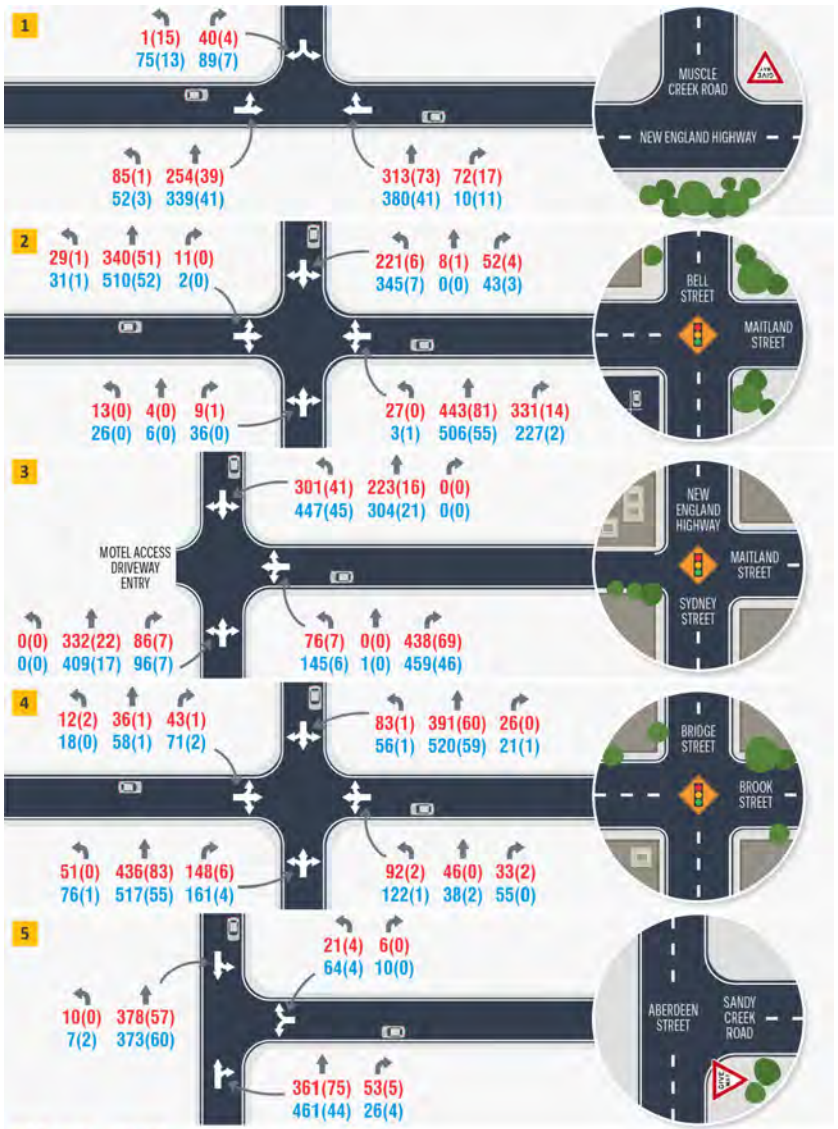
\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_TIA\TIA005_ConstructionPeakHr_20230705_02.mxd 5/07/2023

Construction traffic volumes during AM and PM peak hour

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.25

EMM
creating opportunities





AM Peak Hour LV(HV)
PM Peak Hour LV(HV)

LV – Light Vehicles
HV – Heavy Vehicles

Existing and construction volumes with 0.5% per annum growth scenario in 2024

KEY

- Project area
- Key intersection
- Rail line
- Major road
- Minor road
- Named watercourse
- Named waterbody
- State forest

Source: EMM (2023); ESCO Pacific (2022); DFSI (2017, 2020); ESRI (2023); GA (2011)

0 1 2 km

GDA2020 MGA Zone 56

N

\\emmsvr1\EMM2\2022\E220005 - Muswellbrook solar farm\GIS\02_Maps_TIA\TIA006_ExistingAndConstruction2024_20230705_02.mxd 5/07/2023

Muswellbrook Solar Farm
Environmental Impact Statement
Figure 6.26

EMM
creating opportunities

ii Intersection performance

The key intersections have been modelled with SIDRA Intersection 9.0 software, a micro-analytical tool for individual intersections and linked intersection-network modelling. SIDRA provides the following performance indicators:

- Degree of saturation (DOS) – the total usage of the intersection expressed as a factor of 1 with 1 representing 100% use/saturation (e.g. 0.8 = 80% saturation). In practice the target degrees of saturation of 0.90 for signals, 0.85 for roundabouts and 0.80 for unsignalised intersections are generally agreed to.
- Average delay (DEL) – the average delay in seconds encountered by all vehicles passing through the intersection.
- Level of service (LOS) – this is a categorisation of average delay and is a good indicator of overall performance for individual intersections. LOS range from A to F, where A is good operation, B is good with acceptable delays and some spare capacity, C is satisfactory, D is near capacity, E is at capacity, and F is unsatisfactory with excessive queuing.
- 95% queue lengths (Q95) – is defined to be the queue length in metres that has only a 5% probability of being exceeded during the analysed time period.

The following abbreviations are used to describe the direction of the Q95 approach:

- LT – left turn
- RT – right turn
- TH – through movement.

SIDRA modelling was conducted for the following scenarios:

6. Existing 2022 – surveyed traffic volumes only.
7. Future 2024 + construction – combined surveyed with growth factor and project construction traffic volumes.
8. Future 2024 + construction + cumulative – includes combined existing, project construction traffic and nearby development traffic (including the Muswellbrook Bypass and Firm Power Muswellbrook BESS).

The SIDRA results are presented in Table 6.33 to Table 6.37.

Table 6.33 SIDRA modelling result for New England Highway/Muscle Creek Road

Control: Priority (Give Way)	AM Peak						PM Peak					
Scenarios	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**
1. Existing 2022	729	14.5	(worst: B)	0.218	2.5	RT from Muscle Creek Rd (north-east)	874	18.3	(worst: B)	0.234	2.5	RT from Muscle Creek Rd (north-east)

Table 6.33 SIDRA modelling result for New England Highway/Muscle Creek Road

Control: Priority (Give Way)	AM Peak						PM Peak					
Scenarios	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**
2. Future 2024 + construction	914	17.2	(worst: B)	0.232	3.3	RT from Muscle Creek Rd (north-east)	1061	19.3	(worst: B)	0.306	8.4	RT from Muscle Creek Rd (north-east)
3. Future 2024 + construction + cumulative	1,058	21.0	(worst: B)	0.269	4.4	RT from Muscle Creek Rd (north-east)	1204	23.6	(worst: B)	0.459	13.8	RT from Muscle Creek Rd (north-east)

Note: LOS and average delay is the relevant performance of the intersection for the worst movement due to the higher delays experienced on the leg that needs to give way to other traffic.

Key findings:

- in the AM and PM, the intersection performs well within capacity, with the worst LOS of B at the RT from Muscle Creek Road (north-east) and spare capacity of at least 50% for all scenarios
- the net traffic impact due to the construction related traffic will be marginal
- overall, the intersection has additional capacity to accommodate traffic generated by the project and surrounding developments.

Table 6.34 SIDRA modelling result for Maitland Street/Bell Street

Control: Signalised	AM Peak							PM Peak						
Scenarios	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**		**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**	
1. Existing 2022	1,540	12.7	A	0.455	42.2	TH from Maitland St (west)		1,747	12.4	A	0.401	61.5	TH from Maitland St (west)	
2. Future 2024 + construction	1,647	12.7	A	0.474	48.5	TH from Maitland St (west)		1,857	12.2	A	0.423	65.5	TH from Maitland St (west)	
3. Future 2024 + construction + cumulative	1,759	12.7	A	0.510	53.5	TH from Maitland St (west)		1,967	12.3	A	0.460	74.1	TH from Maitland St (west)	

Key findings:

- in the AM and PM, the intersection performs well within capacity, with LOS A and spare capacity of at least 50% for all scenarios
- overall, the intersection has more than 50% capacity to accommodate traffic generated by the project and surrounding developments.

Table 6.35 SIDRA modelling result for Sydney Street/Maitland Street

Control: Signalised	AM Peak						PM Peak					
Scenarios	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**
1. Existing 2022	1,517	19.0	B	0.671	104.5	RT from Maitland St (south-east)	1,896	21.2	B	0.657	131.5	RT from Maitland St (south-east)
2. Future 2024 + construction	1,618	19.2	B	0.677	113.4	RT from Maitland St (south-east)	2,002	21.4	B	0.689	140.0	RT from Maitland St (south-east)
3. Future 2024 + construction + cumulative	1,744	20.3	B	0.750	141.7	RT from Maitland St (south-east)	2,126	21.6	B	0.728	152.5	RT from Maitland St (south-east)

Key findings:

- in the AM and PM, the intersection performs well within capacity, with LOS B and DoS < 0.75 for all scenarios
- overall, the intersection has over 25% spare capacity to accommodate traffic generated by the project and surrounding developments.

Table 6.36 SIDRA modelling result for Bridge Street/Brook Street

Control: Signalised	AM Peak						PM Peak					
Scenarios	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**
1. Existing 2022	1,478	19.8	B	0.403	61.7	TH from Bridge St (north)	1,758	20.9	B	0.493	77.9	TH from Bridge St (north)
2. Future 2024 + construction	1,555	19.9	B	0.425	65.7	TH from Bridge St (north)	1,840	20.6	B	0.513	82.4	TH from Bridge St (north)

Table 6.36 SIDRA modelling result for Bridge Street/Brook Street

Control: Signalised	AM Peak						PM Peak					
Scenarios	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**
3. Future 2024 + construction + cumulative	1,679	19.4	B	0.435	69.2	TH from Bridge St (north)	1,961	23.2	B	0.579	95.6	TH from Bridge St (north)

Key findings:

- in both the AM and PM, the intersection performs well within capacity, with LOS B and DOS < 0.6 for all scenarios
- overall, the intersection has additional capacity to accommodate traffic generated by the project and surrounding developments.

Table 6.37 SIDRA modelling result for Aberdeen Street/Sandy Creek Road

Control: Priority (Give Way)	AM Peak						PM Peak					
Scenarios	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**	**Intersection volume**	**DEL (s)**	**LOS**	**DOS**	**Q95 (m)**	**Q95 approach and direction**
1. Existing 2022	908	13.5	(worst: A)	0.248	2.7	TH and RT from Aberdeen St (south)	993	14.9	(worst: B)	0.257	2.7	TH and RT from Aberdeen St (south)
2. Future 2024 + construction	970	14.9	(worst: B)	0.260	5.7	TH and RT from Aberdeen St (south)	1053	16.1	(worst: B)	0.261	3.0	LT and RT from Sandy Creek Rd (east)
3. Future 2024 + construction + cumulative	1103	24.9	(worst: B)	0.311	15.2	TH and RT from Aberdeen St (south)	1187	20.9	(worst: B)	0.286	9.3	LT and RT from Sandy Creek Rd (east)

Note: LOS and average delay is the relevant performance of the intersection for the worst movement due to the higher delays experienced on the leg that needs to give way to other traffic.

Key findings:

- In the AM and PM, the intersection performs well within capacity, with the worst LOS of B at the LT and RT from Sandy Creek Road (east) and spare capacity of at least 70% for all scenarios.

- In Scenario 3, during the PM peak, the longest queue of 9.3 m on Sandy Creek Road (east) will not obstruct the nearby railway crossing, as there is a 40 m long stretch of road between the railway crossing and the Aberdeen Street/Sandy Creek Road intersection.

- Overall, the intersection has additional spare capacity to accommodate traffic generated by the project and surrounding developments.

iii Level crossing assessment

The level crossing on Sandy Creek Road near the Aberdeen Street/Sandy Creek Road intersection has been assessed to determine the impacts of the current and future traffic movements in the area.

In the AM peak (8:00 am–9:00 am), there are three train movements that will stop vehicular traffic at the level crossing. In the PM peak (3:30 pm–4:30 pm), there are two train movements that block the level crossing.

A survey of train crossing movements was conducted on Tuesday, 20 September 2022. It was observed that the trains that will likely be passing through the level crossing during the AM and PM peak are longer coal trains. The coal trains that passed through the level crossing were observed to occupy the level crossing for an average time of three minutes and 24 seconds.

During the time of the level crossing closure, queues of up to five light vehicles were observed going eastbound on the short stretch of Sandy Creek Road between Aberdeen Street/Sandy Creek Road intersection and the level crossing. Furthermore, it was noted that the road was at capacity when the five light vehicles were queued in this section of Sandy Creek Road. This means that any further traffic will likely back up onto Aberdeen Street (New England Highway).

As traffic at this intersection will increase due to construction activity for the project, it is likely that traffic will back up beyond the storage capacity of the road between the Aberdeen Street/Sandy Creek Road intersection and the level crossing. Left turning traffic on the north approach of Aberdeen Street (New England Highway) will block the main road (New England Highway) as there is no dedicated left turn lane.

To alleviate the issue, no site related inbound heavy vehicle movements should take place from the Aberdeen Street (New England Highway) north approach if there is no space on Sandy Creek Road for the heavy vehicle to queue while the level crossing lights are flashing. Alternatively, heavy vehicles can continue south on Aberdeen Street and Bridge Street (New England Highway) and take either of the following two options, to return northbound back to the Aberdeen Street/Sandy Creek Road intersection to make a right turn from Aberdeen Street to Sandy Creek Road:

- perform a u-turn around the Bridge Street/Market Street roundabout, and continue northbound through to Aberdeen Street to reach the Aberdeen Street/Sandy Creek Road intersection

- detour via Sydney Street, through to Denman Road, left turn onto Thomas Mitchell Drive, left turn onto New England Highway, through to Maitland Street, right turn at Sydney Street, through to Bridge Street, through to Aberdeen Street to reach the Aberdeen Street/Sandy Creek Road intersection.

On the south approach of Aberdeen Street (New England Highway), there are two northbound lanes, which will allow for right turning traffic to wait at the Aberdeen Street/Sandy Creek Road intersection without obstructing the northbound through traffic movements. It is recommended that during the AM and PM peak, site related heavy vehicles should wait to turn right on the second lane of Aberdeen Street if the level crossing lights are flashing, regardless of whether there is enough space to fit the vehicle. This will ensure that any left turning traffic from Aberdeen Street can be stored on Sandy Creek Road before the level crossing without obstructing the main road. This can be covered in Drivers Code of Conduct.

iv Mid-block capacity analysis

The mid-block level of service on rural and urban roads is assessed based on a vehicle's average travel speed. Mid-block level of service was assessed for Muscle Creek Road and Sandy Creek Road.

Muscle Creek Road is expected to operate at LOS A in the baseline traffic scenario and at LOS C in the cumulative traffic scenario. Sandy Creek Road is expected to operate at LOS A in the baseline traffic scenario and at LOS B in the cumulative traffic scenario.

The reduction in the LOS (by one or two levels) is only for the duration of the period of peak construction activity. When the project construction work has been completed, the LOS will return to the baseline traffic conditions.

Furthermore, this assessment has been carried out for a worst-case scenario where it is assumed that traffic from nearby developments, project construction traffic and road network traffic would all overlap in the same morning and evening peak hours. This is considered highly unlikely, and arrival and departure patterns of traffic may not necessarily coincide.

The LOS C is considered to be a satisfactory condition for traffic flow but is only expected to be experienced in the AM and PM peak hours during the construction period. At other times of the day, the LOS would be better than C.

v Intersection operation

Intersection operations are assessed from a combination of the peak hourly through and turning traffic movements that occur at each intersection.

The assessment found that, in accordance with current design standards (Austroads 2017), the Muscle Creek Road site access does not require any upgrade for the project, while the Sandy Creek Road/northern site access intersection will require:

- a basic right turn treatment (BAR) for right turning traffic from Sandy Creek Road eastbound to the northern site access road.

vi Road safety assessment

The accesses to the southern site access road on Muscle Creek Road and the northern site access on Sandy Creek Road are located on straight sections, hence there are no sight distance or safety issues for entering or existing vehicles to/from the site. In accordance with *Austroads Guide to Road Design Part 4A (Unsignalised and Signalised Intersections)* (Austroads 2017), for a 100 km/h road, the minimum safe intersection sight distance (SISD) required for a general minimum 2 second driver reaction time is 248 m.

On Muscle Creek Road, the sight distances to the left meets the minimum requirement (248 m). Due to the bend in the railway overpass, the sight distance to the right is 210 m, which is shorter than the minimum requirement of 248 m for a 100 km/h road. However, the road has been used for coal operations for many years without any major crash incidents. Hence, the 210 m sight distance to the right of the southern site access is considered satisfactory.

On Sandy Creek Road, the sight distance to the left is measured to the curve in the road (approximately 1090 m), while the sight distance to the right is measured to the location of the crest (approximately 270 m). The sight distances to the left and right of the northern site access on Sandy Creek Road meets the minimum requirement (248 m).

vii Swept path analysis

Swept path assessments have been performed as part of the site access intersection concept design and demonstrate the detour route at the Bridge Street/Market Street roundabout to avoid queues blocking the level crossing at Sandy Creek Road.

The northern site access has been assessed for heavy vehicle movements. The largest type of vehicle that will access the northern site access will be a 26 m B-double.

The southern site access has been assessed for OSOM vehicle movements. The largest type of vehicle that will access the southern site access will be an 8 x 8 low-loader trailer with a gooseneck, 2 x 8 dolly and truck combination.

viii Road corridor upgrade

To accommodate the construction traffic movements associated with the project, an upgrade to the intersection of Sandy Creek Road and the northern site access will be required. A preliminary concept plan has been prepared for a basic right turn treatment from Sandy Creek Road to the northern site access (Appendix K). The intersection geometry is determined by the swept path assessment of a 26 m B-double truck, which is the longest construction vehicle accessing the northern site access.

ix Impact on public transport, pedestrian and cyclists

There are school bus routes passing along Muscle Creek Road and Sandy Creek Road. The potential impacts on school bus traffic associated with construction of the project will be limited to heavy vehicles only as construction staff travelling in light vehicles will all generally be arriving and departing from the site outside of school bus operating hours.

Muscle Creek Road and Sandy Creek Road are rural roads without dedicated footpaths and cycling infrastructure, and there is no active transport accessibility to be considered.

6.7.4 Mitigation measures

Table 6.38 outlines the mitigation measures to be implemented in relation to the potential noise impacts from the project.

Table 6.38 Traffic and transport mitigation measures

ID	Mitigation measure
TT1	A detailed construction traffic management plan (CTMP) will be developed by the construction contractor in consultation with Muswellbrook Shire Council prior to the commencement of works. The CTMP will include a Driver Code of Conduct which informs drivers about the school bus routes along Muscle Creek Road and Sandy Creek Road. During construction, traffic management may be necessary to minimise any traffic impact on Muscle Creek Road and Sandy Creek Road.
TT2	Obtain a permit from NHVR to allow OSOM vehicles to use the road network as part of construction.
TT3	Weekly inspections of Muscle Creek Road and Sandy Creek Road will occur during the construction period.

6.7.5 Conclusion

The project will be accessed via Muscle Creek Road off the New England Highway and Sandy Creek Road off the New England Highway.

Up to 232 peak daily trips (light and heavy vehicles) are anticipated throughout construction phase of the project. An estimated 80% of the project traffic would use the Muscle Creek Road access point and 20% would use the Sandy Creek Road access point. The construction traffic for the project is not expected to adversely affect the intersection and mid-block performance of the surrounding road network.

An upgrade to Sandy Creek Road/Northern Site Access intersection will be required to accommodate turning movements of heavy vehicles accessing the northern project area. Sandy Creek Road is approved for 19 m B-double trucks (with time restrictions). Approval from the National Heavy Vehicle Regulator will be required for a 26 m B-double truck to use this route.

- A detailed Construction Traffic Management Plan (CTMP) will be prepared which will include Drivers Code of Conduct with specific instructions to site related traffic.

6.8 Noise and vibration

6.8.1 Introduction

A noise and vibration impact assessment (NVIA) has been prepared for the project by EMM (2023g) and is provided in Appendix L. The NVIA has been prepared in accordance with the relevant SEARs and with reference to the methods outlined in:

- NSW Noise Policy for Industry (NPfI) (EPA 2017)
- NSW Interim Construction Noise Guideline (ICNG) (DECC 2009)
- NSW Road Noise Policy (RNP) (DECCW 2011)
- NSW Assessing Vibration – a technical guideline (AVTG) (DEC 2006)
- relevant Australian and international standards.

6.8.2 Existing environment

Muswellbrook township is approximately 2.5 km west of the project area and contains residential and industrial land use. The surrounding area also contains rural residences and properties used for grazing and environmental conservation. Given the project's rural setting, background noise at nearby sensitive receptors is likely characterised by New England Highway traffic, intermittent mining and agricultural equipment and machinery associated with production activities.

Given the rural nature of the locality, existing ambient noise levels are likely to be at or below the minimum levels provided in the NPfI. The NPfI minimum rating background noise levels (RBLs) for daytime is 35 decibels (dB) and for evening and night is 30 dB and have been adopted for this assessment.

i Assessment locations

A total of 102 potential assessment locations (residential properties) were included in this assessment (Figure 2.5). This excludes the two associated properties (one within the northern project area and one immediately to the north of the project area).

6.8.3 Potential impacts

i Construction noise

The construction noise management level (NML) adopted for the project is the RBL +10 dB, or $L_{Aeq,15min}$ 45 dB for daytime hours (standard ICNG hours), and a highly noise affected level of 75 dB.

Construction noise levels have been predicted using a computer-generated model that calculates total noise levels at each assessment location from the concurrent operation of multiple noise sources. Predicted noise levels over a typical worst case 15-minute scenario have been modelled and assessed for comparison against the relevant NMLs. Five construction scenarios were assessed:

- Scenario 1: Site preparation and clearing at the north and south extent of the site.
- Scenario 2: Establishment of laydown area and access roads at the north of the site.
- Scenario 3: Installation of underground cabling at the north and south extent of the site.
- Scenario 4: Installation of foundation for the BESS.
- Scenario 5: Installation of foundation and poles of electricity transmission line at the west of the site.

Plant and equipment items, sound power levels and quantities adopted in the noise modelling are provided in Appendix L.

Construction works will be undertaken during standard hours of 7:00 am to 6:00 pm Monday to Friday and 8:00 am to 1:00 pm Saturday.

For scenarios 1 and 3, there are 29 noise assessment locations with predictions above the ICNG noise affected NML of 45 dB for standard day construction hours (Table 6.39). For scenarios 2, 4 and 5, there were no exceedances. All assessment locations, for all modelled scenarios, are predicted to comply with the ICNG highly noise affected level of 75 dB.

Table 6.39 Predicted construction noise levels

Assessment location	Classification	Period	Noise affected NML, dB	Highly noise affected NML, dB	Predicted construction noise level, dB $L_{Aeq,15min}$		Compliance with NML Scenario 1/3
					Scenario 1	Scenario 3	
R7	Residential	Standard	45	75	**56**	**49**	No (+11)/No (+4)
R9	Residential	Standard	45	75	**54**	**47**	No (+9)/No (+2)
R97	Residential	Standard	45	75	**54**	**47**	No (+9)/No (+2)
R99	Residential	Standard	45	75	**54**	**48**	No (+9)/No (+3)
R8	Residential	Standard	45	75	**53**	**46**	No (+8)/No (+1)
R96	Residential	Standard	45	75	**53**	**46**	No (+8)/No (+1)
R98	Residential	Standard	45	75	**53**	**46**	No (+8)/No (+1)
R2	Residential	Standard	45	75	**51**	44	No (+6)/Yes
R14	Residential	Standard	45	75	**51**	44	No (+6)/Yes
R100	Residential	Standard	45	75	**51**	44	No (+6)/Yes
R10	Residential	Standard	45	75	**50**	43	No (+5)/Yes
R12	Residential	Standard	45	75	**50**	43	No (+5)/Yes
R13	Residential	Standard	45	75	**50**	43	No (+5)/Yes
R15	Residential	Standard	45	75	**50**	43	No (+5)/Yes

Table 6.39 Predicted construction noise levels

Assessment location	Classification	Period	Noise affected NML, dB	Highly noise affected NML, dB	Predicted construction noise level, dB $L_{Aeq,15min}$		Compliance with NML Scenario 1/3
					Scenario 1	Scenario 3	
R31	Residential	Standard	45	75	**50**	43	No (+5)/Yes
R17	Residential	Standard	45	75	**49**	42	No (+4)/Yes
R19	Residential	Standard	45	75	**48**	41	No (+3)/Yes
R21	Residential	Standard	45	75	**48**	41	No (+3)/Yes
R22	Residential	Standard	45	75	**48**	41	No (+3)/Yes
R32	Residential	Standard	45	75	**48**	41	No (+3)/Yes
R102	Residential	Standard	45	75	**48**	41	No (+3)/Yes
R114	Residential	Standard	45	75	**48**	41	No (+3)/Yes
R11	Residential	Standard	45	75	**47**	40	No (+2)/Yes
R113	Residential	Standard	45	75	**47**	40	No (+2)/Yes
R3	Residential	Standard	45	75	**46**	39	No (+1)/Yes
R20	Residential	Standard	45	75	**46**	39	No (+1)/Yes
R33	Residential	Standard	45	75	**46**	39	No (+1)/Yes
R40	Residential	Standard	45	75	**46**	39	No (+1)/Yes
R111	Residential	Standard	45	75	**46**	39	No (+1)/Yes

ii Construction vibration

The assessment shows that construction vibration levels associated with onsite works are highly unlikely to impact any of the assessment locations. The nearest residence (R7) to the site is approximately 240 m from the southern site boundary. This assessment location is beyond the safe working distances for human response and cosmetic damage for the plant, and it is not expected that operation of this plant will be required at the southern boundary of the site. Exceedance of relevant vibration criteria is not expected at any assessment locations.

iii Construction road noise

Road traffic noise level predictions for peak construction traffic during the day are provided in Table 6.40.

Table 6.40 Road traffic noise calculations, Day (7:00 am to 10:00 pm)

Road name	Approximate distance of residence from nearest carriageway	Road segments	Existing movements[1]			Existing plus project movements			Noise level increase due to the project, $L_{Aeq,15hour}$, dB
			Total	%HV	Calculated level, $L_{Aeq,15hour}$, dB	Total	%HV	Predicted level, $L_{Aeq,15hour}$, dB	
New England Highway	130 m	North of Muscle Creek Road	7409	22	62	7595	21	62	<0.5
	159 m	South of Muscle Creek Road	7409	22	61	7595	21	61	<0.5
New England Highway	16 m	North of Sandy Creek Road	7671	16	67	7717	16	67	<0.5
	24 m	South of Sandy Creek Road	7671	16	68	7717	16	68	<0.5
Muscle Creek Road	21 m	-	959	12	61	1330	12	62	1.4
Sandy Creek Road	20 m	-	714	5	60	807	6	60	0.5

Notes: 1. Existing movements are based on 2022 road traffic counts from the NSW government Transport for NSW Traffic Volume Viewer website, and the 2022 traffic surveys detailed in the TIA by EMM.

The existing traffic volumes on New England Highway and Muscle Creek Road were found to be above the RNP's absolute criterion of $L_{Aeq,15hour}$ 60 dB, therefor additional traffic volumes were assessed against the relative increase in traffic noise generated by the project. Project related construction traffic noise from all road segments comply with the relative increase criterion of less than 2 dB.

Traffic associated with operations is relatively minor compared to construction periods and hence will also meet the RNP requirements.

iv Operational noise

The operational NML adopted for the project is the RBL +5 dB, or $L_{Aeq,15min}$ 40 dB for daytime hours (standard ICNG hours).

Operational noise levels have been predicted using a computer-generated model and have been assessed for day, evening and night periods. The assessment predicted noise levels for each assessment location over a 15 minute period and assumed all plant operating concurrently under adverse meteorological conditions. No exceedances have been predicted at any nearby assessment locations.

v Cumulative noise

Transport for NSW proposes to build a New England Highway bypass of Muswellbrook. The proposal is located to the east of Muswellbrook and connects the New England Highway to the north and south of Muswellbrook. Muswellbrook bypass construction is expected to commence in 2023 and take 3.5 years to complete.

Firm Power Pty Ltd propose to develop a Battery Energy Storage System (the Muswellbrook BESS) adjacent to an existing substation compound located at 20 Sandy Creek Road, Muswellbrook.

Concurrent construction activities with the Muswellbrook Bypass and Muswellbrook BESS may occur during construction of the project.

Construction noise in the Muswellbrook BESS NVIA was predicted at 13 nearby assessment locations. Predictions were not available for the Muswellbrook Solar Farm assessment locations; however Muswellbrook Solar Farm construction noise is predicted to be below ICNG NML at other assessment locations in this area. Any increase in cumulative construction noise is anticipated to be minor.

Worst case construction predictions for Muswellbrook Solar Farm were combined with Muswellbrook Bypass construction predictions estimated from the noise contour maps provided in the Muswellbrook Bypass NVIA. All predicted increases due to cumulative construction noise were less than 3 dB and there were no new exceedances of the ICNG affected or highly affected NML.

Consultation between ESCO Pacific, Firm Power and Transport for NSW will be undertaken when necessary to manage potential construction noise impacts at nearby assessment locations in accordance with the ICNG.

Construction for the Muswellbrook Bypass and the Muswellbrook BESS will be undertaken over several months and stages. Although it is unlikely that the occurrence of peak construction traffic volumes from all three projects will occur at the same time, there is potential for overlap with the Muswellbrook Solar Farm. A conservative analysis has considered the potential for concurrent peak construction to occur from all three projects. Additional traffic volumes were assessed against the relative increase in traffic noise generated by the three projects. Cumulative construction traffic noise from all road segments comply with the relative increase criterion of less than 2 dB.

With regards to operational noise, the Muswellbrook BESS noise impact assessment (*Muswellbrook BESS – Noise Impact Assessment*, R2, 2022. Assured Environmental) predicted compliance for all receptors with the assessment criteria established in accordance with the NPfI. The Muswellbrook Solar Farm is predicted to comply with the project amenity $L_{Aeq,15min}$ noise level at all assessment locations. This criteria is more stringent than the recommended amenity $L_{Aeq,period}$ noise level and allows for industrial noise contributions from multiple sites/Projects per the NPfI. Given this, no cumulative noise impact is expected due to the operation of the Muswellbrook Solar Farm and the Muswellbrook BESS.

6.8.4 Mitigation measures

Table 6.41 outlines the mitigation measures to be implemented in relation to the potential noise impacts from the project.

Table 6.41 Noise and vibration mitigation measures

ID	Mitigation measure
NV1	Standard noise mitigation measures include: • Ensure the importance of minimising noise and vibration is reinforced at toolbox meetings. • Minimise unnecessary metal-on-metal contact. • Minimise the need for vehicle reversing as much as practical, for example, by arranging for one-way site traffic routes where possible. • Ensure access road is maintained. • Ensure potentially noisy plant and equipment is maintained in accordance with manufacturer specifications. • Where practical, use quieter plant and equipment. • Minimise unnecessary movement of equipment/material/plant. • Operate plant and equipment in the quietest and most efficient manner. • Undertake regular inspections/maintenance of plant and equipment to ensure that all noise reduction devices are operating effectively. • Construction work to be limited to standard construction hours, including delivery of plant and equipment.
NV2	Additional mitigation measures for R7 prior to site preparation works in the south of the project area: • Notification (letterbox drop or equivalent): Advanced warning of works and potential disruptions can assist in reducing the impact on the community. The notification may consist of a letterbox drop (or equivalent) which details work activities, time periods over which these will occur, impacts, and mitigation measures. Notification should be a minimum of 5 working days prior to the start of works. • Verification: Verification should include measurement of construction noise.

6.8.5 Conclusion

Significant impacts in relation to noise at non-associated residents are not anticipated as a result of the project during construction or operation. One residence may experience moderately intrusive noise (NML+10dB) and the project may be audible at 28 other residences during site preparation works. No exceedance of the 'Highly Noise Affected' level is expected.

Operational noise is predicted to satisfy the NPfI project noise trigger levels for all assessment locations.

During peak construction, increases in road traffic noise will occur along the New England Highway, Sandy Creek Road and Muscle Creek Road. Assessed road traffic noise levels indicate that the relative increases for each assessed road will remain below the thresholds provided in the *Road Noise Policy* (RNP) (DECCW 2011).

Assuming the proposed mitigation measures outlined are applied, the project is not anticipated to generate significant noise or vibration impacts.

6.9 Hazards and risk

6.9.1 Introduction

A preliminary hazard analysis (PHA) has been prepared for the project by Sherpa Consulting (2023) and is provided in Appendix M.

The PHA summarises potential hazards and risks associated with the project and details management measures which, when implemented, will reduce these hazards and risks to acceptable levels.

The relevant requirements of the SEARs and how they are addressed, are summarised in Appendix M. The PHA was prepared in accordance with the following guidelines:

- State Environmental Planning Policy (Resilience and Hazards) 2021
- *Hazardous Industry Planning Advisory Paper No 6 – Guidelines for Hazard Analysis* (DoP 2011a) (HIPAP 6)
- *Assessment Guideline – Multi-level Risk Assessment* (DoP 2011b) (Multi-level Risk Assessment Guideline)
- *Hazardous Industry Planning Advisory Paper No 4 – Risk Criteria for Land Use Safety Planning* (DoP 2011c) (HIPAP 4)
- Review of AS/NZS 5139:2019 *Electrical installations – Safety of battery systems for use with power conversion equipment* (Standards Australia 2019)
- *The Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (DoP 2011d) (Hazardous and Offensive Development Guideline)
- *Guidelines for limiting exposure to Time-varying Electric, Magnetic and Electromagnetic Fields* (ICNIRP 2010).

i Preliminary risk screening

The objective of the preliminary risk screening is to determine whether the proposed development is considered as 'potentially hazardous' in the context of SEPP (Resilience and Hazards) 2021.

Development proposals that are classified as 'potentially hazardous' industry must undergo a PHA as per the requirements set in HIPAP No. 6 Guidelines for Hazard Analysis to determine the risk to people, property and the environment. If the residual risk exceeds the acceptability criteria, the development is considered as a 'hazardous industry' and may not be permissible within NSW.

The risk screening process considers the type and quantity of hazardous materials to be stored on site, distance of the storage area to the nearest site boundary, as well as the expected number of transport movements. 'Hazardous materials' are defined within the guideline as substances that fall within the classification of the Australian Dangerous Goods Code (ADGC), i.e. have a Dangerous Goods (DG) classification.

Risk screening is undertaken by comparing the storage quantity and the number of road movements of the hazardous materials with the screening threshold specified in the guideline. The screening threshold presents the quantities below which it can be assumed that significant off-site risk is unlikely.

None of the identified hazardous materials that may be stored or handled on site for the project are expected to exceed the storage or transport threshold.

Appendix 2 of Applying SEPP 33 outlines other risk factors for consideration to identify hazards outside the scope of the risk screening method.

A review of these risk factors was completed, and it was noted that the project would not involve:

- Storage or transport of incompatible materials (i.e. hazardous and non-hazardous). Hazardous materials will be stored in dedicated areas and storage protocols in accordance with standard and guidelines will be followed.
- Generation of hazardous waste.
- Possible generation of dusts within confined areas.

- Type of activities involving the hazardous materials with potential to cause significant off-site impacts.
- Incompatible, reactive or unstable materials and process conditions that could lead to uncontrolled reaction or decomposition.
- Storage or processing operations involving high (or extremely low) temperature and/or pressures.
- Hazardous materials and processes with known past incidents (or near misses) that resulted in significant off-site impacts at similar BESS developments.

Appendix 3 of Applying SEPP 33 provides an illustrative list of industries that may be potentially hazardous. Solar farm or power generation facilities are not included in the example industry listings that may fall within the Resilience and Hazards SEPP or considered as potentially hazardous.

The preliminary risk screening found that the project is not considered as 'potentially hazardous' within the meaning of Resilience and Hazards SEPP and does not require a PHA.

Notwithstanding the outcome of the preliminary risk screening, the Hazards assessment requirements of the SEARs require a PHA and an assessment of hazards and risks for the project to be undertaken. The objective of these assessments was to identify the hazards and assess the risks associated with the project at the planning stage of the DA and determine risk acceptability from a land use safety planning perspective.

6.9.2 Preliminary hazard analysis

i Nearest receptors

Land surrounding the project area contains infrastructure and landforms associated with the Muswellbrook Coal Mine. The surrounding area also contains rural residences and properties used for grazing and environmental conservation.

The nearest township to the project is Muswellbrook, located approximately 2.5 km west of the project. There are 107 residences within 2 km of the project area. Of these residences, 49 are within 1 km and 13 are within 500 m of the project area.

The non-associated residences or occupied areas are considered as sensitive receptors for the purposes of this risk assessment. The separation distance to the nearest non-associated residential dwelling are as follows:

- northern project area (PV arrays): 500 m (R2)
- BESS area: 1,900 m (R7)
- southern project area (PV arrays): 230 m (R7).

ii Hazard identification and risk analysis

Potential hazards associated with operation of the project were identified through a hazard identification process involving a review of previous risk assessments for similar projects, standards for battery systems, literature, and product information from manufacturers (e.g. product datasheet, safety manuals, installation manuals). The assessment was based on the use of the SolBank battery system, and it is assumed that the hazard identification is representative of other lithium-ion based battery systems from other manufacturers, as the modes of failure and control mechanisms are not dissimilar.

For the project, the following hazards and events were identified:

- electrical: exposure to voltage
- arc flash: release of energy
- fire: infrastructure fire
- chemical: release of hazardous materials
- explosive gas: generation of explosive gas
- reaction: battery thermal runaway
- EMF: exposure to Electric and Magnetic Fields (EMF)
- external factors: unauthorised access/trespasser, bushfire, lightning storm, water ingress (rain and flood).

In addition, the SEARs required the assessment of

- exposure to electric and magnetic fields (EMF) against the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guideline
- BESS separation distances to off-site receptors.

The hazard identification process identified that all resulting consequences are not expected to have off-site impacts, and a qualitative risk analysis was determined to be appropriate based on the Multi-Level Risk Assessment guideline (DoP 2011b), the results of which are presented in Table 6.42.

Table 6.42 Qualitative hazard risk assessment

Hazard	Event	Consequence	Off-site consequence	Significant off-site impact?	Risk analysis (off-site and public impact)		
					Severity	Likelihood	Risk
Electrical	Exposure to voltage	• Electrocution. • Injury and/or fatality to onsite employees. • Injury and/or fatality to member of public due to touch and step potential.	As the project site is located in a rural area and there is a large separation distance to the nearest non-associated residential dwelling, the effects are not expected to have an offsite impact.	No	Insignificant	Unlikely	Very Low
Arc flash	Arc flash	• Arc blasts and resulting heat, may result in fires and pressure waves. • Burns. • Exposure to intense light and noise. • Injury and/or fatality to onsite employees.	Localised effects, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low
Fire	Fire on electrical conversion system equipment	• Release of toxic combustion products. • Escalation to adjacent infrastructure. • Injury and/or fatality to onsite employees.	As there is a large separation distance to the nearest non-associated residential dwelling, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low
	BESS fire	• Release of toxic and/or explosive combustion products. • Escalation to the entire BESS. • Injury and/or fatality to onsite employees.	As there is a large separation distance from the BESS area to the nearest non-associated residential dwelling, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low
	Substation fire	• Release of toxic combustion products. • Escalation to adjacent infrastructure. • Injury and/or fatality to onsite employees.	As there is a large separation distance from the substation to the nearest non-associated residential dwelling, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low
	Bushfire	• Escalation to adjacent infrastructure. • Injury and/or fatality to onsite employees.	As there is a large separation distance from the BESS and substation areas to the nearest non-associated residential dwelling, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low

Table 6.42 Qualitative hazard risk assessment

Hazard	Event	Consequence	Off-site consequence	Significant off-site impact?	Risk analysis (off-site and public impact)		
					Severity	Likelihood	Risk
Chemical	Loss of containment of flammable liquids from storage or during handling	• Fire, if ignited. • Injury to onsite employees.	Localised effects (minor storage quantity), the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low
	Exposure to hazardous material (herbicide/ pesticide)	• Irritation/injury for personnel on exposure.	Localised effects, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low
	Release of battery electrolyte (liquid/vented gas) from the battery cell	• Release of flammable liquid electrolyte. • Vapourisation of liquid electrolyte. • Release of vented gas from cells. • Fire and/or explosion in battery enclosure. • Release of toxic combustion products. • Injury and/or fatality to onsite employees.	As there is a large separation distance from the BESS area to the nearest non-associated residential dwelling, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low
	BESS chiller unit or coolant leak	• Irritation/injury to onsite employee on exposure to leak (e.g. inhalation and skin contact). • Ingress of coolant to battery or other electrical components (battery enclosure) leading to short circuit and fire, resulting in injury and/or fatality to onsite employees.	As there is a large separation distance from the BESS area to the nearest non-associated residential dwelling, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low
Explosive Gas	Generation of explosive gas	• Fire and/or explosion in battery enclosure. • Release of toxic combustion products. • Injury and/or fatality to onsite employees.	As there is a large separation distance from the BESS area to the nearest non-associated residential dwelling, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low

Table 6.42 Qualitative hazard risk assessment

Hazard	Event	Consequence	Off-site consequence	Significant off-site impact?	Risk analysis (off-site and public impact)		
					Severity	Likelihood	Risk
Reaction	Thermal runaway in battery	• Fire in the battery cell and enclosure. • Escalation to the entire BESS. • Injury and/or fatality to onsite employees.	As there is a large separation distance from the BESS area to the nearest non-associated residential dwelling, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low
EMF	Exposure to electric and magnetic fields	• High level exposure (i.e. exceeding the reference limits) may affect function of the nervous system (i.e. direct stimulation of nerve and muscle tissue and the induction of retinal phosphenes). • Injury to onsite employees.	EMF created from the project will not exceed the ICNIRP reference level for exposure to the general public. No off-site impact expected as the project site is located in a rural area and there is a large separation distance to the nearest residential dwelling.	No	Insignificant	Rare	Very Low
External factors	Water ingress (e.g. rain, flood)	• Electrical fault/short circuit. • Fire. • Injury and/or fatality to onsite employees.	As there is a large separation distance from the BESS and substation areas to the nearest non-associated residential dwelling, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low
	Vandalism due to unauthorised personnel access and deliberate damage to project infrastructure	• Asset damage and potential hazard to unauthorised person (e.g. electrocution).	Effects to unauthorised person are expected to be localised and not expected to have an off-site impact. The impact is to a member of public but occurs onsite. For a fire event at the BESS and substation areas, the effects are not expected to have an off-site impact as there is a large separation distance to the nearest non-associated residential dwelling.	No	Moderate	Unlikely	Medium
	Lightning strike	• Fire. • Injury and/or fatality to onsite employees.	As there is a large separation distance from the BESS and substation areas to the nearest non-associated residential dwelling, the effects are not expected to have an off-site impact.	No	Insignificant	Unlikely	Very Low

iii Assessment against risk acceptance criteria

Using the study risk matrix referenced from AS/NZS 5139, the identified hazardous events were qualitatively risk profiled. Of the 16 events identified, all were rated as 'Very Low' risks except for one 'Medium' risk event. This event is related to unauthorised person access to the development footprint, resulting in vandalism/asset damage to the infrastructure with the potential for self-injury during the act.

The PHA noted that the controls for this event are well understood and will be implemented accordingly. In addition to the rural location of the site, the project infrastructure will be located within a secure area with fencing and cameras, and warning signs will be provided. Mitigation measures would also include onsite security protocol and presence of staff. In combination, these prevention and mitigation measures are expected to significantly reduce the likelihood of this event. The likelihood rating for this event was rated as 'Unlikely'.

All identified events are not expected to have significant off-site impacts. Based on the study risk acceptance criteria, the risk profile for the project is considered to be tolerable.

The analysis found that the project is compliant with HIPAP No. 4 qualitative risk criteria, in particular:

- The project location is suited for the proposed operation, situated within the Hunter-Central Coast REZ, in a rural area with considerable separation distance to sensitive receptors to avoid off-site risks.
- Based on the separation distance to sensitive receptors, consequence impacts from the identified hazardous events are not expected to have significant off-site impacts.
- There are no hazardous developments (in the context of the Resilience and Hazards SEPP) in the vicinity of the project area.

iv EMF exposure

The PHA considered the ICNIRP guidelines for EMF exposure. The project infrastructure including PV panels, solar arrays, underground cables, substation and grid connection, transmission lines and the BESS were considered with respect to EMF emissions.

The review in the PHA concludes that:

- EMF created from the project will not exceed the ICNIRP occupational exposure reference level.
- As the strengths of EMF attenuate rapidly with distance, the ICNIRP reference level for exposure to the general public will not be exceeded and impact to the general public in surrounding land uses will be negligible.
- For the risk assessment (Table 6.42), consequence from exposure to EMF was assumed to result in no or minor injury ('Insignificant') in reference to the consequence impact rating.

v BESS separation distances

The review of BESS separation distances is required to demonstrate that the proposed BESS capacity can fit within the land area designated for the BESS accounting for the required separation distances. The PHA review found that:

- The BESS concept layout included clearances between the sub-units that would meet the minimum or recommended clearances specified by the manufacturer. Additionally, the proposed BESS has been tested to UL 9540A and the result showed that:
    - Module-to-module propagation was not observed

- Unit level results show a resiliency of the unit to thermal runaway propagation and fire hazard in a single failure event.

- The designated land area can accommodate the proposed BESS units to meet the proposed capacity.
- There is a considerable separation distance between the proposed BESS and the O&M building (i.e. 147 m). In the event of thermal runaway and/or fire, propagation is not expected to affect other onsite receptors (e.g. substation and switchyard) based on the propagation characteristics determined from the UL 9540A test.
- The closest sensitive receptor is approximately 1.9 km from the proposed BESS. No off-site impact is expected as the BESS will be situated in a rural area and there is a large separation distance to the nearest sensitive receptor.

6.9.3 Mitigation measures

The hazard register (Table 5.3 of Appendix M) identifies a range of controls that are required to ensure that hazard consequence and/or the likelihood is reduced or maintained for the project. These measures include, but are not limited to, the implementation of the following during subsequent stages of the project:

- fire management plan
- emergency response plan (ERP)
- design and procurement procedures
- testing and maintenance procedures
- signage and personal protective equipment
- asset protection zone (APZ) to be provided for all structures and associated buildings/infrastructure
- appropriate boundaries and fencing.

Table 6.43 outlines the mitigation measures to be implemented in relation to the potential hazards and risks associated with the project.

Table 6.43 Hazards and risk mitigation measures

ID	Mitigation measure
HR1	Onsite security protocols will be implemented and staff will be present.
HR2	BESS units will be certified to UL 9540A and installed in accordance with the manufacturer's instructions for best practice to mitigate fire propagation.
HR3	ESCO will confirm that the BESS supplier has considered the relevant findings of the investigation reports on the Victorian Big Battery (VBB) Fire (occurred on 31 July 2021) in their design or made improvements to address the lessons learnt from the VBB incident. ESCO is to ensure that the BESS supplier's requirements on equipment clearances, installation, commissioning, operations and maintenance, and emergency response are met.
HR4	ESCO will consult with Fire and Rescue NSW (FRNSW) and NSW RFS to ensure that the relevant aspects of fire protection measures have been included in the design. These may include: (i) type of firefighting or control medium (ii) demand, storage and containment measures for the medium. The above aspects will form an input to the Fire Safety Study which may be required as part of the development consent conditions, for review and approval by FRNSW.

Table 6.43 Hazards and risk mitigation measures

ID	Mitigation measure
HR5	Security fencing, cameras, and warning signs will be installed, and onsite security protocols implemented to deter trespassers and minimise unauthorised person access resulting in vandalism/asset damage to the infrastructure with the potential for self-injury during the act.
HR6	An unexpected finds protocol will be developed for managing contamination encountered during construction. This will include the development and implementation of an Asbestos Management Plan to manage asbestos and asbestos containing material if it is encountered during construction. This will include handling and disposal procedures in accordance with NSW EPA guidelines, Australian Standards, and relevant industry codes of practice.

6.9.4 Conclusion

The PHA concluded that:

- for all identified events associated with the proposed operation of the project, the resulting consequences are not expected to have significant offsite impacts
- the project meets the HIPAP 4 qualitative risk criteria
- EMF created from the project will not exceed the ICNIRP occupational exposure reference level
- BESS concept layout included clearances between the sub-units that would meet the minimum or recommended clearances specified by the manufacturer
- the designated land area can accommodate the proposed BESS units to meet the proposed capacity.

6.10 Bushfire

6.10.1 Introduction

A bushfire strategic study was undertaken by Cool Burn Fire & Ecology (2023) for the project in accordance with the SEARs and is provided in Appendix N. This section provides a summary of the findings from this assessment.

The bushfire strategic study was prepared to address the requirements of the *Planning for Bush Fire Protection 2019* (RFS 2019) (PBP). Bushfire risk is considered in the context of the *Rural Fires Act 1997.*

The bushfire protection planning included a desktop assessment and a review of the proposed development against the following guidelines, legislation, and regional information:

- NSW *Rural Fires Act 1997*
- *Planning for Bushfire Protection 2019* (RFS 2019)
- *Large-Scale Solar Energy Guideline*, NSW Government August 2022 (DPE 2022a)
- Australian Standard (AS) 3959-2018 *Construction of buildings in bushfire-prone areas*
- *Bushfire Risk Management Plans* (BFRMP) for the Local Government Area (LGA)
- *Bushfire history* (SEED geo-mapping).

6.10.2 Existing environment

The project area is in the Muswellbrook LGA in the Upper Hunter which has an accepted fire danger rating of Fire Danger Index (FDI) 100.

The project area is mapped as Vegetation Category 1 and Vegetation Category 2 bushfire prone vegetation and associated buffers. Much of the project area is cleared, partially cleared and managed, with remaining vegetation classified as a mix of grassy woodland and grassland.

An effective slope assessment for a development proposal is generally measured out to a distance of 100 metres from the asset. At a macro scale, the project area is predominantly located on a lower lying valley sloping upward to the west and the to the northeast. The effective slopes to the north/northwest and to the southeast are generally flat to upslope.

The majority of the project area (central and eastern portions) are predominantly modelled as having a lower fire intensity risk associated with managed modified landscapes and low slopes.

No detailed fire history has been recorded on the project area (SEED geo-mapping; DPE 2022a; Muswellbrook BFMC 2011). The fire history for the locality (within 20 km of the investigation area) is predominantly small-scale wildfires, hazard reduction burns and/or suspicious or deliberate ignition (arson).

The fire history demonstrates that the project area is not a recognised 'fire path', likely due to the vegetation clearing and management associated with urban, agricultural and mining history.

6.10.3 Potential impacts

Fire is capable of damaging the structures associated with the project and consequently impacting upon the safety of staff and contractors. Fire emanating from the project poses a human safety and property threat within the locality, as well as threatening native flora, fauna and ecosystems within the locality of the project.

The project area is considered as moderate to potentially high risk for bushfire. A 'high' bushfire risk can be associated with the perimeter assets exposed to fire runs to the west and east. 'Moderate' bushfire risk areas will be associated with isolated remnant vegetation, vegetated drainage lines and corridors, as well as adjacent to high-risk areas.

The solar farm development would result in a reduction of unmanaged bushfire prone vegetation and connectivity in the locality, such that adjoining land uses would benefit from an overall reduced bushfire risk. No additional bushfire management actions would be required on adjoining land or land owners.

The main potential sources of ignition of unplanned fires during construction and decommissioning of the project are likely to be:

- storage of flammable liquids (e.g. fuel storage)
- vehicle and machine movement over long grass
- sparks generated from hot works (e.g. welders and grinders)
- human error, such as non-compliance of hot works procedures or incorrect disposal of cigarette butts.

The main potential sources of ignition of unplanned fires from the operation of the project are likely to be the same as those listed above, with the addition of fire risks associated with electrical equipment associated with the operation of the project (e.g. PCUs, BESS, onsite substation and connection infrastructure). Due to the electrical hazards associated with any power generation facility, including large-scale PV installations, there are additional health and safety considerations for the implementation of effective and appropriate risk control measures when managing an emergency incident that involves an electrical fire.

6.10.4 Mitigation measures

Table 6.44 summarises the bushfire protection measures and recommendations. With the provisions of these recommendations, the project would comply with the aims and objectives and specific performance criteria of PBP 2019.

In summary, the broad principles which apply to a bushfire strategic study have been demonstrated to find that:

- the site is suitable for development in the context of bush fire risk
- the proposed development on bushfire prone land can comply with PBP
- the planning and design would provide for adequate infrastructure associated with emergency evacuation and firefighting operations
- the planning and design would facilitate appropriate ongoing land management practices.

Table 6.44 Bushfire mitigation measures

ID	Mitigation measure
BFR1	A minimum 10 m wide APZ will be established around solar array assets, substation and permanent operations and maintenance buildings. The APZ will be installed and maintained for the life of the project to the standard of an Inner Protection Area as outlined within Appendix 4 of PBP and the NSW RFS document *Standards for Asset Protection Zones.*
BFR2	A Bushfire and Emergency Management Operation Plan will be developed, to guide landscape management, monitor and reduce potential fuel loads within the development footprint (including the APZ) via ongoing management activities (e.g. slashing, grazing).
BFR3	All buildings (BESS, substation buildings, management and operational buildings) will provide for minimum ember protection consistent with Bushfire Attack Level (BAL) 12.5 construction standards (AS3959-2018).
BFR4	A 50 to 80kL steel tank dedicated water storage to be strategically located in consultation with NSW RFS, to allow for permanent emergency supply and ease of access. The tank is to have fast fill water connections (65 mm stroz fittings) and suitable access provisions for Cat 1 fire fighting vehicle (weight load and manoeuvrability).
BFR5	The project site access point and internal roads will provide for safe, reliable, and unobstructed passage by a Cat 1 firefighting vehicle and maintained for the life of the development.
BFR6	Bushfire and Emergency Management Operation Plan for the solar farm will be prepared in consultation with the local NSW RFS District Office and communicated to relevant stakeholders. The Bushfire and Emergency Management Operation Plan will guide annual monitoring of the fire mitigation works for the solar farm and surrounding landholding, including: • access • water • landscape management.

6.10.5 Conclusion

The study area is on designated bushfire prone land. Notwithstanding, a bushfire assessment in accordance with PBP (RFS 2019) has been undertaken for the project, which demonstrated that the bushfire risk associated with project is moderate to potentially high risk, however the project design and operation can comply in full to the objectives and specific performance criteria of PBP.

6.11 Historic heritage

6.11.1 Introduction

A historic heritage impact assessment (HHIA) was undertaken by OzArk for the project and is provided in Appendix O (OzArk 2023). The HHIA aimed to investigate whether historical heritage items or areas are likely to be present in the project area, the significance of these items or areas, potential impacts, and management recommendations. A desktop study of the project area was undertaken assisted by photographs provided by the proponent. This section of the EIS provides a summary of the findings from this assessment.

6.11.2 Existing environment

There are no items listed on the National Heritage List, Commonwealth Heritage List of State Heritage Register within or near the project area. No items listed on the Muswellbrook LEP are located within the project area. There are five items listed on the Muswellbrook LEP within 2km of the project area:

- Muswellbrook LEP.111 'Stone Bridge', located 1.3 km south of the project area
- Muswellbrook LEP.112 'Muswellbrook Brick Works', located 1 km west of the project area
- Muswellbrook LEP.113 'St Heliers', located 0.05 km north of the project area
- Muswellbrook LEP.114 'Gelston', located 1.7 km north of the project area
- Muswellbrook LEP.115 'Lime Kiln', located 1.1 km north of the project area.

A desktop investigation using Google maps, followed by an in-person investigation carried out by the Proponent, indicates that there are five potential historic items within the project area (Figure 6.27). These items are listed in Table 6.45 including a summary of the assessment of significance against the criteria established in the Heritage Office publication, *Assessing Heritage Significance* (Heritage Office 2001).

These are typical rural structures, with no remarkable features, mostly dating to the mid to late twentieth century. This short period of occupation would not allow for the accumulation or deposition of historically significant materials. The remainder of the project area has been utilised for agricultural purposes. Aside from modifications to the environment (most visibly, vegetation clearing), enclosure of land, and the establishment of farm infrastructure, farming leaves few traces in the form of artefacts and built structures.

Table 6.45 Potential items of historical significance

Item	Description	Significance criteria	Level of significance
HS01: 'Shed'	A large, mostly deteriorated, structure with three walls and half a ceiling remaining. The shed is constructed of corrugated metal sheets applied to the outside walls and a timber frame interior. The interior of the shed contains mostly overgrown grass and some modern materials such as wooden pallets. The shed does not appear to be more than 50 years old.	Does not satisfy criteria	Nil
HS02: 'Sheds and Yards'	Consists of one small shed (Shed 1), one long shed (Shed 2) and some fencing. Shed 1 consists of corrugated metal sheets attached to the outside, with a corrugated metal roof and a timber interior frame. Shed 2 consists of corrugated metal sheets on the exterior and corrugated metal roof. There is currently no information about the interior or supporting structure of Shed 2. The yard consists of a single metal fence. None of these items appear to be older than 50 years.	Does not satisfy criteria	Nil

Table 6.45 Potential items of historical significance

Item	Description	Significance criteria	Level of significance
HS03: 'Yards'	Consists of timber fencing, metal fencing and a timber sheep loading ramp. These items appear to be in good repair and less than 50 years old.	Does not satisfy criteria	Nil
HS04: 'Shearing Shed'	Consists of a sheep shearing shed, constructed mostly on stumps, with several covered outdoor areas. The Shearing Shed consists of corrugated metal sheets on the outside, wooden stumps, a wooden frame supporting a section of roof and one external wall, and a corroded corrugated metal sheet roof. The interior appears to consist of wooden support beams and fencing.	Does not satisfy criteria	Nil
HS05: 'House'	Consists of a residence, a courtyard, part of a collapsed structure, and a shed. The residence consists of light blue fibro panels on the exterior with faded burgundy window trims, a front porch constructed with bricks and concrete, a small staircase with a metal handrail, a back porch with burgundy metal roof supports and concrete flooring, brick stilts, and a faded burgundy corrugated metal sheet roof. The residence is fitted with modern features such as a satellite dish, an air conditioning system, and an electric hot water system. The courtyard consists of a large concrete slab with grass growing through the cracks, a concrete water tank, and the remains of a collapsed wood, corrugated metal sheeting and fabric structure. The shed consists of corrugated metal sheets supported by an internal timber frame. The main structure appears to be of a mid-twentieth century date.	Does not satisfy criteria	Nil

6.11.3 Potential impacts

No historic sites or areas of significance were recorded during the surveys and therefore the project will not impact any historic heritage sites.

Ground disturbing works associated with the project will not harm significance historical archaeological deposits and no further archaeological investigation is required.

6.11.4 Mitigation measures

Table 6.46 outlines the mitigation measures to be implemented in relation to the potential historic heritage impacts from the project.

Table 6.46 Historic heritage mitigation measures

ID	Mitigation measure
HH1	A historic heritage management plan (HHMP) will be prepared for the project in consultation with DPE, prior to the commencement of construction. The HHMP will include an unanticipated finds protocol that will be implemented if previously unrecorded or unanticipated historic objects are encountered during construction.

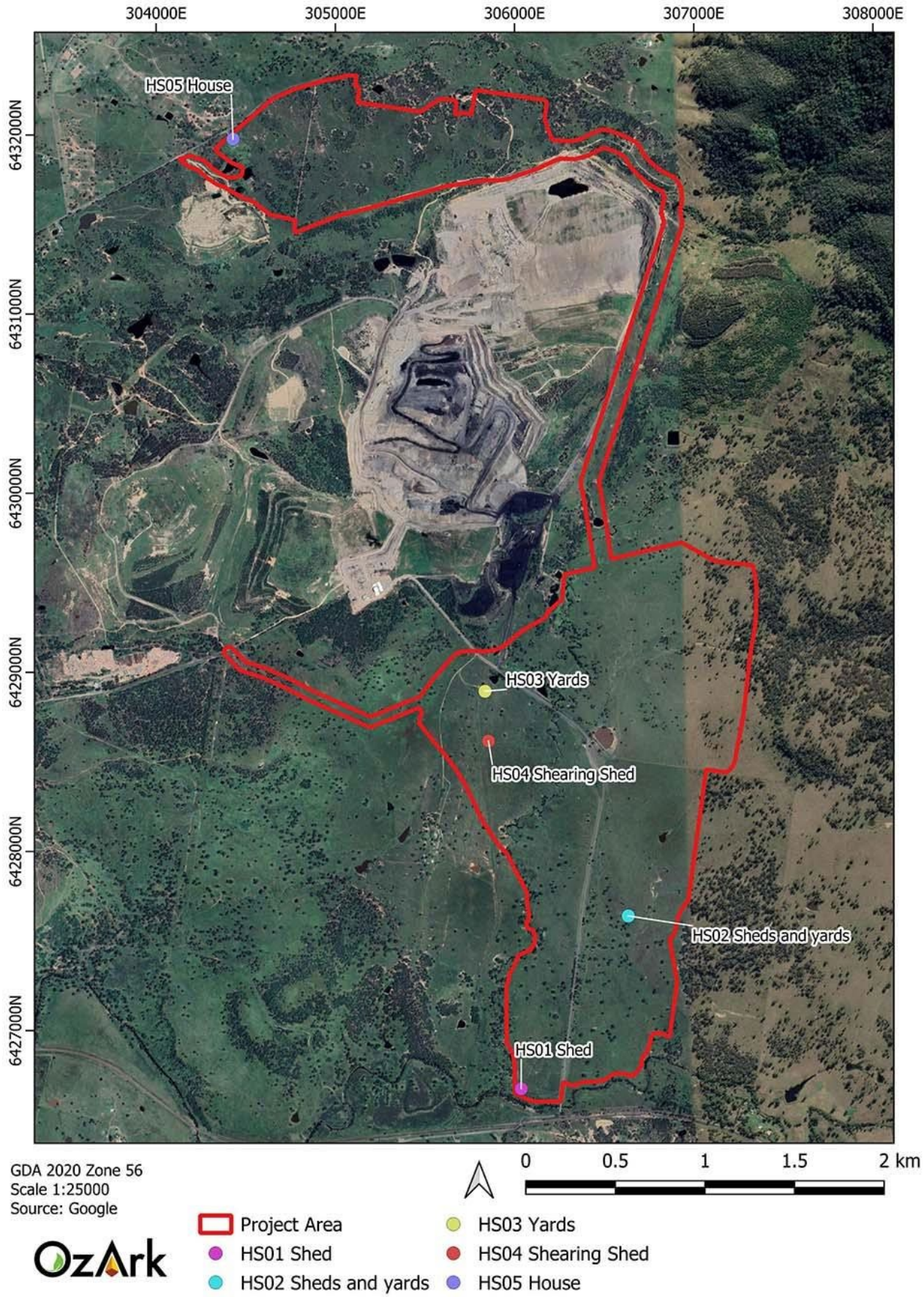


Figure 6.27 **Potential historic items within the project area**

6.12 Air quality

6.12.1 Existing environment

Land use within the study area and surrounds is primarily mining and agricultural, which is likely to influence local and regional air quality. Sources of emissions are likely to include dust extractive industries, dust from agricultural properties, exhaust from vehicles, wood smoke, smoke and particulates from bushfire and controlled burning.

Muswellbrook Coal Mine, an open cut coal mine, is located adjacent to the project boundary.

There are nine facilities in Muswellbrook LGA that reported emissions as part of the National Pollutant Inventory (NPI) (DCCEEW 2022b) for the 2020/2021 reporting year. This includes two power stations, five coal mines, an LPG facility and a rail freight facility. Two of these facilities, Muswellbrook Coal Mine and Elgas Muswellbrook, are within 5 km of the project area. The NPI reporting for the Muswellbrook Coal Mine indicates fugitive air emissions were 590,000 kg for PM10 and 21,000 kg for $PM_{2.5}$ (NPI 2022).

Two air quality monitoring stations are located in Muswellbrook as part of the Upper Hunter Air Quality Monitoring Network: Muswellbrook and Muswellbrook NW. Muswellbrook measures oxides of nitrogen (NO, NO2 and Nox), sulfur dioxide (SO2), fine particles as $PM_{2.5}$, fine particles as PM_{10}. Muswellbrook NW measures fine particles as PM_{10}.

DPE air quality categories rate pollutant emissions on a scale from 'good' to 'extremely poor' as shown in Figure 6.28.

Monthly average data from November 2021 to October 2022 was reviewed and assessed against the air quality categories (Table 6.47). Monthly averages for the year were all categorised as 'good' indicating a generally good air quality for the region.

			Air quality categories (AQC)				
Air pollutant	Averaging period	Units	GOOD	FAIR	POOR	VERY POOR	EXTREMELY POOR
Ozone O_3	1-hour	pphm	<6.7	6.7–10.0	10.0–15.0	15.0–20.0	20.0 and above
	4-hour rolling	pphm	<5.4	5.4–8.0	8.0–12.0	12.0–16.0	16.0 and above
Nitrogen dioxide NO_2	1-hour	pphm	<8	8–12	12–18	18–24	24 and above
Visibility Neph	1-hour	bsp	<1.5	1.5–3.0	3.0–6.0	6.0–18.0	18.0 and above
Carbon monoxide CO	8-hour rolling	ppm	<6.0	6.0–9.0	9.0–13.5	13.5–18.0	18.0 and above
Sulfur dioxide SO_2	1-hour	pphm	<13.3	13.3–20.0	20.0–30.0	30.0–40.0	40.0 and above
Particulate matter < 10 µm PM_{10}	1-hour	µg/m^3	<50	50–100	100–200	200–600	600 and above
Particulate matter < 2.5 µm $PM_{2.5}$	1-hour	µg/m^3	<25	25–50	50–100	100–300	300 and above

Source: DPE 2022e

Figure 6.28 DPE air quality categories

Table 6.47 Monthly average air quality for Muswellbrook and Muswellbrook NW

Month	Muswellbrook					Muswellbrook NW
	SO2 1h average (pphm)	NO 1h average (pphm)	NO2 1h average (pphm)	PM10 1h average (µg/m³)	PM2.5 1h average (µg/m³)	PM10 1h average (µg/m³)
Nov 2021	0.3	0.5	0.8	16.5	5.1	14.6
Dec 2021	-	-	-	18.5	6.4	16.6
Jan 2022	-	-	-	19.5	6.4	17.5
Feb 2022	-	-	-	17.9	5.5	16.7
Mar 2022	0.4	0.5	0.6	15.2	4.5	11.2
Apr 2022	0.3	1	0.7	16.3	5.3	12.9
May 2022	0.3	1.4	0.8	15.8	6.7	11.9
Jun 2022	0.1	1.5	0.8	17.1	8.9	13.2
Jul 2022	0.1	0.9	0.7	13.6	7.9	10.7
Aug 2022	0.1	1.4	0.8	14.5	8.3	11.2
Sep 2022	0.2	0.7	0.7	14.8	5.5	12.7
Oct 2022	0.2	0.5	0.6	15.2	4.9	14.3

Source: DPE 2022d

A review of daily maximum emissions for the year November 2021 to October 2022 showed air quality in the region is generally good, with only days where air quality was poor (Table 6.48).

Table 6.48 Number of days with AQC rating achieved for daily maximum emissions

AQC	Muswellbrook					Muswellbrook NW
	SO2 1 hour maximum	NO 1 hour maximum	NO2 1 hour maximum	PM_{10} 1 hour maximum	$PM_{2.5}$ 1 hour maximum	PM_{10} 1h maximum
Good	365	-	365	320	311	342
Fair	0	-	0	43	53	22
Poor	0	-	0	2	1	1
Very Poor	0	-	0	0	0	0
Extremely Poor	0	-	0	0	0	0

6.12.2 Potential impacts

i Construction

Emissions to the atmosphere from the project during construction will be temporary and restricted to dust caused by land disturbance and vehicle, plant and equipment exhaust emissions. Construction of the project will take approximately 31 months from the commencement of site establishment works.

Civil works will be required to prepare the construction laydown area and array areas by installing fencing, internal access tracks, and undertaking minor earth works. In addition, there will be excavation of the trenches for the medium voltage and high voltage cable network that may be buried underground.

Civil works will also be required for the substation, BESS and O&M area where a level pad is necessary for construction works.

In addition, grading around lower order streams and drainage channels within the development footprint may also be required in order to manage erosion during construction.

Vehicle exhaust emissions would be expected from light vehicles and heavy vehicles accessing the project area, and plant and equipment used during construction.

It is expected that similar air quality impacts would occur during decommissioning.

ii Operation

Ongoing maintenance of the development footprint and project infrastructure will be required during operation. This may result in minor localised vehicle emissions and the generation of dust from vehicles travelling along the internal unsealed access tracks. Assuming the recommended mitigation measures are implemented, predicted impacts will be adequately managed.

6.12.3 Mitigation measures

The project is not expected to generate significant air quality impacts during construction, operation or decommissioning with the implementation of the mitigation measures outlined in Table 6.49.

Table 6.49 Air quality mitigation measures

ID	Mitigation measure
AQ1	Water truck(s) will be used during construction for dust suppression along internal, unsealed access roads and disturbed areas.
AQ2	Vehicle movements will be minimised, where possible.
AQ3	All vehicles, plant and equipment will be cleaned and washed regularly.
AQ4	All vehicles, plant and equipment will be regularly inspected and maintained to ensure that they are operating efficiently.
AQ5	Regular maintenance of unsealed access roads will be undertaken to minimise wheel-generated dust.
AQ6	Dust suppression requirements during construction will take into consideration weather and the likelihood of extended dry periods which could exacerbate impacts.

6.13 Waste

6.13.1 Existing environment

The management of waste in NSW, including recycling, is via the NSW *Protection of the Environment Operations Act 1997* (POEO Act) and the *Waste Avoidance and Resource Recovery Act 2001* (WARR). The WARR sets out a hierarchy of management, including avoidance, recovery and then disposal.

Muswellbrook Council operates a waste management facility adjacent to the project area which is licensed to accept the following waste streams:

- general waste
- recyclables (cannot accept large commercial quantities of cardboard, and cannot accept polystyrene)
- scrap metal
- timber, tree trunks and branches
- concrete and bricks
- used motor oil
- car batteries
- tyres (cannot accept commercial quantities)
- asbestos
- DrumMuster containers.

6.13.2 Potential impacts

i Construction

A detailed summary of the waste types, classification, proposed management methods, and estimated annual quantities of wastes produced during the construction and ongoing operation of the project will not be available until the detailed design stage of the project has been completed. These will be included in the project's detailed waste management plan (WMP). Table 6.50 summarises the waste streams that are likely to be generated during construction of the project.

The WMP is being prepared in consultation with Muswellbrook Council and DPE to identify acceptable waste streams and volumes that may be accepted at Muswellbrook Waste Management Facility.

Notwithstanding, the need to consider specific issues as part of the preparation of the WMP, based on practical experiences with other solar projects the following can be anticipated:

- arrangements will be put in place between the contractor selected for the project, a licensed waste management company and, where available, local sub-contractors (or similar)
- a significant proportion of the waste generated during construction is likely to be the cardboard packaging used for the PV modules and tracker components, which can be recycled (the volume of this waste stream may be in the order of several thousand kilograms per week during peak delivery periods)

- wooden pallets will be another significant waste stream during peak delivery periods, and these can be reused if in good condition or sold for wood chip if damaged (it is anticipated that around 15,000 pallets will be used during construction)
- PCUs will typically be self-contained (containerised) or pre-assembled on a skid or concrete mounted platform and will generate limited waste materials
- skip bins will typically be implemented on-site to encourage waste separation (e.g. separate skip bins for cardboard recycling and timber collection) and general waste bins will be provided for disposal of materials that cannot be cost-effectively recycled.

Potential impacts from poor management of waste include contamination of land and water, and human and animal health impacts.

Table 6.50 Construction waste types, classification, and management

Waste type	Description	Classification	Management
Paper and cardboard	Packaging materials, general office wastes and confidential documents.	General Solid Waste (non-putrescible)	Separated for recycling.
Wood	Pallets and cable drums, timber offcuts, wood separators (to prevent damage to photovoltaic modules).	General Solid Waste (non-putrescible)	Separated for reuse or recycling.
Plastic	Packaging materials ties, straps and excess building materials such as safety fencing and barriers.	General Solid Waste (non-putrescible)	Disposed to landfill.
Green waste	Vegetation waste from clearing activities.	General Solid Waste (non-putrescible)	Beneficial onsite or offsite reuse or disposal to a green waste facility or landfill.
Soil	Surplus spoil from excavations and earthworks.	General Solid Waste (non-putrescible)	Onsite reuse or offsite reuse or disposal at a licenced facility. Any contaminated soils (if encountered) would be tested and treated onsite and/or disposed of to a suitably licensed facility.
Electrical	Excess building materials, retired equipment, or broken solar panels	General Solid Waste (non-putrescible)	Separated for reuse or recycling or disposal at an approved facility.
Metals	Excess building materials such as safety fencing and barriers or retired equipment.	General Solid Waste (non-putrescible)	Separated for reuse or recycling.
Liquid waste	Oils and fuels, contaminated water from equipment washing.	Liquid waste	Collection in tanks and transported to an offsite licensed facility.
Sewage	Biological waste from onsite septic systems.	Liquid waste and General Solid Waste (non-putrescible)	Collection in tanks and transported to an offsite licensed facility.
General	Food scraps aluminium cans, glass bottles, plastics and paper containers from the operations and maintenance buildings.	General Solid Waste (putrescible and non-putrescible)	Collection by a waste management contractor and disposed of to a suitably licensed facility.

Table 6.50 Construction waste types, classification, and management

Waste type	Description	Classification	Management
Commercial waste	Oily rags, filters and drums (non-volatile).	General Solid Waste (non-putrescible)	Collection by a contractor and disposed of to a suitably licensed facility.
Waste batteries	Retired batteries used in appliances and construction equipment.	Hazardous waste	Collection by a contractor and disposed of to a suitably licensed facility.

During decommissioning, dismantled and decommissioned infrastructure will be recycled, where possible. Structures and equipment that cannot be recycled will be disposed of at an appropriately licensed waste management facility.

PV module recycling companies are emerging in Australia, and they are expected to be well established by the time the project is decommissioned as the industry develops. PV modules can be separated into component parts including metals (aluminium, copper, silver), glass, silicon and plastic for beneficial reuse.

ii Operation

Operational waste associated with the facility will be limited to small amounts of packaging associated with plant maintenance/replacement and general waste from site staff. Some waste will be generated during maintenance activities including vegetation management, weed and pest management and during cleaning of the solar modules.

PCUs typically have a lifetime of 15 years +/- 5 years, however select components may be able to be replaced rather than replacing the whole unit to extend the life to 35 years. PV modules may be able to last 35 years, though there may be a business case to replace at some point (e.g. 20 years) with more efficient modules. Where PV panels are replaced, they will be recycled, where possible.

It is likely that batteries will require replacement during the life of the project. Batteries are classed as hazardous waste and their transport for disposal or recycling is regulated under the *Australian Code for the Transport of Dangerous Goods by Road and Rail*. The operator will be required to ensure that all transport requirements are met for the off-site transport of batteries at their end of life. This would be managed by the operator at the time in line with the applicable hazardous materials requirements in effect at that time.

During the 35-year operational life of the project, recycling and reuse facilities for batteries and solar panels may advance in Australia allowing for beneficial reuse of parts of the project. An Operational Waste Management Plan would be updated periodically during the life of the project to capture technological updates.

6.13.3 Mitigation measures

To encourage the efficient use of resources and reduce potential environmental impacts from the project, all waste will be managed in accordance with the POEO Act, the NSW *Waste Avoidance and Resource Recovery Act 2001* and the following hierarchy, which is listed in order of preference:

- reduce waste production
- recover resources
- dispose of waste appropriately.

All wastes produced by the project will be classified, stored and handled in accordance with the *Waste Classification Guidelines – Part 1: Classifying Waste* (EPA 2014). A detailed WMP is being prepared. This plan will include consideration of the following:

- measures to reduce the types and volumes of waste generated during construction
- measures to maximise reuse and recycling and reduce the volume of waste generated by the project and subsequently disposed of at licensed waste management facilities
- a breakdown of anticipated waste streams and volumes
- evidence of consultation with Muswellbrook Council, neighbouring councils and licensed waste management facilities to confirm the capacity of nearby facilities and their availability to manage the project's waste
- on-site waste management measures in line with relevant guidelines
- commitments around disposal of project assets at the completion of operations.

A key objective of the WMP will be to ensure that any use of local waste management facilities does not disadvantage local businesses and, more generally, the local community, by exhausting any available capacity at these facilities. Consultation with Muswellbrook Council, neighbouring councils and licensed waste management facilities will continue throughout the implementation of the WMP.

The WMP will also include appropriate consultation frameworks with Muswellbrook Council, neighbouring councils and licensed waste management facilities to maintain communication and forward planning and provide a grievance mechanism through which any identified adverse impacts can be addressed.

As part of decommissioning, ESCO will attempt to recycle all dismantled and decommissioned infrastructure and equipment, where possible. For example, steel piles to support PV modules, tracker components and copper used in electrical conductors may be sold for scrap metal. In addition, materials in PV modules will be recycled, wherever possible. It is anticipated that a high percentage of the materials within the PV modules will be able to be recovered and recycled during project decommissioning. Structures and equipment that cannot be recycled will be disposed of at an appropriately licensed waste management facility.

Table 6.51 Waste mitigation measures

ID	Mitigation measure
WAS1	All waste will be managed in accordance with the NSW *Protection of the Environment Operations Act 1997* and the NSW *Waste Avoidance and Resource Recovery Act 2001*.
WAS2	All wastes produced by the project will be classified, stored and handled in accordance with *the Waste Classification Guidelines – Part 1: Classifying Waste* (EPA 2014).
WAS3	Waste will be managed in accordance with the waste hierarchy, which is listed in order of preference: • reduce waste production • recover resources • dispose of waste appropriately.
WAS4	A detailed waste management plan is being prepared. The waste management plan is being prepared in accordance with the Solar Guideline.
WAS5	As part of decommissioning, all dismantled and decommissioned infrastructure and equipment will be recycled, where possible.

Table 6.51 Waste mitigation measures

ID	Mitigation measure
WAS6	General waste bins will be provided for disposal of materials that cannot be cost-effectively recycled.

6.14 Economics

This chapter was prepared with assistance from independent economic advisory firm Sapere Research Group. It provides a summary analysis of the estimated net economic value of the proposed Muswellbrook Solar Farm Project to the local economy of Muswellbrook Shire LGA and Singleton LGA (referred to as Study Area throughout this chapter).

6.14.1 Economic costs assessment

i Agricultural impacts

ESCO are currently considering options to combine the proposed solar farm with ongoing agricultural grazing activities as well as substitution of the land away from agricultural activity for solar generation.

One option is that the 482 ha project area may be removed from agricultural service over the full 35 year operational lifecycle. Agricultural enterprises can then re-commence at an equivalent level of agricultural productivity. A second option, which is subject to ongoing investigations by ESCO, is integrating agricultural use such as sheep grazing with solar generation, as has occurred on other sites.

Given that the extent to which the land may be used for agricultural purposes in combination with the solar farm activities is unknown, a conservative approach has been adopted. Therefore, the following quantifications (from Minesoils 2023) assume no agricultural activity takes place. As such, this analysis may understate the benefits (overstate the opportunity cost) associated with the project.

The primary impact of the project on productivity of agricultural land based on change in land use within the project area is from $83,759 to $198,562 per year or between $4.6 – $10.9 million over the 35-year operational lifecycle (incorporating CPI adjustment of 2.5%, based on the Reserve Bank of Australia's long run inflation target rate of between 2-3%). The range takes into consideration whether the land is used for Feeder Steers ($83,759 per year) or Growing-out Steers 240–460kg ($198,562 per year).

There are also a range of upstream and downstream jobs associated with agricultural production in the project locality and wider region. For the purposes of this assessment, the related economic activity equates to an estimated $182,494 – $432,627 per year of the project or $10 – $23.8 million over the 35 year operational lifecycle (incorporating CPI adjustment of 2.5%).

ii Labour and regional impacts

As a result of the project, some agricultural jobs associated with activities currently undertaken at the project area might be lost. It is estimated that between 1–2.5 Full Time Equivalent (FTE) jobs in the Study Area are currently supported by the project area.[2] The method used to calculate these FTE jobs is:

- Determine the percentage of total agricultural output lost (i.e., ABS data illustrates that the total value of agricultural output in the Study Area during 2020/21 was $89 million. Therefore, a loss of agricultural output of between $83,759 – $198,562 equates to a percentage loss of total agricultural output of 0.2%-0.5%) (ABS 2022a).

- Multiply the percentage lost by the total number of FTE working in agriculture in the Study Area (1,106 FTE) to produce the number of jobs currently supported and therefore likely to lose employment (ABS 2021b).

However, the reduction in employment is likely to be less than this as the proponent intends to continue grazing across the site, thus the employment impacts are likely to be lower. There is an estimated 15 to 18-month gap in grazing opportunities while construction of the solar farm takes place, however this would constitute a short-term construction impact. Grazing could recommence prior to the BESS construction commencing. Upon construction completion, the land may benefit from dual economic revenue streams from both grazing and the solar farm.

6.14.2 Economic benefits assessment (direct and indirect)

i Project investment

ESCO estimates that the total construction cost for the Muswellbrook Solar Farm Project is $302 million. While most of the investment cost is associated with the purchase of approximately 300,000 PV panels, batteries and other electrical infrastructure, a significant outlay is also required for civil, electrical and grid connection works.

The proponent estimates for large infrastructure projects that up to 10% of the investment remains in the local economy through direct purchases, contracts and labour wages (for example ESCO hiring contractors and equipment from the Study Area). Therefore, the Study Area's local economy could benefit from up to $30.2 million during the construction and commissioning phase of the project.

ii Project employment

Project employment is assessed in terms of direct jobs (i.e. site-related) and indirect (or flow-on) jobs in the local and wider economies (i.e. jobs that are generated through the industrial and consumption impacts of the initial investment). Although it is anticipated that significant employment will be generated indirectly, these flow-on impacts have not been quantified following ABS advice on the shortcomings and limitations of multipliers for economic impact analysis (ABS 2022b).

a Construction phase

Direct construction employment

ESCO estimates that on average approximately 76 FTE jobs will be supported over the 31 month solar farm construction period. This estimate is based on the average anticipated monthly number of personnel required on site. At the project's peak 200 FTE positions are expected to be supported.

As highlighted in Chapter 4 of SIA (EMM 2023c), the industry, business and occupational structure of the Study Area should be well-suited to a project of this scale and nature.

[2] 2.2 – 5.4 FTE jobs potentially lost across the supply chain. Same method to calculate but use $182,494 – $432,627.

ESCO has also assumed that up to 54% of workers will be locally sourced (EMM 2023c). A higher proportion of trade assistants/labours are expected to be sourced within the Study Area, whereas Electricians and Project Managers will be sourced externally. Therefore, it is assumed that the project will support on average 39 local FTEs for the 31 month estimated construction period.

The Study Area has a labour force of 9,070 resident workers occupied in construction-related activities.[3] Therefore, the project should not present a constraint to labour supply in the local economy with the projects labour requirement representing less than 1% of the local construction-related workforce.

The project will positively impact the Study Area by providing opportunities for local workers to upskill and develop renewable energy skills which will help grow the renewable energy workforce. Additionally, the project offers the potential for some unemployed job seekers (864 persons) to find work (EMM 2023c).

b Operating phase

Direct operating employment

ESCO indicates that 6 FTE jobs will be supported locally on an ongoing basis over the 35 year operational lifecycle of the Muswellbrook Solar Farm. Further local part-time/contractor positions will be required, including for vegetation management, module cleaning, internal access track maintenance and vermin management. This would equate to an estimated 2.5 FTE positions.

Other offsite FTE positions are assumed to be related to the corporate head office.

iii Business participation

Local business participation may provide opportunities in terms of cost efficiencies (lower transport, equipment hire, labour costs etc.). Many large construction projects located in regional areas are, where possible, serviced from within the same region. This is ESCO's intent for the project.

The Study Area has approximately 413 construction firms and many other businesses associated with activities likely to be required for the project (EMM 2023c). Within the Study Area there are likely to be firms of sufficient scale and expertise to compete for contracts or provide services and equipment to the project.

To maximise local business participation, ESCO may partner with the Industry Capability Network (ICN) (as per previous ESCO projects) to identify and source local contractors and suppliers. The Industry Capability Network is an independent, non-profit organisation funded by the Federal Government to support business opportunities, including linking suppliers to project contracts at a local level through its ICN Gateway website where details of work packages are advertised.

iv Housing and commercial accommodation supplier impacts

Accommodation suppliers in the Study Area will be positively impacted as the influx of non-local workers will support higher occupancy rates and revenues, particularly during off-peak periods.

Information provided by ESCO indicates that up to 87 non-local workers may need to be accommodated in the region at the project's peak (estimated to occur for only a month but will remain around 80 for another three months). Contract lengths will vary. This highlights the need for multiple types of accommodation which would be expected to range from higher-end options for professional staff on longer contracts, to convenient low-cost options for those on short-term contracts.

The availability of short-term accommodation within the Study Area is assessed in the SIA (EMM 2023c).

[3] Australian Bureau of Statistics, Census of Population and Housing 2021. The employment figures for Technicians and Trades Workers, Machinery Operators and Drivers, and Labourers have been summed together for both Muswellbrook Shire LGA and Singleton LGA.

v Additional retail expenditure

This section considers all non-local workforce expenditure related to the project that otherwise would not have occurred in the Study Area.

As described above, ESCO estimates that approximately 37 FTE jobs (on average across the construction phase) would be sourced from outside the Study Area, particularly for specialist (like electricians) and management positions. This level of employment would therefore equate to $12.3 million in wages on the basis that each non-local worker is employed for 31-months and earns the average construction wage of $93,000 per annum (ABS 2023).

However, only a portion of these wages would be spent locally, with the rest either saved or spent outside the Study Area. Up to an estimated $4.6 million in wages is likely directed to local businesses and service providers during the construction period.

This is based on reference to the ABS 2015-16 Household Expenditure Survey and an estimate of post-tax income. Given it is unlikely non-local workers would permanently shift, a large proportion of income would be spent externally (i.e., on mortgages, utilities, food, etc). For this reason, up to 50% of annual post-tax disposable income (i.e., up to $35,000) is estimated to be spent in the Study Area. It is important to note that these expenses are likely split between the individual and ESCO/other contractors. Spending would include the following:

- housing expenditure, including spending on accommodation at hotels, motels, caravan/holiday parks B&Bs, and private rental dwellings
- retail expenditure, including spending on supermarket items, restaurants, cafes, clothing, books, homewares etc
- recreation spending associated with day trips and excursions, gaming (lottery, sports betting, etc), purchases in pubs and clubs
- personal, medical and other services, such as GP fees and local prescriptions, fuel, vehicle maintenance, etc.

vi Ongoing economic stimulus (community benefits)

a Local wage stimulus

The largest ongoing economic benefit to the local community is the ongoing wages provided through the project. Over the 35-year operating lifecycle, the Muswellbrook Solar Farm will support 8.5 direct FTE jobs within the Study Area. These jobs will provide an estimated $828,000 per annum or $45.5 million (with an annual average CPI adjustment of 2.5%) over 35 years in additional wages. [4]

The per annum figure is calculated on the average weekly salary of 6 FTE operations managers (Electricity, Gas, Water and Waste Services – $2,098.2); and 2.5 FTE maintenance workers (Other Services – $1,332.20) (ABS 2023).

b Landowner payments

The proponent will make annual payments to the host private landowner to facilitate the solar farm project. However, these figures are personal and confidential and have not been included in this report but will bring some local private community benefits.

[4] Note: Only a proportion of additional wages will be spent in the Study Area with 20% of post-tax income (on averaged) saved and another proportion spent on external goods and services.

c Returns to Council and the community

A Community Benefits Fund will be provided during the operational phase of the facility. At this stage a decision regarding the structure of the Community Benefits Fund has not been finalised. However, this is likely to involve annual payments to the Fund over the life of the solar farm (likely managed through a Voluntary Planning Agreement with Muswellbrook Shire Council). Community Benefits Fund payments can be used to support local projects and programs, which may include community, educational and environmental initiatives.

The project will also provide training opportunities for local workers in the construction and operational aspects of solar farms. These workers will be able to transfer this knowledge to other renewable energy projects in the future, which is important noting the growth of the renewable sector in the region.

Additional Council and community benefits not quantified is the uplift in annual council rates.

vii National energy market transition and environmental benefits

When fully operational, the Muswellbrook Solar Farm is expected to generate 135 MWac of renewable energy annually, which boosts NSW solar generation capacity by around 7.1%[5]. This is sufficient to support the annual electricity needs of approximately 79,000 NSW households[6], aligns with the NSW Government goals to achieve 70% of net zero emissions reductions by 2035 (OECC 2022) and contributes to NSW renewable generation capacity targets. These align with the national strategy to grow renewables generation capacity across Australia.

According to the ABS Census 2021, the Study Area contains approximately 14,000 private dwellings. Therefore, the proposed project has the potential to provide almost six times the annual electricity requirements of the Study Area.

ESCO also estimates that the proposed project is equivalent to 233,884 t CO_2e per annum of avoided greenhouse gas emissions, which produces an estimated $1.1 billion CO^2e equivalent (undiscounted, based on NSW Treasury Cost-Benefit Analysis Guidelines and non-inflated) over the 35-year project life.[7] This equates to an estimated total of 7.6 Mt of avoided emissions over 35 years.[8]

viii Tourism

One potential impact on the tourism sector could be the lack of visitor accommodation if the motel and/or tourist parks were used to house by construction workers for long periods during peak festival and event periods.

The Study Area hosts several significant regional events each year and are illustrated in Section 4.5 of the SIA (EMM 2023c). These events typically occur throughout the year with each potentially attracting thousands of visitors annually.[9]

[5] As per Energy NSW website statistics, https://www.energy.nsw.gov.au/nsw-plans-and-progress/major-state-projects/shift-renewables/renewable-energy-nsw

[6] As per information from ESCO

[7] NSW Treasury Government Guide to Cost-Benefit Analysis – Carbon value

[8] Guidance from ESCO: 233,884 t CO_2e in year 1 with a generation degradation of 0.4% each year for a total of 7,623,662 t CO_2e of avoided emissions over 35 years.

[9] For example: https://www.muswellbrookchronicle.com.au/story/6261058/highland-fun-at-aberdeen-photos/

6.14.3 Net economic impact assessment – conclusion

The economic costs and benefits have been considered for the project and are summarised in Table 6.52, and as follows:

1. The anticipated negative economic impacts of the project are expected to be comparatively small. Agricultural impacts from the removal of 482 ha of land from agricultural services is expected to directly cost the local economy between $4.6 – $10.9 million and indirectly between $10 – $23.8 million over the 35-year operating lifecycle. In addition, an estimated 10–2.5 agricultural FTE jobs in the Study Area (2.2–5.4 FTE jobs across the supply chain) are expected to be lost. However, an opportunity exists for sheep grazing which would reduce the agricultural cost impact.

2. The Muswellbrook Solar Farm will require approximately $302 million in investment over the 31-month construction phase with up to 10% expected to flow directly to the local economy through direct contracts and labour wages.

3. The project will require approximately 76 FTE on average during construction but will support up to 200 FTE workers at the peak. ESCO expects up to 54% of these workers are sourced locally, providing opportunities for businesses and workers located in the Study Area to develop necessary skills in solar farm construction. This should create efficiencies for future solar farm projects proposed in the surround regions. Additionally, once operational, 8.5 FTE (6 operations managers and 2.5 maintenance services) will be supported locally by the facility generating up to $45.5 million in additional wages over the 35-year operational lifecycle.

4. Although not quantified because of the limitations of multipliers, significant indirect jobs (i.e., jobs that indirectly support the project like accommodation and retail services) will also be supported during both the construction and operational phases.

5. The non-local labour requirement would expect to generate an average monthly accommodation need for 37 workers, with up to 87 rooms required at the peak of the project. This represents just over 10% of accommodation in the Study Area. Although there appears to be relatively low occupation rates which means the project will support new revenues for accommodation providers, especially in off-peak seasons, these figures appear dated with SIA analysis identifying an average occupancy rate of 70-90% based on Monday to Friday averages. This could potentially result in some challenges for accommodating non-local workers in the Study Area.

6. Non-local construction workers relocating to the Study Area are expected to inject up to $4.6 million in additional spending into the economy over the construction phase.

7. It is estimated that the project accounts for 233,884 t CO_2e per annum which produces an estimated greenhouse gas emissions value of approximately $1.1 billion (undiscounted and non-inflated) over the 35-year project, contributing to national and state goals of cutting emissions in energy supply.

8. Potential Council and community benefits include rates payments and Community Benefits Fund payments which are yet to be determined.

Table 6.52 Net economic impact assessment – summary

Factor	Value (undiscounted)
Negative outcomes	
Temporary loss of agricultural land	482 ha
Temporary loss of agricultural production	Directly: $4.6 – $ 10.9 million over 35 years Indirectly: $10 – $23.8 million over 35 years
Temporary loss of employment	Directly: 1–2.5 FTE jobs in Study Area Indirectly: 2.2–5.4 FTE jobs across supply chain
Positive outcomes	
Construction phase	
Capital investment	$302 million
Local purchases (services and labour) + Local additional retail expenditure	Up to $30.2 million (assumes up to 10% of total investment). This includes up to $4.6 million in additional retail expenditure (over 31 months)
Construction employment	76 FTEs (average over 31-months with up to 54% sourced locally)
Operational phase	
Operation employment	8.5 locally based FTEs for 35 years
Local economic stimulus	Up to $45.5 million (over 35 years)
Other	
Environmental	Estimated avoided emissions of 233,884 t CO^2e per annum, which produces an estimated carbon market value of approximately $1.1 billion (over 35 years and non-inflated)

6.15 Cumulative impacts

The project will contribute to the overall growth of the Hunter-Central Coast REZ. Other proposed, approved, under construction and operational renewable energy developments known at the time of this EIS and within the vicinity of the Hunter-Central Coast REZ are shown in Figure 2.6. As indicated, there are several renewable energy generation and other projects (proposed and approved) in the vicinity of the project.

Development in the vicinity of the project has the potential to generate cumulative impacts with the project during both construction and operation. An assessment has been completed with reference to the *Cumulative Impact Assessment Guidelines for State Significant Projects* (DPE 2022l). The assessment has included consideration of:

- Incremental assessment – impacts of the project to the existing baseline condition of each relevant assessment matter (e.g. noise, water, biodiversity, heritage, traffic, employment and workforce). The impacts from existing developments have been assumed as part of the baseline conditions, and the incremental impacts of the project have been considered to identify the change in baseline. This is completed in relevant technical assessments and summarised in the relevant sections above in Chapter 6.

- Combined incremental assessment – combined effect of the different impacts of the project, summarised in this section. Existing and approved developments within the local area (known at the time of EIS finalisation) have been considered in the cumulative assessments of each of the technical assessments for visual, noise, traffic, water and social aspects. Cumulative impacts with other existing development, including those contributing to visual impacts to the landscape, generation of noise that contributes to background noise levels, use of transport routes by local traffic and nearby developments, flooding impacts, and social impacts and benefits associated with other development in the local area have all been considered.

- Issue-specific cumulative assessment – impacts of the project together with the impacts of other relevant future projects on key matters, summarised in this section.

- Combined cumulative assessment – the combined effect of the different cumulative impacts of the project on key matters, sensitive receptors or important features with other relevant future projects. This is largely qualitative and combined with the issue-specific cumulative assessment in this section. The qualitative nature relates to a range of uncertainties including:

    - The level of detail available for future projects – often future projects are at early stages of the planning process and limited information is available regarding the nature, timing and potential impacts of such projects.

    - The likelihood that those projects will proceed – while many projects will gain approval, some may not, and some projects may never proceed despite gaining approval.

    - The uncertainty of timing of future projects – while they may proceed at some point in the future, the timing is unknown.

6.15.1 Other state significant projects

There are several sate significant development projects (Section 2.4) recently approved or proposed in the local area, as identified through the DPE Major Project Planning Portal at the time this EIS. A radius of approximately 20 km from the project has been used to identify future project for consideration of potential cumulative impacts.

A summary of the potential for cumulative impacts with future projects within 20 km of the project is provided in Table 6.53. Cumulative impacts are explained further in Section 6.15.3.

Table 6.53 Cumulative impacts with future projects identified within 20 km of the project

LGA	Project name and development type	Approximate distance to project	Status	Overlap with project and potential for cumulative impacts
Muswellbrook	Muswellbrook Coal Mine	Adjacent to project	Operational	Coal extraction and processing has ceased at the Muswellbrook coal mine. Rehabilitation is ongoing and will continue during the construction phase of the project. Cumulative impacts of this operational mine have been considered as part of the baseline impact assessment.

Table 6.53 Cumulative impacts with future projects identified within 20 km of the project

LGA	Project name and development type	Approximate distance to project	Status	Overlap with project and potential for cumulative impacts
Muswellbrook	Muswellbrook Bypass	Adjacent to project	Approved. Construction commencing 2023.	The development involves the construction of a highway bypass around Muswellbrook. There is potential for cumulative impacts related to construction (construction workforce demand and construction workforce accommodation, traffic and noise impacts) and operation (visual).
Muswellbrook	Muswellbrook Pumped Hydro	Adjacent to project	In planning. Four-year construction phase, commencing 2026. 50-year operational life.	The development involves the construction of a pumped hydro facility between Bells Mountain and the Muswellbrook Coal Min pit. The development is still in planning and construction is not expected to commence until 2026. This may coincide with the construction of the BESS stage of the project. There is potential for cumulative impacts related to construction (construction workforce demand and construction workforce accommodation, traffic and noise impacts) and operation (visual).
Muswellbrook	Muswellbrook Battery Energy Storage Project	1.5 km W	Assessment. More information required. 12 months construction phase, commencing 2024. 20-year operational life.	The development involves the construction of a 150 MW BESS to the west of the project, off Sandy Creek Road. Cumulative impacts which may overlap would primarily be related to traffic movements, workforce demand and higher demand for short-term accommodation.
Muswellbrook	Mount Pleasant Coal Mine	5 km W	Operational.	An existing established coal mine considered as part of the baseline impact assessment.
Muswellbrook	Mount Pleasant Optimisation Project	5 km W	Approved. Mining operations may take place until 2048.	The optimisation works are to extend the life of the open cut operation and include upgrades to site infrastructure. Cumulative impacts of this operational mine have been considered as part of the baseline impact assessment.
Muswellbrook	Maxwell Solar Farm	6 km S	Approved. Under construction, expecting to be commissioned in 2023, with an operational life of 30 years.	The development involves the construction and operation of a 25 MW solar farm. The construction of this development is expected to be completed prior to the commencement of construction of the project. Cumulative impacts associated with the operation of the project are not expected.
Muswellbrook	Bengalla Coal Mine	7 km W	Operational.	An existing established coal mine considered as part of the baseline impact assessment.
Muswellbrook	Mount Arthur Coal Mine	8 km SW	Operational.	An existing established coal mine considered as part of the baseline impact assessment.

Table 6.53 Cumulative impacts with future projects identified within 20 km of the project

LGA	Project name and development type	Approximate distance to project	Status	Overlap with project and potential for cumulative impacts
Muswellbrook	Liddell Power Station – Future Land Use and Enabling Works Project	10 km S	Prepare EIS. 20-year operations.	The development involves demolition and rehabilitation of Liddell Power Station and works to enable future land uses. The timing of this development is not known at this stage. Potential cumulative impacts may include demand for short-term accommodation and access to community services should the construction periods overlap.
Muswellbrook	Liddell Battery and Bayswater Ancillary Works Project	10 km S	Approved. Staged construction with works continuing through to 2035.	The development involves the construction and operation of a BESS, and decoupling of the Liddell and Bayswater power stations. Potential cumulative impacts may include increased demand for short term accommodation and access to community services.
Muswellbrook	Bowmans Creek Windfarm	14 km W	Assessment. More information required. 18-month construction phase	The development involves the construction of a wind farm with up to 60 wind turbines and associated infrastructure. The timing of this development is not known at this stage. There is potential for cumulative impacts related to construction (construction workforce demand and construction workforce accommodation, traffic, and noise impacts) should construction periods overlap, and operation (visual).
Muswellbrook / Singleton	Focono Quarry	15 km SE	Prepare EIS. 12 month construction phase, commencing 2024. 50 year operational life.	The development involves the construction of a hard rock quarry. Potential impacts would be associated with demand for short-term accommodation should the construction periods overlap.
Muswellbrook / Singleton	HVO Mine Continuation	16 km S	Response to submissions. 5 year construction period, commencing 2023. Mining operations expected to take place until 2050 for HVO North and 2045 for HVO South.	The proposed development involves the continuation of mining at an established mine. Potential impacts would be associated with demand for short-term accommodation should the construction periods overlap.
Muswellbrook	Maxwell Underground Coal Mine project	19 km SW	Approved. 36 month construction phase (commenced 2022). Mining operations may take place until 2047.	This development involves the construction and operation of an underground coal mine. This future development is spatially distant from the project and no cumulative impacts have been identified in terms of traffic movements, noise, and visual.

Table 6.53 Cumulative impacts with future projects identified within 20 km of the project

LGA	Project name and development type	Approximate distance to project	Status	Overlap with project and potential for cumulative impacts
Muswellbrook	Hunter River Solar Farm	19 km SW	Prepare EIS. 18 month construction phase, commencing 2025. 50 year operational life.	This development involves the construction and operation of a 60 MW solar farm. The timing of this development is not known at this stage. This future development is spatially distant from the project and no cumulative impacts have been identified in terms of traffic movements, noise, and visual.

6.15.2 Other related development

Related development is discussed in Section 1.4. The cumulative impacts associated with the Muswellbrook Coal mine has been considered as part of the baseline impact assessment. The connection point of the project to the electricity network has been assessed in this EIS. Connection works will be short term and impacts arising from the construction of the transmission line will be managed with standard environmental mitigation and management measures.

6.15.3 Assessment of cumulative impacts

The cumulative impacts identified below have been assessed and discussed in the SIA (Appendix G), TIA (Appendix K), LVIA (Appendix F) and NVIA (Appendix L).

i Workforce demand and supply

The employment demands for the future projects identified may cause potential impacts on the availability of skilled workforce in the local area, should construction periods overlap substantially. This may require additional workers to be sourced from outside the local and regional areas.

The potential of a non-resident and relocating workforce to service the concurrent developments may contribute to the cumulative impacts in the local area. This may result in impacts on the capacity and availability of local service providers, accommodation providers and increased traffic. However, potential cumulative benefits may also be associated with the high number of SSD projects in the local area, such as increased employment and economic opportunities for local businesses and suppliers.

Local construction and general labour workforce availability may also be impacted by these concurrent developments. This may result in a shortage of workers which would increase the need for drive-in-drive-out workers that would exacerbate pressures on accommodation and housing. However, there is potential for an increase in local job availability supported by a number of SSDs to drive industry growth in the local area and the region.

The construction workforce is estimated to peak at approximately 200 full time equivalent employees during the peak construction phase and will consist of a combination of local hires and non-local hires.

ESCO has prepared an Accommodation and Employment Strategy (Appendix P) which outlines the project workforce requirements and interaction with other projects. The Strategy provides a commitment to local hiring and provision of training and apprenticeship opportunities with the aim of reducing the need for outsourcing of workers. Local employment strategies have been developed with an evaluation and monitoring framework with key performance indicators/targets. These will be regularly reviewed and updated as required.

ii Housing and short term accommodation

The availability of rental and short-term accommodation in the local and regional study areas is constrained. The demand for temporary accommodation in the regional area has been highlighted by both Singleton and Muswellbrook Council and the local area has limited capacity to absorb the housing demand generated by construction projects of multiple SSD projects.

Assuming the majority of workforces associated with other projects that overlap with the project will be sourced from outside the regional area, the projected cumulative demand for short-term accommodation and rental housing in the regional area will be extreme. Commitments to local hiring, provision of training and apprenticeship opportunities for local workers, and partnerships with local employment and training services could reduce the need for sourcing of workers from outside the area.

The number of projects in the regional area suggests a long-term pipeline (possibly upwards of 10 years) of construction work. With industry collaboration there is an opportunity to draw a permanent resident construction workforce to the regional area. This would have a positive effect on accommodation demand as workers may seek to buy in the regional area and relocate permanently if there is a clear pathway for long-term employment. Encouraging a permanent construction workforce in the regional area would benefit long term sustainability of these communities and the services and facilities they provide, as well as supporting long term economic benefits for business operators.

ESCO has prepared an Accommodation and Employment Strategy (Appendix P) which outlines the project accommodation requirements and interaction with other projects. An analysis of available housing and short-term accommodation in Muswellbrook and surrounding towns has been prepared. A detailed review would be undertaken closer to construction to determine the level of current workforce being accommodated in the region on projects which have already begun construction and how this is impacting occupancy rates.

Several strategies to prioritise local accommodation and ensure sufficient accommodation have been considered.

iii Traffic and transport

Development in vicinity of the project has the potential to generate cumulative traffic impacts with the project. The greatest potential for cumulative impacts with the proposal are associated with construction of the Muswellbrook Bypass and the Muswellbrook BESS which have the potential to have construction periods that are currently scheduled to overlap with the project.

These projects are expected to require heavy vehicle movements during construction and would use the New England Highway, Muscle Creek Road and Sandy Creek Road. The TIA (Appendix K) has considered the potential impacts associated these projects. The intersection analysis of key intersections in Muswellbrook and the mid-block capacity of Muscle Creek Road and Sandy Creek Road indicate that there will not be significant impacts to these intersections and roads as a result of construction traffic.

iv Amenity

Potential amenity impacts may include accumulated dust from increased truck movements and earthworks, noise caused by plant and equipment, and increased traffic. Cumulative noise assessment has been considered in the NVIA (Appendix L) and summarised in Section 6.8.3. The assessment concluded that there would be no new exceedences of the ICNG affected or highly affected NML

Visual impacts from the development of multiple projects that may have a low impact individually, but when viewed together, can have significant visual impact on the landscape. The LVIA (Appendix F) has considered the potential for cumulative visual impacts.

The Muswellbrook Pumped Hydro project is in the planning stages, and little is known about the potential visual impacts, however, there is the potential for increased visible infrastructure for residents north of the project. The visual impacts from the project, including the cumulative impacts, and associated mitigation measures will be assessed as part of the Muswellbrook Pumped Hydro EIS.

The Muswellbrook Bypass construction will coincide with the construction of the solar farm, and there is likely to be increased visual impacts for residents surrounding the southern array. The Bypass is likely to screen the solar infrastructure from the west and increase the total visual impact from areas to the east and south of the southern solar array. The Muswellbrook Bypass project has included vegetative screening to mitigate visual impacts.

7 Project justification

This chapter provides a justification and evaluation of the project, having regard to the economic, environmental, and social impacts and benefits of the project and the principles of ecologically sustainable development (ESD).

7.1 Summary

The development and operation of the project, in conjunction with other large-scale renewable energy projects, has potential to fill the need for replacement power as ageing coal-fired generators face closure. The project is consistent with relevant Commonwealth, State, regional and local strategic plans and polices, in particular the NSW Electricity Infrastructure Roadmap, which sets out the plan to deliver REZs in NSW. The project will contribute to the energy generation and storage targets for the Hunter-Central Coast REZ, with an indicative capacity of around 135 MWac and storage of up to 135 MWac for a 2-hour duration.

In addition to its location within the Hunter-Central Coast REZ and at the site of the Muswellbrook Coal mine, the study area is favourable for the construction and operation of a solar and battery project due to the available solar resource, physical conditions (flat to gently undulating topography and predominantly cleared, agricultural land), proximity to existing 132 kV and 330 kV transmission lines, absence of biophysical strategic agricultural land and relatively few residences within proximity.

Were this project not to proceed, the project's benefits, including contributions to the generation of renewable energy and increased energy security, would not be realised. Given the need to establish renewable energy generation and storage projects in NSW, not proceeding with the project in its current location may encourage development in a less favourable location, resulting in undesired outcomes, such as greater requirements for grid connection infrastructure and greater environmental and social impacts.

The project will have both impacts and benefits on the surrounding natural and built environments. The impacts have been investigated, are not predicted to be significant, and can be adequately managed through appropriate design, mitigation and management during construction and operation. On balance, it is therefore considered that the project is in the public interest.

7.2 Design development

During the preparation of the EIS, the development footprint within the study area has been refined based on environmental constraints identification, stakeholder engagement and design of project infrastructure with the objective of developing an efficient project that avoids and minimises environmental and social impacts.

Throughout the project refinement process (refer to Section 2.5.4), ESCO has avoided potential environmental impacts where possible. In those instances where the potential for impacts cannot be avoided, ESCO's design principles have sought to minimise environmental impacts and/or implement mitigation measures to manage the extent and severity of residual impacts. The proposed mitigation measures that will be implemented for each of the key environmental matters assessed in this EIS are summarised in Appendix C.

The development footprint reflects the most appropriate area for the project infrastructure based on inputs provided during consultation activities with regulatory and community stakeholders (refer to Chapter 5), environmental assessments undertaken to date (refer to Chapter 6) and the functional requirements of project infrastructure.

During detailed design and prior to the commencement of construction, it is anticipated that the placement of infrastructure and extent of construction activities will be further refined in keeping with impact avoidance and minimisation objectives.

7.3 Strategic context

The project is supported by Commonwealth, State, regional and local plans and policies (as described in Table 2.1) and will support the Commonwealth and State governments to achieve their respective renewable energy and greenhouse gas emission reduction targets. Importantly, the project will also contribute to the continued growth of renewable energy generation and storage capacity in the Hunter-Central Coast REZ.

7.4 Objects of the EP&A Act

The objects of the EP&A Act are set out in clause 1.3 of the Act. An assessment of the consistency of the project with the objects of the EP&A Act is provided in Table 7.1.

Table 7.1 Project's consistency with the objectives of the EP&A Act

Object	Consistency with the project
a) 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	Resources within the study area and, more specifically, the development footprint, include land that is being used for mining of coal resources, agricultural production, and land which has biodiversity and Aboriginal cultural heritage values. This constitutes the 'natural resources', which must be properly managed, developed or conserved. It is acknowledged that the development of the project will reduce the utilisation of the land within the development footprint for agricultural production; however, this impact will be mitigated by a number of factors including: • The use of single axis tracking PV modules involves a typical row spacing of 6.5 m, which would allow for the colocation of sheep grazing during operations. • Site selection – the development footprint has been strategically placed adjacent to an existing coal mine that has ceased the extraction of coal, and the northern project area is located above historical underground mine workings. There are also minimal areas of BSAL near the project area. • Return to agricultural land – the development footprint can be returned to agricultural land use at the completion of the project's operations. Land management practices will avoid or minimise potential impacts to neighbouring properties that have been identified during engagement with the local community and as part of the LUCRA. Throughout the design process, the project has sought to minimise impacts on biodiversity values (refer Section 6.1.3). The existing mining and agricultural use of the development footprint was considered in the selection of the project area to reduce biodiversity impacts. The residual biodiversity values that will be impacted by the project will be offset. Four Aboriginal cultural heritage sites will be impacted by the project, two of which will be salvaged prior to construction.
b) to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment	This EIS describes the economic, environmental and social context of the project and the potential impacts of it to allow informed consideration of these aspects in determining the development application. The project will contribute to the continued growth of renewable energy generation and storage capacity, as well as providing energy security and reliability.

Table 7.1 Project's consistency with the objectives of the EP&A Act

Object	Consistency with the project
c) to promote the orderly and economic use and development of land	The orderly and economic use of land is best served by development that is permissible under the relevant planning regime and predominately in accordance with the prevailing planning controls. The project is permissible with consent, is consistent with statutory and strategic planning controls and will form part of the Hunter-Central Coast REZ. As detailed in this EIS, the project will result in positive economic impacts, with appropriate mitigation measures and management strategies being proposed to reduce any adverse environmental and social impacts.
d) to promote the delivery and maintenance of affordable housing	Not directly applicable to the project.
e) to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats	Measures to avoid and minimise impacts to native vegetation and threatened species habitat were considered during the initial design stages of the project, resulting in avoidance of significant biodiversity values and minimisation of impacts on other areas of native vegetation. All unavoidable impacts will be offset in accordance with NSW Government policy. Establishing offsets will enhance biodiversity values in the medium to short-term.
f) to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage)	Four Aboriginal sites and/or objects were identified within the development footprint (MSF-FA1, MSF-FA-2, MSF-BS1, MSF-CMT1). The project would result in the total or partial loss of all sites, however, portions of MSF-FA1 and MSF-FA2 would be preserved and there would be opportunities for heritage interpretation and public outreach. The project will not impact any historic heritage sites.
g) to promote good design and amenity of the built environment	Potential visual, noise and air quality impacts on sensitive receptors (including residences) have been fully assessed and described in Chapter 6.
h) to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants	Over the life of the project, infrastructure will be maintained, or upgraded, to ensure safe and efficient operations. All construction associated with the project will be compliant with the Building Code of Australia and all other relevant statutory requirements.
i) to promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State	This is a matter for the different levels of government in the State. As summarised in Chapter 5, a wide range of government agencies have been consulted regarding the project, including Muswellbrook Council and DPE.
j) to provide increased opportunity for community participation in environmental planning and assessment	As described in Chapter 5, there have been a range of engagement activities to inform the community about the project and to seek community (and other stakeholder) feedback. This EIS provides further detailed information regarding the project and its potential impacts. It will be placed on public exhibition by DPE, and community members will be able to make formal submissions. ESCO will prepare a report responding to these submissions

7.5 Consideration of community views

Consultation conducted for the project is described in Chapter 5. Feedback from the community included both positive and negative views on a range of topics.

Some stakeholders recognised the benefits of the project. In particular, stakeholders acknowledged the project as important for the transition of the area from mining to renewables, and as a source of local employment, particularly during construction.

Some concerns were raised by community stakeholders regarding how the project will change the landscape and associated visual amenity impacts.

Detail of community views and responses are included in Chapter 5 and were identified as part of targeted engagement and the SIA field study. Stakeholder requests were responded to, and further information was provided to address concerns.

7.6 Summary of project impacts

This EIS has considered the potential impacts associated with the project, as well as the need for the project and alternative development options. This section summarises the potential impacts and provides a justification for the project on environmental, economic and social grounds.

7.6.1 Environmental impacts

The environmental aspects of this project are assessed in Chapter 6. Environmental impacts include:

- Biodiversity – the project has been designed to avoid and minimise impacts to biodiversity, resulting in the avoidance of areas of high biodiversity as much as possible. The project will result in residual impacts to 125.2 ha of PCT1691 (10.7 ha requiring offsets), 118 ha of PCT281 (61 ha requiring offsets), 71.4 ha of PCT 1603 (24.4 requiring offsets), and 1.1 ha of PCT1607 (all of which requires offsets), and associated habitat for flora and fauna species. The project will result in significant impacts to two MNES threatened communities due to a reduction in the extent of these communities. A biodiversity offset strategy is proposed to compensate for the residual impacts.

- Aboriginal cultural heritage – the project will result in the partial loss of three Aboriginal heritage sites, and the total loss of one Aboriginal heritage site. Two of these sites (MSF-FA1 and MSF-FA2) will be salvaged prior to the commencement of construction.

- Landscape and visual – the development of the project will result in some changes to the landscape. Visual impacts will occur during the construction and operational stages of the project, however these are expected to be minor. No landscape screening is proposed.

- Land and soils – the project will result in a temporary change of land use for the land within the development footprint. Land management will include consideration of the viability of the colocation of sheep grazing throughout the operational life of the project.

- Water resources – the project is not expected to have significant impacts on water resources in the local area. The majority of the project area is free of mainstream flooding or subject to flood hazard that is generally safe for people, vehicles and buildings for events up to, and including, the 1% AEP. Residual flood impacts can be adequately managed. All waterway crossings will comply with relevant guidelines.

- Historic heritage – the project will not impact historic heritage sites.

7.6.2 Economic impacts

The project is justified economically due to the economic benefits and stimulus it will provide to the local region. The project will generate up to 200 jobs during construction and six full time equivalent jobs and up to three full time equivalent contractor opportunities throughout operations and will provide ongoing economic benefits for both the local economy within the Muswellbrook LGA and more broadly, the regional economy within the Hunter region.

ESCO will work in partnership with Muswellbrook Shire Council and the local community to ensure that, as far as possible, the benefits of the projected economic growth in the region are maximised and impacts minimised.

7.6.3 Social impacts

The social impacts of the project are assessed in Section 6.4 and Appendix G. The project is justified on social grounds for three principal reasons:

- the main issues raised by the local community have been addressed and mitigated
- it will contribute to the local and regional economy
- it will provide indirect benefits through the use of services and facilities both locally and regionally.

It will also generate energy from a renewable energy source, contributing to filling the need for replacement power as ageing coal-fired power stations progressively close.

Subject to their availability, the project has some potential to utilise existing community services and facilities, notably during construction. As identified within Section 6.4, an influx of a significant number of workers during the project's construction period has the potential to impact social infrastructure within the local community such as accommodation, local infrastructure and local businesses, including community services and facilities. Construction staging is intended to spread the workforce demand and reduce the aggregate peak construction workforce.

During construction, the project will have potential to cause noise and vibration, traffic impacts and impacts to visual amenity. Where potential impacts or exceedances of relevant assessment criteria have been identified, mitigation measures have been proposed to manage identified impacts.

The potential traffic impacts will generally be confined to the construction phase and can be managed using standard mitigation measures including specific construction hours, maintenance of local roads and implementation of a comprehensive traffic management plan.

While the project has some potential negative impacts, it is considered that these can be managed to acceptably low levels and are outweighed by the project's benefits. Mitigation and management strategies have been proposed for each of the identified potential social impacts to minimise negative consequences and to maximise social benefits for the local community.

Public safety risks, including bushfire, hazards and risks associated with project infrastructure, will be mitigated through design of buildings, construction areas and other assets to include appropriate bushfire protection measures (e.g., asset protection zones), and emergency access and evacuation protocols, which will be developed as part of the emergency response plan.

7.6.4 Cumulative impacts

The project has potential for cumulative impacts with nearby development and future projects. Cumulative impacts have been addressed in Section 6.14.

7.7 Ecologically sustainable development

The principles of ESD are outlined in part 8, division 5, Section 193 of the EP&A Regulation and are addressed in Table 7.2.

Table 7.2 Consideration of the principles of ecologically sustainable development

Principle	Ecologically sustainable development principle	Evaluation of project impact against principle
Precautionary principle	The **precautionary principle**, namely, 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.	During the project planning phase and preparation of this EIS, experts in their respective fields have carefully considered environmental outcomes through the preparation of quantitative technical assessments, providing a high degree of certainty around the impacts that may arise from the project. The findings of the technical assessments are provided in Chapter 6. The project has been designed with regard to the precautionary principle and in response to legislation, policies, and guidelines to ensure that it does not pose an unacceptable risk to human health or the environment. Management measures have been proposed for all potential environmental impacts. Taking these measures into account, it is considered that there would be no threat of serious or irreversible damage to the environment. Therefore, the project is consistent with the precautionary principle.
Social equity including inter-generational equity	**Inter-generational equity**, namely, 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.	A range of mitigation measures are proposed that will minimise the impacts of the project during construction and operation. The project will contribute to the sustainable transition of electricity generation in NSW to a more reliable, more affordable and cleaner energy future and contribute to a net reduction in greenhouse gas emissions. Once decommissioned, the land within the development footprint can be rehabilitated to its current use if required thereby allowing for either continuation of renewable energy generation or a return to agricultural production, both of which would provide benefits for future generations. Further, the project will enable the generation of electricity for a renewable energy source. Given the above, it is considered that the project supports inter-generational equity.

Table 7.2 Consideration of the principles of ecologically sustainable development

Principle	Ecologically sustainable development principle	Evaluation of project impact against principle
Conservation of biological diversity and maintenance of ecological integrity	**Conservation of biological diversity and ecological integrity**, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration.	The conservation of biological diversity and ecological integrity was a fundamental consideration in the development of the project. The location of the project on land with a long history of agricultural use means that biodiversity values are minimal in the study area. In addition, the project has been sited within the study area to minimise impacts to biodiversity values where possible. Specifically, the development footprint was refined to avoid areas of high biodiversity value once these areas were identified by the biodiversity assessment carried out for the project, namely the vegetation in the northern section of the project area which contains *Diuris tricolor,* a threatened species in NSW. The BDAR was prepared to assess the project's potential impacts on biodiversity (Section 6.1 and Appendix D). Direct impacts to four PCTs and six threatened flora and fauna species will require offsetting under the NSW BOS. Management and mitigation measure have been prescribed to minimise, manage and offset residual impacts on biodiversity (Appendix D).
Improved valuation and pricing of environmental resources	**Improved valuation, pricing and incentive mechanisms**, namely, 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, and iii) established environmental goals 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.	Project benefits are considered to outweigh the costs. The project will generate up to 200 jobs during construction and six full time equivalent jobs throughout operations and will provide economic benefits to the local community. The project also supports the transition away from fossil fuel (coal and gas) energy generation, thereby contributing to a net reduction in greenhouse gas emissions. ESCO accepts the financial costs associated with all the measures required for the project to avoid, minimise, mitigate and manage potential environmental and social impacts.

7.8 How compliance with be ensured

A monitoring and management framework will be developed to enable the potential positive and negative impacts to be monitored over time. It is proposed that the monitoring and management framework identifies the following key aspects:

- track progress of mitigation and management strategies
- assess actual project impacts against predicted impacts
- identify how information will be captured for reporting to impacted stakeholders including landholders, communities and government on progress and achievements
- key performance indicators, targets and outcomes

- responsible parties
- mechanisms for ongoing adaption of management measures when required.

To ensure the effectiveness of the management measures for the identified positive and negative impacts, it is recommended that a continuous improvement approach be adopted allowing for the review and adaption of impacts, management measures and outcomes.

7.9 Key uncertainties and proposed measures

ESCO is developing and operating solar and battery projects in Australia and has experience in the construction and operation of their facilities to meet relevant standards and best available technologies. A competitive bid process will select an engineering, procurement and construction contractor with a demonstrated ability to build the project in a manner that is consistent with those mitigation and management strategies that have been proposed and summarised in Appendix C.

7.10 Conclusion

The project involves the development and operation of a large-scale solar PV generation facility along with battery storage and associated infrastructure. The project is within the NSW Government declared Hunter-Central Coast REZ and will play an important part in achieving the objectives of the REZ. It will also provide economic stimulus to the region through construction jobs and associated flow-on benefits.

The residual environmental and social impacts identified throughout the EIS will be managed through the mitigation and management measures described throughout, such that the project will not result in significant impacts on the environment or the local community.

The project will achieve the following overall benefits:

- contributions to energy security and reliability in NSW by diversifying the State's energy mix and helping to prepare for the retirement of large-scale coal-fired power generation
- alignment with Commonwealth and NSW Government electricity policies and strategies and regional plans
- providing ongoing economic benefits for both the local economy within the Muswellbrook LGA and more broadly, the regional economy within the Hunter
- provide significant employment opportunities during the 31 month construction period.

Abbreviations

Item	Definition
ABS	Australian Bureau of Statistics
AC	Alternating current
ACHA	Aboriginal cultural heritage assessment
ACHMP	Aboriginal cultural heritage management plan
ADGC	Australian Dangerous Goods Code
AEMO	Australian Energy Market Operator
AEP	annual exceedance probability
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
ALUM	Australian land use and management
APZ	asset protection zone
AQC	Air quality control
AVTG	NSW *Assessing Vibration – a technical guideline* (DEC 2006)
BAL	Bushfire attack level
BAM	Biodiversity Assessment Method
BCF	Biodiversity Conservation Fund
BDAR	biodiversity development assessment report
BESS	battery energy storage system
BMP	biodiversity management plan
BOPC	biodiversity offsets payment calculator
BSA	Biodiversity Stewardship Agreements
BSAL	Biophysical Strategic Agricultural Land
CEEC	Critically endangered ecological community
CICs	Critical Industry Clusters
CIV	Capital investment value
CO_2e	Carbon dioxide equivalent
CTMP	construction traffic management plan
dB	decibels
DCCEEW	Commonwealth Department of Climate Change, Energy, Environment and Water
DC	Direct current
DEL	average delay
DG	dangerous goods

Item	Definition
DOS	degree of saturation
DP	deposited plan
DPI	Department of Primary Industries
DPE	Department of Planning and Environment (formerly the Department of Planning, Industry and Environment, DPIE)
EEC	Endangered ecological community
EIS	Environmental Impact Statement
EMF	electric and magnetic fields
EMM	EMM Consulting Pty Limited
EMP	environmental management plan
EnergyCo	Energy Corporation of NSW
EPA	NSW Environment Protection Authority
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESD	ecologically sustainable development
FDI	Fire Danger Index
FMP	flood management plan
FRNSW	Fire and Rescue NSW
GDEs	groundwater dependent ecosystems
GLIVA	*Guidelines for Landscape and Visual Impact Assessment Third Edition* (Landscape Institute & Institute of Environmental Management and Assessment 2013)
GWh	gigawatt hours
ha	hectares
HHIA	historic heritage impact assessment
HHMP	historic heritage management plan
IBRA	Interim Biogeographic Regionalisation for Australia
ICNG	NSW *Interim Construction Noise Guideline* (DECC 2009)
KFH	Key Fish Habitat
kL	kilolitres
km	kilometres
kV	Kilovolt
LALC	Local Aboriginal Land Council
LCZ	landscape character zones
LEP	Local Environmental Plan

Item	Definition
LGA	Local government area
LOS	level of service
LPG	Liquified petroleum gas
LRET	Large Scale Renewable Energy Target
LSC	land and soil capability
LT	left turn
LUCRA	land use conflict risk assessment
LUSEA	Land use, soils and erosion assessment
LVIA	landscape and visual impact assessment
m	metres
MCC	Muswellbrook Coal Company
ML	megalitres
MNES	Matters of national environmental significance
Mt	Megatonne (1 million tonnes)
MW	Megawatt (1 million watts of power)
MWac	Megawatt alternating current
MWdc	Megawatt direct current
MWh	Megawatt hour (a megawatt hour is equivalent to 1 million watts of electricity being used for an hour. A megawatt hour could be 2 megawatts of power being used for half an hour or it could be 0.5 megawatts of power being used continually for 2 hours).
NATA	National Association of Testing Authorities
NEM	National Electricity Market
NHVR	National Heavy Vehicle Regulator
NMLs	noise management levels
NPfI	NSW *Noise Policy for Industry* (EPA 2017)
NSW	New South Wales
NVIA	Noise and vibration impact assessment
O&M	Operations and maintenance
OSOM	Oversize and/or overmass
PAD	Potential archaeological deposit
PBP	Planning for Bushfire Protection 2019 (NSW RFS 2019)
PCT	Plant community type
PCU	Power conversion unit
PHA	Preliminary hazard analysis

Item	Definition
PMF	Probable Maximum Flood
PMST	Commonwealth Protected Matters Search Tool
PV	Photovoltaic
Q95	95% queue lengths
RAPs	Registered Aboriginal parties
RBLs	Rating background noise levels
REZ	Renewable Energy Zone
RFS	NSW Rural Fire Service
RT	right turn
SAII	serious and irreversible impacts
SEARs	Secretary's Environmental Assessment Requirements
SIA	Social impact assessment
SISD	safe intersection sight distance
SLC	soil loss class
SRD SEPP	*State Environmental Planning Policy (State and Regional Development) 2011*
SSAL	State significant agricultural land
SSD	State significant development
SWMP	Soil and water management plan
TEC	Threatened ecological communities
TfNSW	Transport for NSW
TH	through movement
The project	Muswellbrook Solar Farm Project; a large scale solar photovoltaic generation facility along with battery storage and associated infrastructure
ti	Turill
TIA	Traffic impact assessment
TN	Total nitrogen
TSS	Total suspended solids
TP	Total phosphorus
VRZ	vegetated riparian zone
Watt	A watt is the basic unit of power. Watts = voltage x current.
WMP	Waste management plan
WRIA	water resources impact assessment
WSP	water sharing plan
µs/cm	microsiemens per centimetre

References

ABS 2021a, *2021 Census QuickStats - Muswellbrook*. Australian Bureau of Statistics.

ABS 2021b, *Census Place of Work Employment (Scaled)*, ABS 2019 / 2020 National Input Output Tables, and ABS June 2022 Gross State Product. Retrieved from: https://app.remplan.com.au/muswellbrook/economy/industries/employment?state=KLaJFA!Jwe7H978lu9a0mDH57M7ECwFQhB65CKXDXpsDPYPMtYhD4T3hKSEEZeHW0Z, and https://app.remplan.com.au/singleton/economy/industries/employment?state=yNVpFR!EVEKIeMVbFk8em2I6yx86uLFafrRvI8aEaLf2ELEASnfabfDfyInn72U6PK.

ABS 2022a, *Value of Agricultural Commodities Produced*, Australia, 2020/21. Cat. No. 7503.0

ABS 2022b, *Australian National Accounts: Input-Output Tables*. *Limitations of Input-Output multipliers for economic impact assessment*. Retrieved from: https://www.abs.gov.au/statistics/economy/national-accounts/australian-national-accounts-input-output-tables/2019-20.

ABS 2023, *Average Weekly Earnings, Australia*, Reference period: November 2022. ABS 6302. Retrieved from: https://www.abs.gov.au/statistics/labour/earnings-and-working-conditions/average-weekly-earnings-australia/latest-release

AECOM 2021, *Technical Working Paper: Surface and Groundwater Assessment, New England Highway bypass of Muswellbrook,* prepared for Transport for NSW, Warabrook.

AEMO 2022, 2022 *Integrated System Plan*, June 2022, For the National Electricity Market.

ANZECC 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ)

ANZG 2018. *Australian & New Zealand Guidelines for Fresh & Marine Water Quality*. Retrieved from Australian & New Zealand Guidelines: https://www.waterquality.gov.au/anz-guidelines

Austroads 2017, *Austroads Guide to Road Design Part 4A (Unsignalised and Signalised Intersections).*

BMT 2023, *Flood Model for Muswellbrook Solar Project*, prepared by BMT Group Ltd for EMM Consulting Pty Limited on behalf of ESCO Pacific Holdings Pty Ltd.

BoM 2022, *Groundwater Dependent Ecosystems Atlas,* Australian Bureau of Meteorology, accessed 21 April 2023 from http://www.bom.gov.au/water/groundwater/gde/map.shtml.

Clean Energy Regulator 2021, *Clean Energy Regulator Annual Report 2020–21*. Clean Energy Regulator.

Clean Energy Regulator 2022, *Quarterly Carbon Market Updates, June Quarter 2022. 2., Large-scale generation certificates (LGCs),* accessed 20 October 2022 from https://www.cleanenergyregulator.gov.au/Infohub/Markets/Pages/qcmr/june-quarter-2022/Large-scale-generation-certificates-(LGCs).aspx.

Cool Burn Fire & Ecology 2023, *Bush Fire Strategic Study, Muswellbrook Solar Farm*, prepared by Cool Burn Pty Ltd for EMM Consulting Pty Limited on behalf of ESCO Pacific Holdings Pty Ltd.

DCCEEW 2022a, *Renewable Energy Target scheme*, accessed 20 October 2022 from https://www.dcceew.gov.au/energy/renewable/target-scheme.

DCCEEW 2022b, *National Pollutant Inventory,* accessed 10 November 2022 from https://www.dcceew.gov.au/environment/protection/npi/data/search-npi-data.

DEC 2006, *NSW Assessing Vibration – a technical guideline (AVTG).* Department of Environment and Conservation.

DECC 2008, *Managing Urban Stormwater: Soils and construction - Volume 2A.* NSW Department of Environment and Climate Change.

DECC 2009, *NSW Interim Construction Noise Guideline* (ICNG). NSW Department of Environment and Climate Change.

DECCW 2010a, *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW*. NSW Department of Environment, Climate Change and Water.

DECCW 2010b, *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010.* NSW Department of Environment, Climate Change and Water.

DECCW 2011, *NSW Road Noise Policy* (RNP), NSW Department of Environment, Climate Change and Water.

DISER 2021, *Australia's whole-of-economy Long-Term Emissions Reduction Plan*, Department of Industry, Science, Energy and Resources.

DoE 2013, *Matters of National Environmental Significance – Significant Impact Guidelines 1.1.* Department of the Environment.

DoP 2011a, *Hazardous Industry Planning Advisory Paper No 6 – Guidelines for Hazard Analysis.* Department of Planning.

DoP 2011b*, Assessment Guideline – Multi-level Risk Assessment*. Department of Planning.

DoP 2011c*, Hazardous Industry Planning Advisory Paper No 4 – Risk Criteria for Land Use Safety Planning*. Department of Planning.

DoP 2011d, *The Hazardous and Offensive Development Application Guidelines: Applying SEPP 33.* Department of Planning.

DPE 2016a, *Hunter Regional Plan 2036*. NSW Department of Planning and Environment.

DPE 2016b, Wind Energy: *Visual Assessment Bulletin AB 01 For State Significant Wind Energy Development*. NSW Department of Planning and Environment.

DPE 2016c, *The Dark Sky Planning Guideline.* NSW Department of Planning and Environment.

DPE 2020, *NSW Landuse 2017 v1.2,* NSW Department of Planning and Environment, accessed 21 April 2023 from https://datasets.seed.nsw.gov.au/dataset/nsw-landuse-2017-v1p2-f0ed.

DPE 2022*, State significant development guidelines – preparing an environmental impact statement.* NSW Department of Planning and Environment.

DPE 2022a, *Large-Scale Solar Energy Guideline*. NSW Department of Planning and Environment.

DPE 2022b, *Technical Supplement – Landscape and Visual Impact Assessment.* NSW Department of Planning and Environment.

DPE 2022c, *Controlled activities – Guidelines for riparian corridors on waterfront land.* NSW Department of Planning and Environment.

DPE 2022d, *Air quality monitoring in the Upper Hunter*, NSW Department of Planning and Environment, accessed 21 April 2023 from https://www.environment.nsw.gov.au/topics/air/monitoring-air-quality/upper-hunter.

DPE 2022e, *About the air quality categories*, NSW Department of Planning and Environment, accessed 10 November 2022 from https://www.environment.nsw.gov.au/topics/air/understanding-air-quality-data/air-quality-categories.

DPE 2022f, *Controlled activities – Guidelines for laying pipes and cables in watercourses on waterfront land*. NSW Department of Planning and Environment.

DPE 2022g, *Controlled activities – Guidelines for watercourse crossings on waterfront.* NSW Department of Planning and Environment.

DPE 2022h, *Controlled activities – Guidelines for instream works on waterfront land*. NSW Department of Planning and Environment.

DPE 2022i, *Controlled activities – Guidelines for outlet structures on waterfront land*. NSW Department of Planning and Environment.

DPE 2022j, *Controlled activities – Guidelines for vegetation management plans on waterfront land*. NSW Department of Planning and Environment.

DPE 2022k, *Undertaking Engagement Guidelines for State Significant Projects*. NSW Department of Planning and Environment.

DPE 2022l*, Cumulative Impact Assessment Guidelines for State Significant Projects*. NSW Department of Planning and Environment.

DPE 2022m, *Hunter Regional Plan 2041*. NSW Department of Planning and Environment.

DPE 2023a, *Social Impact Assessment Guideline for State Significant Projects*. NSW Department of Planning and Environment.

DPE 2023b, *Technical Supplement: Social Impact Assessment Guideline for State Significant Projects.* NSW Department of Planning and Environment.

DPI 2013, *Policy and guidelines for fish habitat conservation and management (update 2013*). NSW Department of Primary Industries.

DPI 2019, *Gross Margin Budgets for Livestock.* NSW Department of Primary Industries.

DPI Water 2016, *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources, Background document*. NSW Department of Primary Industries -Water.

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

DPIE 2020a*, NSW Electricity Infrastructure Roadmap*. Building an energy superpower: detailed report. NSW Department of Planning, Industry and Environment.

DPIE 2020b, *Net Zero Plan Stage 1: 2020-30.* NSW Department of Planning, Industry and Environment.

DPIE 2020c*, Biodiversity Assessment Method*. NSW Department of Planning, Industry and Environment.

DPIE 2020d*, eSPADE NSW soil and land information database*, Version 2.2, NSW Department of Planning, Industry and Environment, accessed 1 November 2022 from https://www.environment.nsw.gov.au/eSpade2Webapp.

DPIE 2020e, *NSW River Styles database, and River Styles Framework River Styles Of The Hunter Catchment 2014*, NSW Department of Planning, Industry and Environment, accessed 1 November 2022 from https://www.industry.nsw.gov.au/water/science/surface-water/monitoring/river-health/river-styles.

DPIE 2021a, *Net Zero Plan Stage 1: 2020-30 Implementation Update.* NSW Department of Planning, Industry and Environment.

DPIE 2021b, *Draft Hunter Regional Plan 2041*. NSW Department of Planning, Industry and Environment.

DPIE 2021c, *Australian soil classification (ASC) soil type map of NSW – v4.5*, NSW Department of Planning, Industry and Environment, accessed 1 November 2022 from https://www.environment.nsw.gov.au/eSpade2Webapp.

DPIE 2021d*, Estimated Inherent Soil Fertility of NSW– v4.5,* NSW Department of Planning, Industry and Environment, accessed 1 November 2022 from https://www.environment.nsw.gov.au/eSpade2Webapp.

DPIE 2021e, *Land and Soil Capability Mapping for NSW – v4.5*, NSW Department of Planning, Industry and Environment, accessed 1 November 2022 from https://www.environment.nsw.gov.au/eSpade2Webapp.

Eco Logical 2023, *Biodiversity Development Assessment Report*, prepared by Eco Logical Australia for ESCO Pacific Holdings Pty Ltd.

EMM 2023a, *Aboriginal Cultural Heritage Assessment*, prepared for ESCO Pacific Holdings Pty Ltd by EMM Consulting Pty Limited.

EMM 2023b, *Landscape and Visual Impact Assessment*, prepared for ESCO Pacific Holdings Pty Ltd by EMM Consulting Pty Limited.

EMM 2023c*, Social Impact Assessment*, prepared for ESCO Pacific Holdings Pty Ltd by EMM Consulting Pty Limited.

EMM 2023d*, Soils, Land and Erosion Assessment*, prepared for ESCO Pacific Holdings Pty Ltd by EMM Consulting Pty Limited.

EMM 2023e, *Water Resources Assessment*, prepared for ESCO Pacific Holdings Pty Ltd by EMM Consulting Pty Limited.

EMM 2023f*, Traffic Impact Assessment*, prepared for ESCO Pacific Holdings Pty Ltd by EMM Consulting Pty Limited.

EMM 2023g*, Noise and Vibration Impact Assessment*, prepared for ESCO Pacific Holdings Pty Ltd by EMM Consulting Pty Limited.

EPA 2014, *Waste Classification Guidelines – Part 1: Classifying Waste*, NSW Environmental Protection Authority.

EPA 2017, *NSW Noise Policy for Industry* (NPfI). NSW Environmental Protection Authority.

Heritage Office 2001*, Assessing heritage significance.* NSW Heritage Manual 2.

ICNIRP 2010, *Guidelines for limiting exposure to Time-varying Electric, Magnetic and Electromagnetic Fields.* International Commission on Non-Ionizing Radiation Projection

IECA 2008, *Best Practice Erosion and Sediment Control*. International Erosion Control Association.

Landcom 2004, *Managing Urban Stormwater: Soils and construction - Volume 1.*

Landscape Institute & Institute of Environmental Management and Assessment 2013, *Guidelines for Landscape and Visual Impact Assessment Third Edition*. Landscape Institute and Institute of Environmental Management and Assessment.

MCC 2018, *Water Management Plan*, Muswellbrook Coal Company Limited

Minesoils 2023, *Agricultural impact assessment*. Prepared for ESCO Pacific Holdings Pty Ltd.

Muswellbrook BFMC 2011, *Muswellbrook Bushfire Risk Management Plan, NSW RFS 2011.* Muswellbrook Bushfire Management Committee (BFMC)

Muswellbrook Shire Council 2022*, 2022-2032 Community Strategic Plan*.

NFPA 2023, *NFPA 855, Standard for the Installation of Stationary Energy Storage Systems.* National Fire Protection Association.

NPI 2022, *National Pollutant Inventory, Muswellbrook Coal Company, Emissions 2020-2021*

NSW Treasury 2022, *Hunter-Central Coast Renewable Energy Zone*, accessed 20 October 2022 from https://www.energyco.nsw.gov.au/hcc-rez.

OECC 2022, Net Zero Plan Implementation Update 2022. NSW Office of Energy and Climate Change.

OEH 2011, *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW.* NSW Office of Environment & Heritage.

OEH 2012, *The land and soil capability assessment scheme, second approximation: A general rural land evaluation system for New South Wales.* NSW Office of Environment & Heritage.

OEH 2013, *Interim protocol for site verification and mapping of biophysical strategic agricultural land.* NSW Office of Environment & Heritage and NSW Office of Agricultural Sustainability & Food Security.

OzArk 2023, *Muswellbrook Solar Farm Historic Heritage Impact Assessment*. Prepared for ESCO Pacific Holdings Pty Limited, March 2023

RFS 2019, *Planning for Bushfire Protection*. NSW Rural Fire Service.

RTA 2002, *Guide to Traffic Generating Developments*. Roads and Traffic Authority.

Sherpa Consulting 2023, *Preliminary Hazard Analysis, Muswellbrook Solar Farm*, prepared by Sherpa Consulting for EMM Consulting Pty Limited on behalf of ESCO Pacific Holdings Pty Ltd.

Standards Australia 2019, *AS/NZS 5139:2019 Electrical installations – Safety of battery systems for use with power conversion equipment*

Summerhayes G 1983, *Muswellbrook 1:25,000 Geological Map, I9033-II-N,* Geological Survey of NSW Sydney

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Level 2 Suite 2.04
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 8.03 Level 8 454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 9.02 Level 9 109 St Georges Terrace
Perth WA 6000

Canada

TORONTO
2345 Younge Street Suite 300
Toronto ON M4P 2E5

VANCOUVER
60 W 6th Ave Suite 200
Vancouver BC V5Y 1K1

linkedin.com/company/emm-consulting-pty-limited

emmconsulting.com.au