umwelt
Environmental & Social Consultants

lightsource bp

GOULBURN RIVER SOLAR FARM

Soil, Land and Agriculture Assessment

FINAL

April 2023

lightsource bp

GOULBURN RIVER SOLAR FARM

Soil, Land and Agriculture Assessment

FINAL

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Lightsource bp

Project Director:	Malinda Facey
Project Manager:	Jessica Henderson-Wilson
Technical Project Director:	Malinda Facey
Technical Project Manager:	David McQueeney
Report No.:	21507/R12
Date:	April 2023

umwelt
Environmental & Social Consultants

APPROVED COMPANY ISO 9001
QMS Certification Services

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
V1	Jessica Henderson-Wilson	22/11/2022	Malinda Facey	22/11/2022
V2	Jessica Henderson-Wilson	14/02/2023	Malinda Facey	14/02/2023
V3	Jessica Henderson-Wilson	12/04/2023	Malinda Facey	13/04/2023
V4	Jessica Henderson-Wilson	24/04/2023	Malinda Facey	24/04/2023

Abbreviations

Acronyms	
AHD	Australian Height Datum
BoM	Bureau of Meteorology
BSAL	Biophysical Strategic Agriculture Land
DPE	Department of Planning and Environment.
DPI	Department of Primary Industries
EC	Electrical Conductivity
ECEC	Effective Cation Exchange Capacity
EIS	Environmental Impact Assessment
ESP	Exchangeable Sodium Percentage
FTE	Full Time Equivalent
km	kilometres
SEARs	Secretary's Environmental Assessment Requirements
LUCRA	Land Use Conflict Risk Assessment
LVIA	Landscape and Visual Impact Assessment
LEP	Local Environmental Plan
LGA	Local Government Area
m	metres
mm	millimetres
OEMP	Operational Environmental Management Plan

Table of Contents

Figures

Photos

Tables

Appendices

1.0 Introduction

Umwelt (Australia) Pty Limited (Umwelt) has been engaged by Lightsource bp to complete a *Soil, Land Capability and Agricultural Impact Assessment* in accordance with the Planning Secretary's Environmental Assessment Requirements (SEARs) to support the Environmental Impact Statement (EIS) that has been prepared for the proposed Goulburn River Solar Farm located approximately 28 km south of Merriwa, New South Wales (NSW) (the Project). The Project is located within the Upper Hunter Local Government Area (LGA), as shown in **Figure 1.1**.

1.1 Project Overview

The Project will involve the construction, operation and decommissioning of approximately 550-megawatt peak (MWp) of solar photovoltaic (PV) generation as well as a Battery Energy Storage System (BESS) with 280 MWp/570 megawatt hour (MWh) capacity. The Project will also include a substation and connection to an existing 500 kilovolt (kV) transmission line. The Project will include various associated infrastructure, including road repairs and upgrades to Ringwood Road, temporary construction facilities, operation and maintenance buildings, internal access roads, civil works and electrical infrastructure to connect the Project to the existing transmission line which passes through the Project Area. The Project's conceptual layout is included in **Figure 1.2**. The Project Area is zoned *RU1 (Primary Production)* under the *Upper Hunter Local Environmental Plan 2013* (Upper Hunter LEP).

Access to the site will be via Ringwood Road and Wollara Road (existing local roads), from the north via the Golden Highway.

- The Project encompasses two freehold properties and sections of Crown Land (approximately 47 ha over the Project Area), covering a total area of approximately 2000 ha. These properties are primarily utilised for cropping and grazing activities. The Development Footprint for the Project is approximately 799.5 ha.
- The Project is expected to generate up to 350 direct Full Time Equivalent (FTE) jobs over the construction period and 10 direct FTE jobs during operation.

The Project is a State Significant Development (SSD) under the *State Environmental Planning Policy (Planning Systems) 2021* as the capital value of the Project is over $30 million. A development application (DA) for the Project is required to be submitted under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Project will have an operational lifespan of 40 years. It is proposed that during the Project's operational life, the land could also support sheep grazing within the development footprint. This will be subject to the outcomes of a trial of sheep grazing. Refer to **Photo 1.1** for an example of co-habitation of a solar farm development and sheep grazing.

Photo 1.1 Example of Dual Land Use

Source: LSbp, 2022.

1.2 Purpose and Objectives of the Report

The purpose of this report is to evaluate the suitability of the site for solar infrastructure, identify and assess the potential impact of the Project on agricultural land, and to identify measures to manage and mitigate any potential impacts.

This report has been prepared in accordance with the *Large-Scale Solar Energy Guideline* (DPE 2022) (the Solar Guideline). It is acknowledged that the SEARs issued by DPE references the now superseded *Large Scale Solar Energy Guideline (2018)*. Umwelt has conducted the assessment with reference to the current guidelines which contain greater detail surrounding soil, land capability and agricultural assessments.

Under the Solar Guideline (2022) site verification is required (see **Section 3.2** for further details), with the *Soil, Land Capability and Agricultural Impact Assessment* (SLCAIA) to include the following.

- Complete a land and soil capability assessment including figures, showing the land capability within the Project Area using *The Land and Soil Capability Assessment Scheme: Second Approximation* (Office of Environment and Heritage (OEH), 2013).
- Undertake a site soil survey and classify the soil profiles within the Project Area using the *Australian Soil Classification* (ASC) system (Isbell, 2007), including a description and figure showing the distribution of each soil type.
- Undertake a *Land Use Conflict Risk Assessment* (LUCRA), provided as a standalone report in **Appendix A**.

- Complete an assessment of impacts to agriculture (in accordance with the Solar Guideline).
- Identify suitable management and mitigation measures to mitigate any potential impacts in relation to soil, land capability or agriculture.

1.3 Secretary's Environmental Assessment Requirements (SEARs)

The SEARs (SSD-33951458) issued for the Project identify matters that must be addressed in the EIS. **Table 1.1** specifically lists the requirements relevant to this assessment and where they have been addressed in this report.

Table 1.1 SEARs Relevant to the Soil Survey Report

Requirement	Section Addressed
Land – including: • a detailed justification of the suitability of the site and that the site can accommodate the proposed development having regard to its potential environmental impacts, permissibility, strategic context and existing site constraints;	This is addressed in the EIS **Section 9.0** and **Section 5.7** of this document. This report is a component of the justification of the suitability of the site.
• an assessment of the potential impacts of the development on existing land uses on the site and adjacent land, including: o flood prone land, Crown lands, mining, quarries, mineral or petroleum rights; o a soil survey to determine the soil characteristics and consider the potential for erosion to occur; and o a cumulative impact assessment of nearby developments;	**Section 4.0**. **Section 3.2** and **Section 4.0**. This is addressed in the EIS in **Section 7.0** and **Section 5.5** of this report.
• an assessment of the compatibility of the development with existing land uses, during construction, operation and after decommissioning, including: o consideration of the zoning provisions applying to the land, including subdivision (if required); o completion of a Land Use Conflict Risk Assessment in accordance with the Department of Industry's Land Use Conflict Risk Assessment Guide; and • a detailed assessment of the impact on agricultural resources and agricultural productivity, including: o an agricultural impact statement; o consideration of potential mitigation measures which may reduce project impacts on agricultural land; o detailed economic assessment of impacts on agricultural land, agricultural production and agricultural supply chains; o justification for the project considering other alternatives and site design which may have lesser impacts on agricultural land.	This is addressed in the EIS in **Section 4.1.2**. Refer to **Appendix A** of this report. **Section 5.0**. **Section 6.0**. **Section 5.3.2**. This is addressed in **Section 9.0** of the **EIS** and **Section 5.7** of this report.

1.4 Structure of this Report

The structure of this report includes:

- **Section 1.0** Introduction – includes a project overview, purpose, structure and objective of the report and the relevant SEARs.
- **Section 2.0** Existing Environment – outlines the main features of the Project Area's location.
- **Section 3.0** Assessment Methodology – describes the methodology of the field work undertaken to prepare the soil survey.
- **Section 4.0** Results – describes the results of the soil survey, laboratory analysis, soil classification, and the land capability classification of the Project Area.
- **Section 5.0** Agricultural Impact Assessment – describes the potential agricultural impacts of the proposed Project.
- **Section 6.0** Management and Mitigation Measures – provides a summary of the mitigation and management recommendations based on the soil characteristics and agricultural impacts identified.
- **Section 7.0** Conclusion.
- **Section 8.0** References.
- **Appendix A** Land Use Conflict Risk Assessment.
- **Appendix B** Site Descriptions, Photographs and Key Results.
- **Appendix C** Laboratory and Field Assessment Parameters.
- **Appendix D** Laboratory Results.

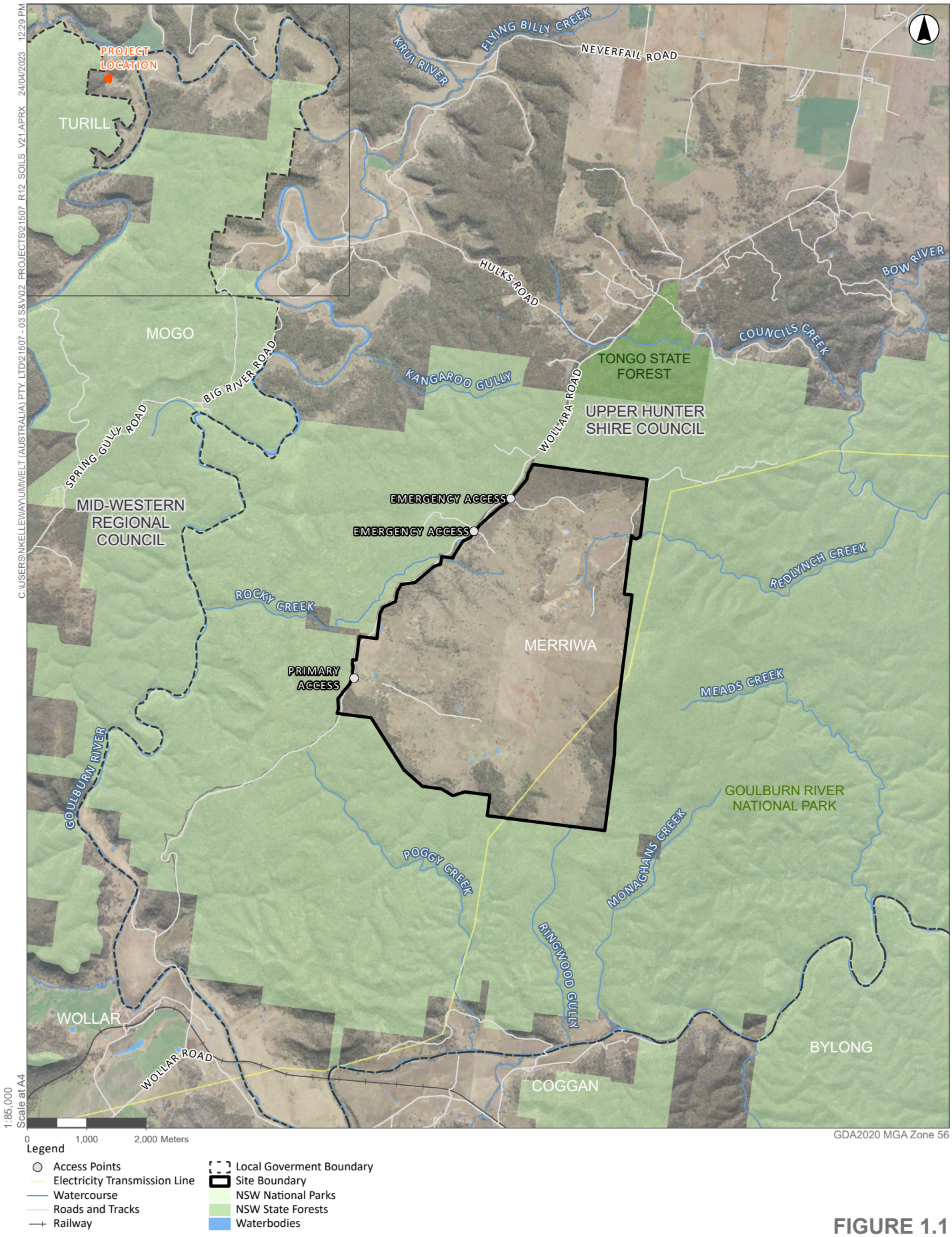


FIGURE 1.1

Location and Local Context

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

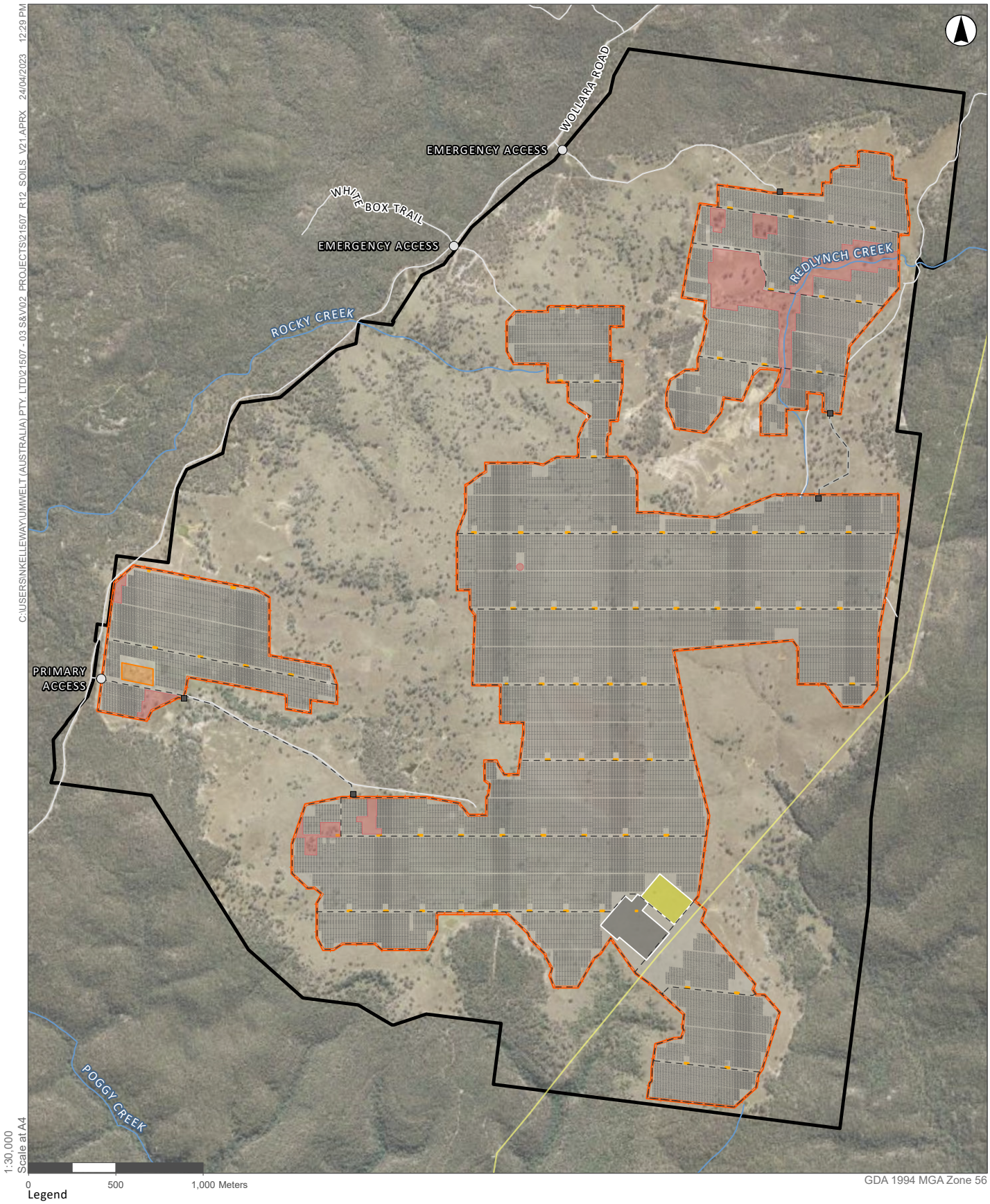


FIGURE 1.2

Project Layout

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

2.0 Existing Environment

2.1 Topography

As shown in **Figure 2.1**, the general topography of the Project Area is generally flat to undulating, with some drainage lines and creeks providing minor undulation in the landscape. The terrain is generally higher in the centre of the Project Area, with a gradual slope down to its north-eastern and western boundaries. The Project area is between 400 m AHD and 440 m AHD, with elevation between 350 m AHD and 390 m AHD in the north and southwest of the Project Area.

2.2 Climate

Temperatures are highest in January, with a mean maximum temperature of 31.4°C, and lowest in July, with a mean minimum temperature of 16.2°C (Bureau of Meteorology, 2022a).

The average annual rainfall is 590.1 mm, with the highest mean monthly rainfall occurring in January (67.2 mm) and the lowest mean monthly rainfall occurring in May (37.2 mm) (Bureau of Meteorology, 2022b).

2.3 Natural Features

The Project Area is described as predominately heavily disturbed due to historical land clearing, cropping and livestock grazing. Small areas of native vegetation remain within the Project Area, with remnant trees (paddock trees) and introduced grass and weed species present (Umwelt 2023) and a small rocky outcrop along the western boundary of the Project Area. Further, the Project Area is surrounded by the Goulburn River National Park.

As a result, the Project Area supports a mosaic of exotic vegetation, derived native grasslands in generally poor condition, isolated paddock trees, areas of thinned woodland and forest, and areas of intact woodland and forest around the periphery of the Project Area. These remaining vegetated areas in the Project Area act as a potential corridor for fauna species across the National Park, supporting the local biodiversity.

2.4 Hydrology

The Project Area is located within the Hunter River catchment, within the Goulburn River sub-catchment. In the surrounding area of the Project, Redlynch Creek is located to the northeast, Rocky Creek to the northwest, Poggy Creek to the southwest and Ringwood Gully to the south. Goulburn River is located approximately 3 km to the south and to the west of the Project Area (refer to **Figure 2.1**).

The identified watercourse alignments with their corresponding Strahler stream order are shown in **Figure 2.1**. As the Project Area is located on top of a ridge, watercourses and unnamed flow paths within the Project Area are located towards the boundary. The majority of the watercourses in the Project Area are 1st and 2nd order watercourses with sections of Redlynch Creek, Rocky Creek and Monaghans Creek also becoming 3rd order watercourses within the Project Area. All watercourses within the Project Area eventually flow into the Goulburn River.

There are approximately 20 to 30 small man-made farm dams present within the Project Area where water pooling occurs for extended periods, as shown in **Figure 2.1**.

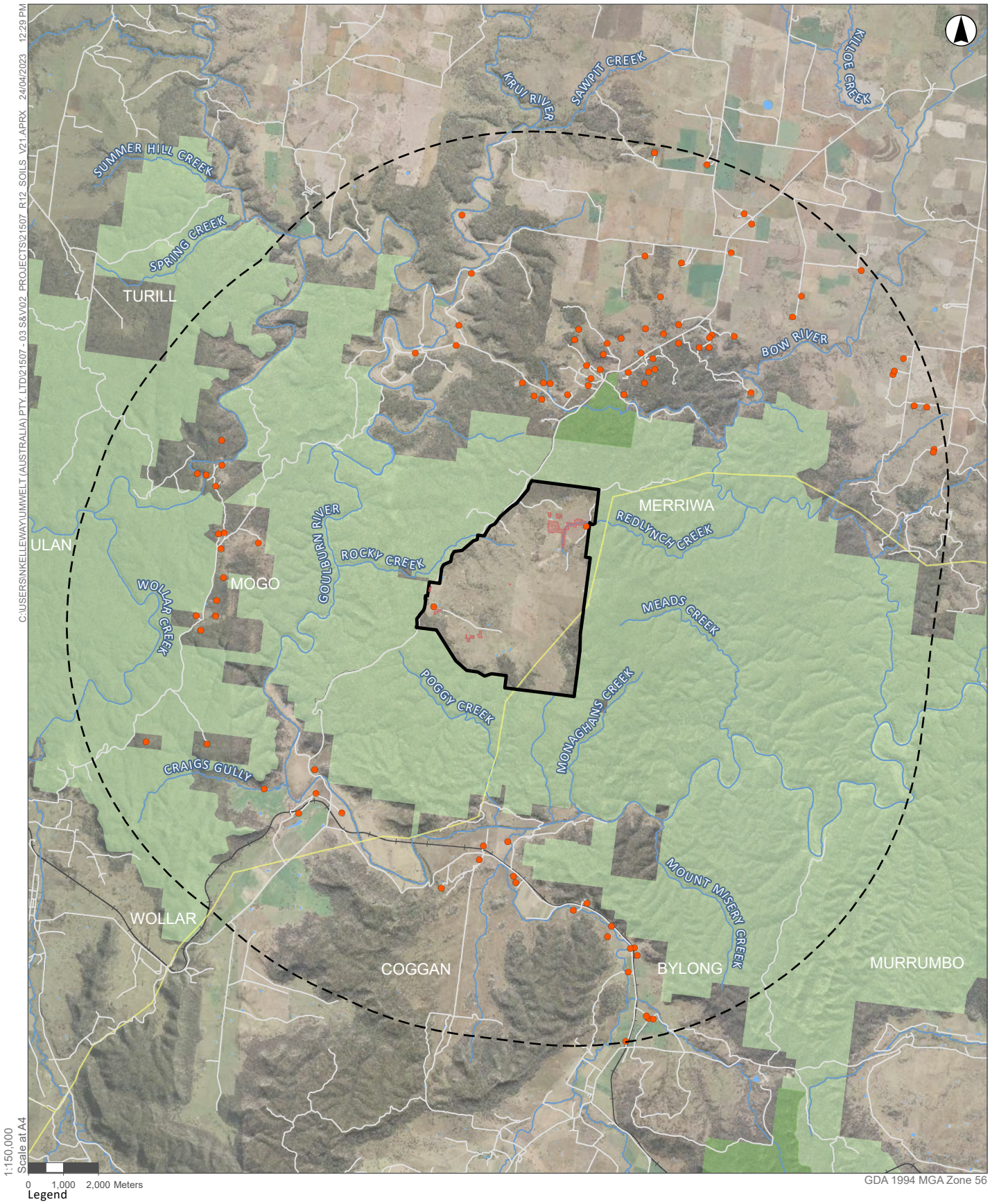


FIGURE 2.1

Location of Nearest Receivers

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

2.5 Geology

The *Singleton 1:250,000 Geological Map* (Rasmus, *et al.*, 1969) indicates that the Project Area is predominantly underlain by Olivine basalt with occasional sediment interbeds, Dolerite, Trachyte and Microsyenite.

2.6 Agricultural Context

The Project Area is characterised by undulating plains, comprising of open paddocks which have been extensively cleared of vegetation for agricultural use (cropping and grazing for cattle). Fragmented sections of vegetation and isolated trees are also evident throughout the area. The Project Area is surrounded by the Goulburn River National Park.

The Upper Hunter LGA has a long-standing association with agriculture. Since the surveying of the region between 1820 and 1821 by William Lawson the area has been known for its large expanses of good pastoral land. Historically the region is known to predominantly be used for grazing activities and cropping including but not limited to cereal crops, hay and horticulture. Within the greater region, there is also strong history of viticulture, with winemaking dating back to the 1850s.

2.6.1 Travelling Stock Reserves

As shown in **Figure 2.2**, a *Travelling Stock Reserve* (TSR) is located along Wollara Road, with a portion of the TSR (an area of approximately 7.4 ha) located partially within the Project Area on the western boundary (near the main site access road). Lightsource bp will seek a lease from DPE – Crown Lands for the portions of the TSR that are located within the Project Area. These portions of TSRs subject to the lease will still facilitate the movement of cattle through the TSR through implementing safety measures including fencing and gates which will be installed in consultation with DPE – Crown Lands.

Landowner's consent has been obtained from Crown Lands and is provided within **Appendix 4** of the EIS.

2.7 Surrounding Land Use

Surrounding the Project Area, adjacent lands are associated with the Goulburn River National Park. The National Park contains high conservation values as it is unique in topography and geology which support a diverse number of plant communities and animal species (NPWS, 2003). In particular, the National Park supports extensive geological and geomorphological diversity in an east-west direction, and along with significant transition in rainfall, this creates a diverse botanical transition zone.

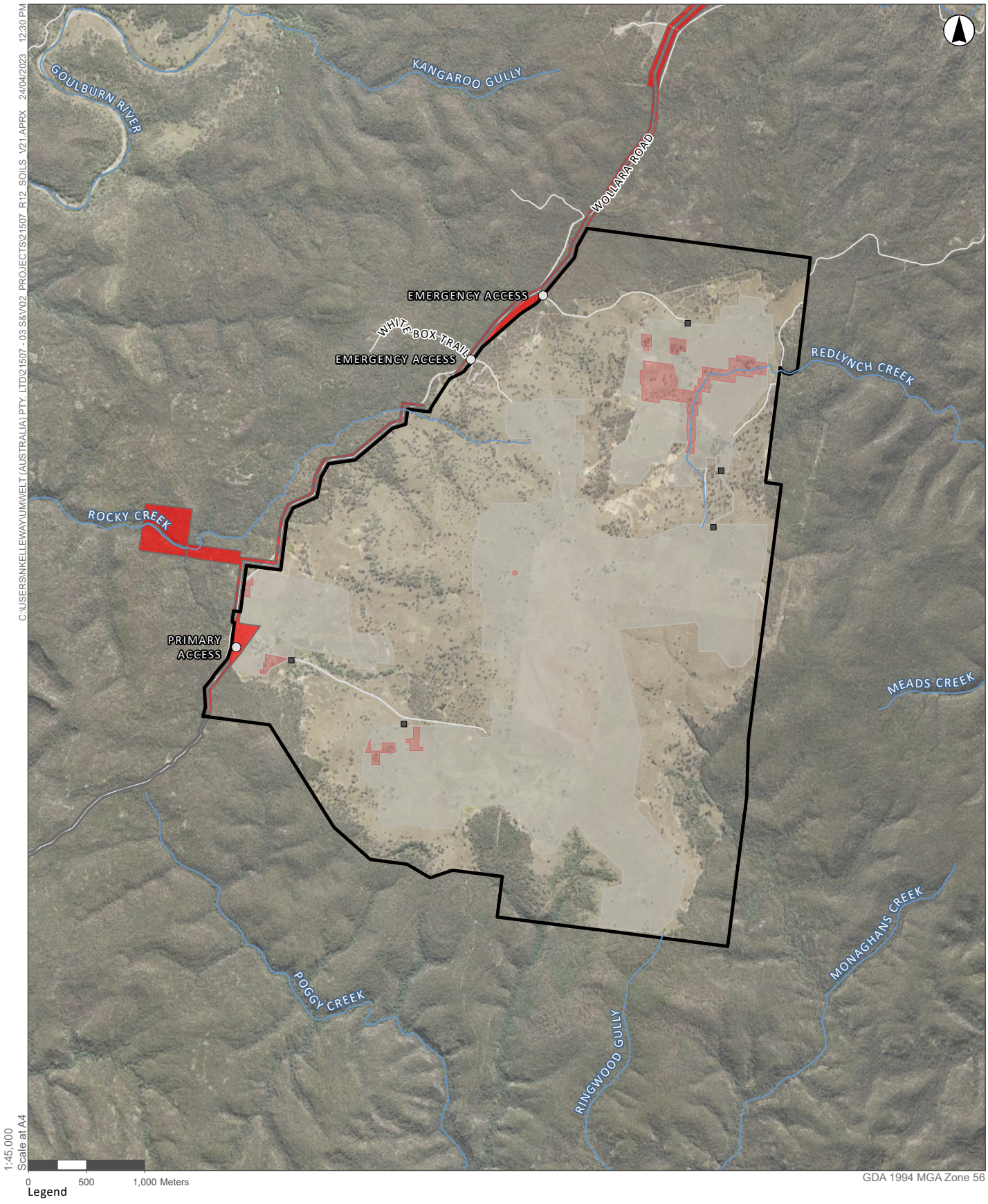


FIGURE 2.2

Travelling Stock Reserves

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

3.0 Assessment Methodology

This section details the desktop review and the assessment methodology for the soil survey, *land and soil capability* (LSC) assessment, and LUCRA.

The assessment has been conducted generally in accordance with the requirements of the Solar Guidelines (2022), as described in **Section 1.2**.

3.1 Desktop Review

The desktop assessment included a review mapping units provided by NSW DPE (2021) accessed at espade.environment.nsw.gov.au, and seed.nsw.gov.au, these included:

- Australian Soil Classification (ASC) system soil type mapping of NSW.
- Great Soil Group mapping of NSW.
- Land and Soil Capability (LSC) classes mapping.
- Inherent Soil Fertility.
- BSAL (seed.com.au).
- Soil Landscapes.

These mapping units are predominately based on high level regional mapping and require ground truthing through site assessment and soil analysis to determine their accuracy.

3.1.1 Regionally Mapped Soil Types, Land Capability, Soil Fertility, Draft State Significant Agricultural Land, and BSAL

The following findings are based on the regional mapping available (as identified in **Section 3.1**):

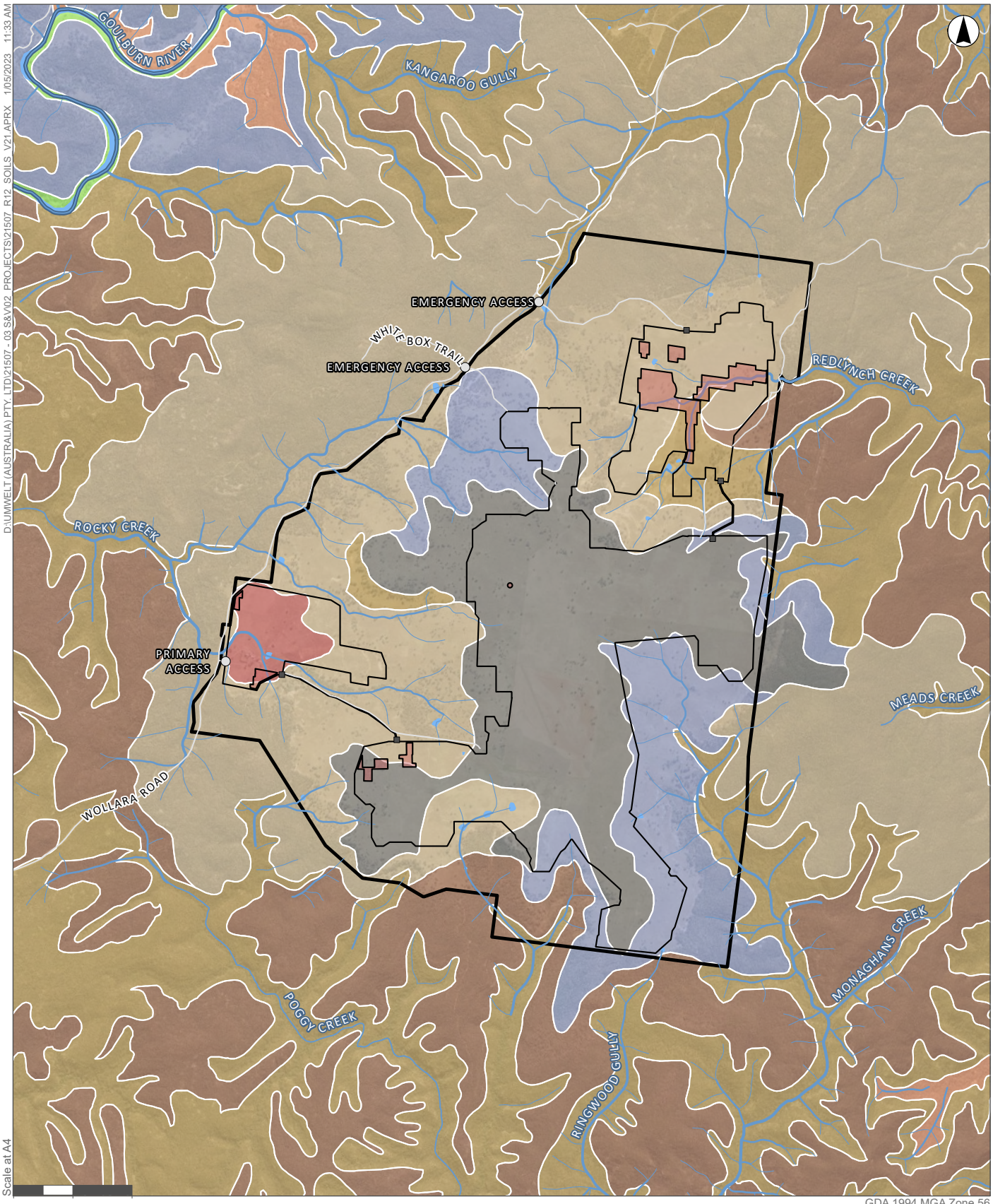
- The soil types within the Project Area are classified as Ferrosols, Kurosols, Vertosols, Dermosols, Rudosols and Tenosols (refer to **Figure 3.1** under the *Australian Soil Classification Soil Type map of NSW* (DPIE 2020).
- The soil great groups within the Project Area are identified as Chocolate Soils, Red Podzolic Soils, Earthy Sands, Brown Earths, Siliceous Sands and Euchrozems (refer to **Figure 3.2**) under the *Great Soil Group mapping of NSW* (DPIE 2020).
- The Project Area is mapped as Land and Soil Capability Classes 2, 3, 4, and 5 under the NSW *Land and Soil Capability Assessment Scheme.*
    - The areas of Land Class 2 (slight but significant limitations) are considered to have an inherent 'moderately high' land fertility, indicating that it has high quality soil and water resources capable of sustaining high levels of productivity.

- The areas of Land Class 3 (moderate limitations) are considered to have an inherent 'high' land fertility.
- The land mapped as Land Class 4 is mapped as having inherently 'moderate' land fertility.
- The land mapped as Land Class 5 is mapped as having inherently 'low' fertility.

- The Project Area is mapped as *State Significant Agricultural Land* (SSAL) under the draft mapping prepared by the Department of Primary Industries (DPI), noting the draft mapping uses available information based on various criteria and data layers, which can be of variable quality. Characteristics considered for this draft mapping included, rainfall, inherent soil fertility, land and soil capability, soil pH, *Biophysical strategic agricultural land* (BSAL), land zones, irrigation lands and north coast farmland mapping. The Project Areacontains some of these characteristics such as fertile soils associated with its location on basalt soils, rainfall conditions and general land capability.
- No BSAL was mapped within the Project Area.

These regionally mapped soil and land features (LSC and inherent soil fertility) are shown in **Figure 3.3**.

The Land and Soil Capability assessment aims to ground truth the available mapping and is presented in **Section 4.0**.



Legend

- Gate
- Access Points
- Watercourse
- Roads and Tracks
- Development Footprint
- Study Area
- Exclusion Zones - Environmentally Sensitive Areas

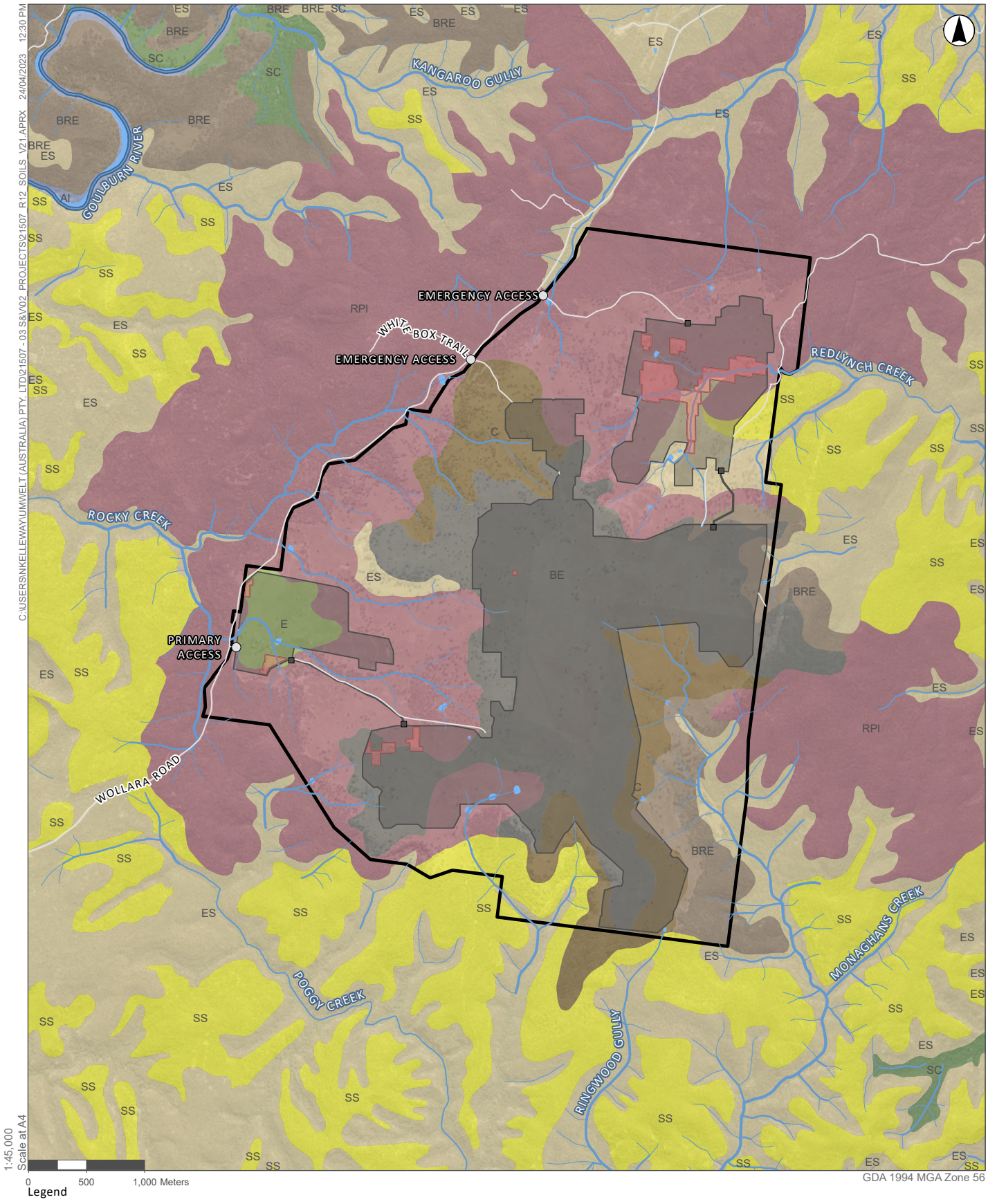
Australian Soil Classifications

- Dermosols (DE)
- Ferrosols (FE)
- Kurosols (KU)
- Rudosols (RU)
- Rudosols - alluvial (RUa)
- Sodosols (SO)
- Tenosols (TE)
- Vertosols (VE)

FIGURE 3.1

Regionally Mapped Australian Soil Classification Soil Type Mapping

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



C:\USERS\NKELLEWAY\UMWELT (AUSTRALIA) PTY. LTD\21507 - 03 S&V\02_PROJECTS\21507_R12_SOILS_V21.APRX 24/04/2023 12:30 PM

1:45,000 Scale at A4

Legend

- Gate
- Access Points
- Watercourse
- Roads and Tracks
- Study Area
- Exclusion Zones - Environmentally Sensitive Areas
- Disturbance Footprint

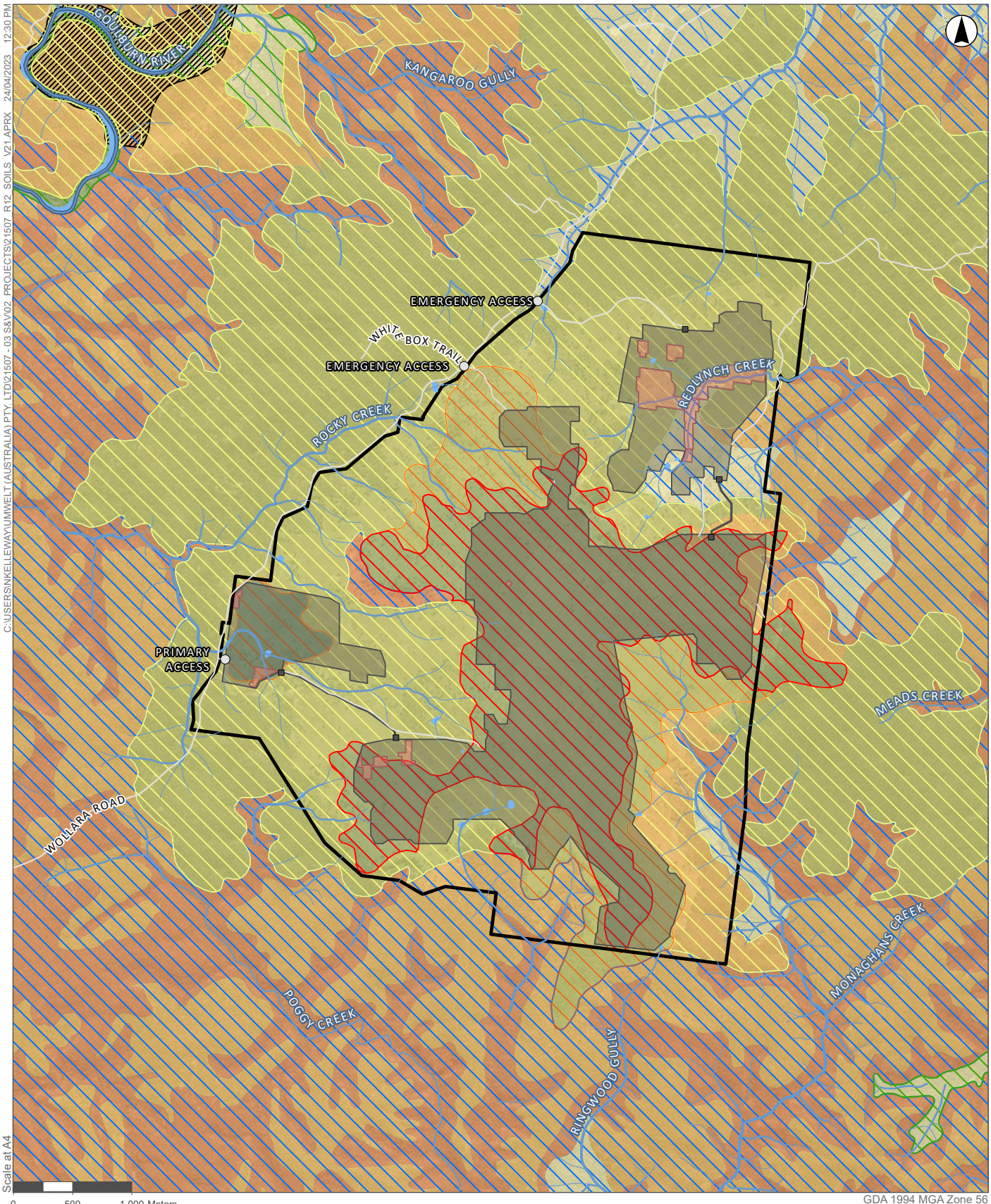
Dominant Great Soil Group (GSG)

- Alluvial Soils - light sandy textured (AI)
- Black Earths (BE)
- Brown Earths (BRE)
- Chocolate Soils (C)
- Earthy Sands (ES)
- Euchrozems (E)
- Red Podzolic Soils - less fertile (RPI)
- Siliceous Sands (SS)
- Solodic Soils (SC)

FIGURE 3.2

Regionally Mapped Great Soil Groups

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)



C:\USERS\NKELLEWAY\UMWELT (AUSTRALIA) PTY. LTD\21507 - 03 S&V\02_PROJECTS\21507_R12_SOILS_V21.APRX 24/04/2023 12:30 PM

1:45,000 Scale at A4

Legend

- Gate
- Access Points
- Watercourse
- Roads and Tracks
- Study Area
- Exclusion Zones - Environmentally Sensitive Areas
- BSAL Area
- Disturbance Footprint

Land and Soil Capability

- 2 - Slight but significant limitations
- 3 - Moderate limitations
- 4 - Moderate to severe limitations
- 5 - Severe limitations
- 6 - Very servere limitations
- 7 - Extremely severe limitations

Soil Fertility

- Low
- Moderately low
- Moderate
- Moderately high
- High

FIGURE 3.3

Regionally Mapped Soil and Land Features

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

3.1.2 Mapped Soil Landscapes

Kovac and Lawrie (1991) described the Soil Landscape units of the Singleton 1:250,000 Sheet through a classification of landscape assemblages and their associated soil characteristics. The Soil Landscapes within the Project Area are mapped by DPE (2020) (refer to **Figure 3.4**), presented in **Table 3.1** and summarised in the following sections.

Table 3.1 Soil Landscapes within the Project Area

Soil Landscape	Abbreviation	Great Soil Group(s)
Bald Hill	E-bh	Euchrozem – Chocolate Soil intergrades (Dr4.12) w
Lees Pinch	SL-1p	Siliceous Sands, Some Yellow and Brown Earths, Yellow Podzolic Soils and Earthy Sands

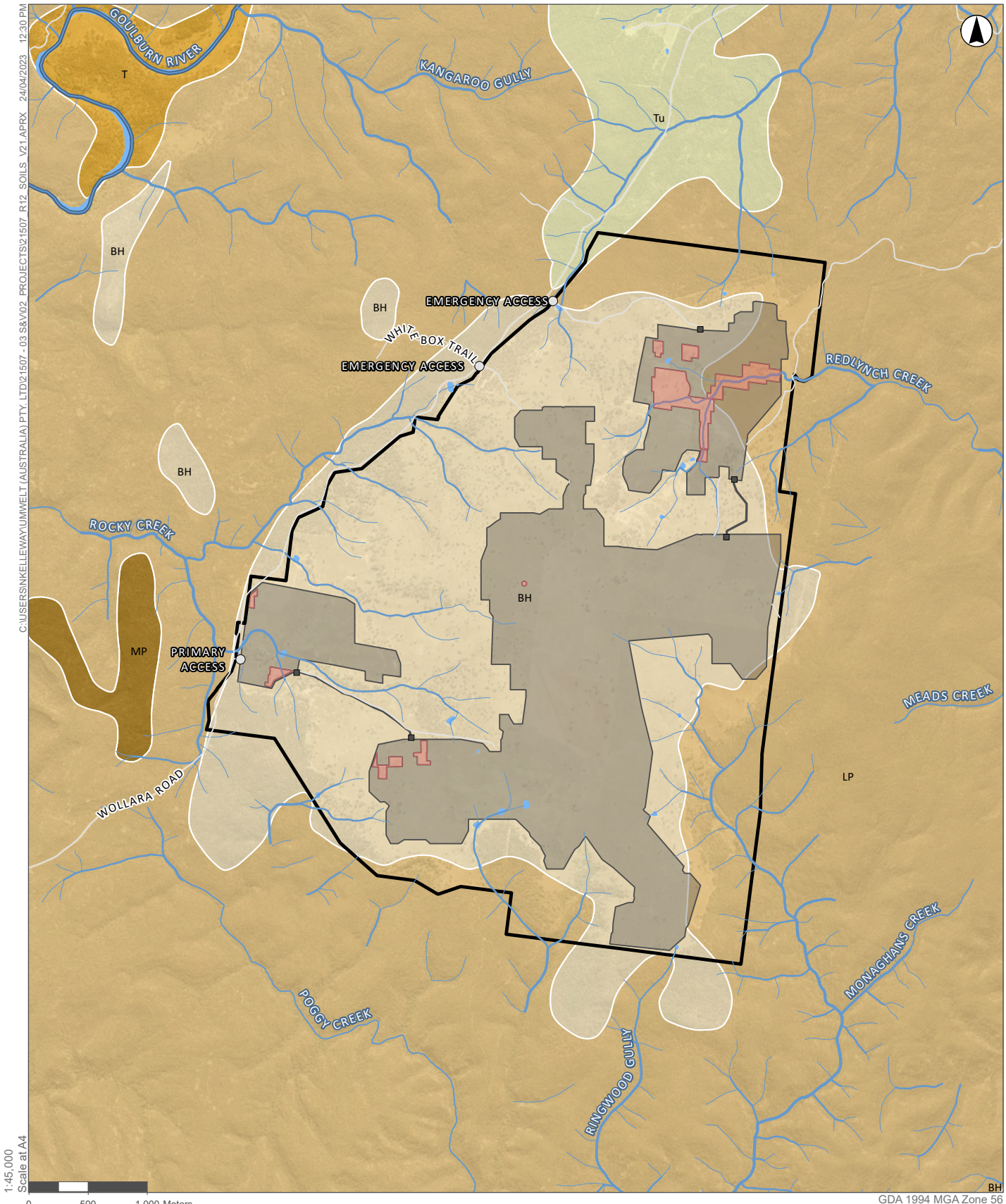
Bald Hill

The *Bald Hill* soil landscape covers the majority of the Project Area (**Figure 3.4**) and is characterised by low hillocks and basalt or dolerite caps to the south of Merriwa. The main soils are Euchrozems – Chocolate Soils intergrades (Dr4.12) on the lower slopes with shallow stony loams (Lithosols – Um) on crests.

Limitations within this soil landscape include erodibility, and potential nutrient deficiencies including phosphorous, nitrogen and sulphur.

Lees Pinch

Th *Lees Pinch* soil landscape covers a small section in the northeast of the Project Area (**Figure 3.4**) and includes rolling to steep hills in the mountains to the south-west. The main soils are shallow Siliceous Sands (Uc1.43, Uc2.12, Uc5.11, Uc5.13) with shallow loams (Lithosols – Um5.51) on local occurrences of finer textured rocks. Some Yellow and Brown Earths (Gn2.34, Gn2.84. Gn2.41, Gn2.42) occur on foot slopes. There are Yellow Soloths (Dy4.51, Dy3.41) at slope breaks, with grey soloths (Dg1.41) in midslope positions. Yellow Podzolic Soils (Dy4.51) and Earthy Sands (Gn1.22) occur on some better drained upper slopes.



Legend

- Gate
- Access Points
- Roads and Tracks
- Watercourse
- Waterbodies
- Study Area
- Exclusion Zones - Environmentally Sensitive Areas
- Disturbance Footprint

Soil Landscapes

- Bald Hill (BH)
- Lees Pinch (LP)
- Munghorn Plateau (MP)
- Talbragar (T)
- Turill (Tu)

FIGURE 3.4

Soil Landscape Mapping

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

3.2 Soil Survey

As regional mapping identified LSC 2 and 3, under the *Large-Scale Solar Guidelines* (2022), a soil survey was required to be conducted across the Project Area. The soil survey, including field sampling and in-situ soils classification, was conducted in reference to the *Australian Soil and Land Survey Field Handbook* (2009) and *The Australian Soil Classification* (Isbell, 1996). During the assessment drainage was inferred from certain soil characteristics including effective root depth, and soil colour and mottling.

The soil survey was initially conducted on 23, 24 and 25 August 2022, and further on 11 and 12 January 2023, with the soils survey and sampling site locations shown in **Figure 3.5**.

3.2.1 Soil Survey Density

Twenty-eight (28) soil test pits were excavated (using a mechanical excavator) to depths ranging from 800 mm to 1200 mm (depths at which refusal occurred) and a further eight (8) bore holes we produced (using a hand auger) to depth ranging 100 mm to 600 mm (depths at which refusal occurred), resulting in thirty-six (36) sampling sites over the 799.5 ha development footprint.

This is equivalent to a sampling density of 1 per 22.2 ha.

Under the Solar Guideline (2022), it is recommended that the soil survey should be completed at an inspection density of 1 site per 5 ha to 25 ha. The sample density iss compliant with the Solar Guideline (2022), with the selection process discussed in **Section 3.2.2**.

3.2.2 Sample Site Selection and Sampling

The sampling pattern and locations were pre-determined based on an extensive desktop review which examined site topography, landscapes, and potential soil types to be encountered to ensure selected sites were representative of the different landform types in the Development Footprint. This selection process was then used to determine the site-specific sample site density to be adopted for the soil survey. These locations were confirmed following ground truthing. The sampling pattern prepared prior to the field survey also provided sufficient site coverage and density to be able to appropriately classify the site soils based on these described factors.

Based on these factors, it was determined that a sampling density of 1 site per 22.2 ha was considered appropriate for the soil survey.

The field program was designed as an integrated free survey, which assumes that numerous land characteristics are interdependent and tend to occur in correlated sets (NSCT, 2008). Survey sites are irregularly located according to the assessor's judgement to enable the delineation of soil boundaries. Soil boundaries can be abrupt or gradual, and catena and toposequences are used to aid the description of gradual variations.

The field survey included collection of GPS recordings and photographs of soil sampling sites and profiles, and slope (using a clinometer) and landforms of the sites, as shown in **Table 6.2** in **Appendix B**.

In total, ninety-one (91) soils samples were collected from the 36 test pits and submitted to the NATA accredited (N°. 14960) Environmental Analysis Laboratory (EAL) for laboratory analysis of the parameters identified in **Appendix C**. Laboratory results are attached in **Appendix D**.

The results of the assessment are discussed in **Section 4.0**.

3.3 Land and Soil Capability Assessment Methodology

The *Land and Soil Capability* (LSC) assessment was conducted in accordance with *The Land and Soil Capability Assessment Scheme; Second approximation* (DPIE, 2012), herein referred to as the LSC Guideline.

The LSC assessment scheme uses a range of data covering the biophysical characteristics of the landscape to establish the limitations to the land and the likelihood of degradation under 8 hazards. Included are land features such as slope, exposure to wind, drainage, groundwater recharge and discharge, cliffs, wetlands and rock outcrop, soil features such as texture, pH, structure and erodibility, and climate features such as average annual rainfall and wind erosive power.

These eight hazards are identified in the LSC guideline are as follow.

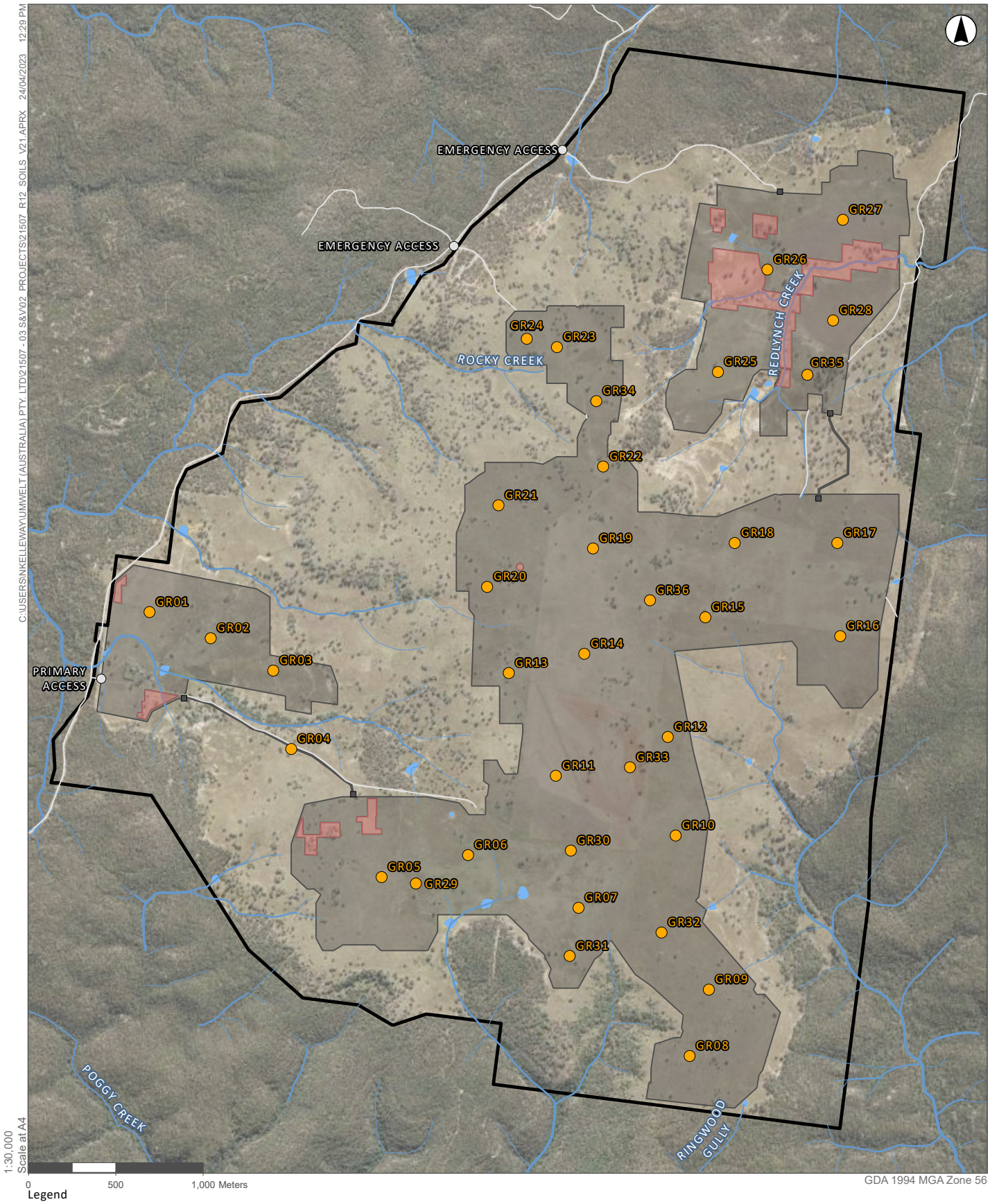
- Hazard 1 Wind erosion (including sheet, rill and gully erosion).
- Hazard 2 Water erosion.
- Hazard 3 Soil structure decline.
- Hazard 4 Soil acidification.
- Hazard 5 Salinity.
- Hazard 6 Water logging.
- Hazard 7 Shallow soils and rockiness.
- Hazard 8 Mass movement.

Following an assessment of each site and soil profile against the eight identified hazards, the results were used to establish the LSC of each site based on the 8 classes presented in **Table 3.2** and discussed in **Section 4.3**.

Table 3.2 Land and Soil Capability Classification (DPIE, 2012)

Class	Land and Soil Capability
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	**Extremely high capability land:** Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land:** Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	**High capability land:** Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available, and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4*	**Moderate capability land:** Land has moderate to high limitations for high-impact land uses. 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.
5	**Moderate–low capability land:** Land has high limitations for high-impact land uses. 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.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
6*	**Low capability land:** Land has 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.
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land:** Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land:** Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

**LSC class located within the Study Area based on results of the assessment.*



Legend

- Gate
- Access Points
- Soil Sample Sites (36)
- Watercourse
- Roads and Tracks
- Study Area
- Exclusion Zones - Environmentally Sensitive Areas
- Disturbance Footprint

FIGURE 3.5

Soil Sample Sites

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

3.4 Biophysical Strategic Agricultural Land

BSAL are areas that consist of high-quality soil and water resources capable of sustaining high levels of agricultural productivity.

No BSAL was mapped across or within close proximity to the Project Area. The nearest regionally mapped BSAL is approximately 4 km to the northwest of the site and is shown in **Figure 3.6**.

Given the lack of presence of BSAL across or immediately surrounding the site, a BSAL assessment was not conducted.

3.5 State Significant Agricultural Land

DPI has prepared draft mapping of land identified as SSAL. SSAL land is essential for future agricultural land use planning, providing clear information for informed prioritisation of future land uses. The SSAL enables planning authorities, land holders and development proponents to have clear information about key locations for the best agricultural land in the state.

The Project Area is mapped as SSAL under the draft mapping prepared by DPI. Characteristics considered for this draft mapping included, rainfall, inherent soil fertility, land and soil capability, soil pH, Biophysical strategic agricultural land (BSAL), land zones, irrigation lands and north coast farmland mapping.
The Project Area contains some characteristics such as fertile soils associated with its location on basalt soils, rainfall conditions and general land capability. As the Project Area is mapped as SSAL it is important to recognise that it is important for future agricultural activities ongoing, the Project has been designed to facilitate grazing this into the future, once construction is complete. The SSAL mapping has not been finalised or made public, the identification of SSAL in the Project Area was based on preliminary mapping exhibited.

3.6 Land-Use Conflict Risk Assessment (LUCRA)

A LUCRA was conducted for the Project, with the report attached in **Appendix A**.

3.7 Consultation

As the Project Area is surrounded by National Park, no consultation with immediately adjacent neighbours was undertaken as part of the LUCRA. There was an interview conducted with National Parks and Wildlife Service (NPWS) (2/08/2022) to establish their views on the potential use of the agricultural land for energy production. This is discussed in further detail in Section 2.8 of the LUCRA (**Appendix A**).

A meeting was held with the DPI Agriculture on Wednesday 9 November 2022 to discuss the findings of the SLCAIA. The feedback provided by DPI – Agriculture included:

- Operational management of Project and farming enterprise – to provide measures on how the land will be managed.
    - This is addressed in **Section 6.0**.

- Dual-land use/sheep grazing within the Development Area.
    - This is addressed in **Section 5.6**.
- Agriculture use (cattle grazing) outside the Development Area (within the Project Area).
    - This is addressed in **Section 5.3.1**.
- Erosion management – due to presence of sodic and dispersive soils on site, management of erosion need to be adequate to address this issue.
    - This is addressed in **Section 6.1**.

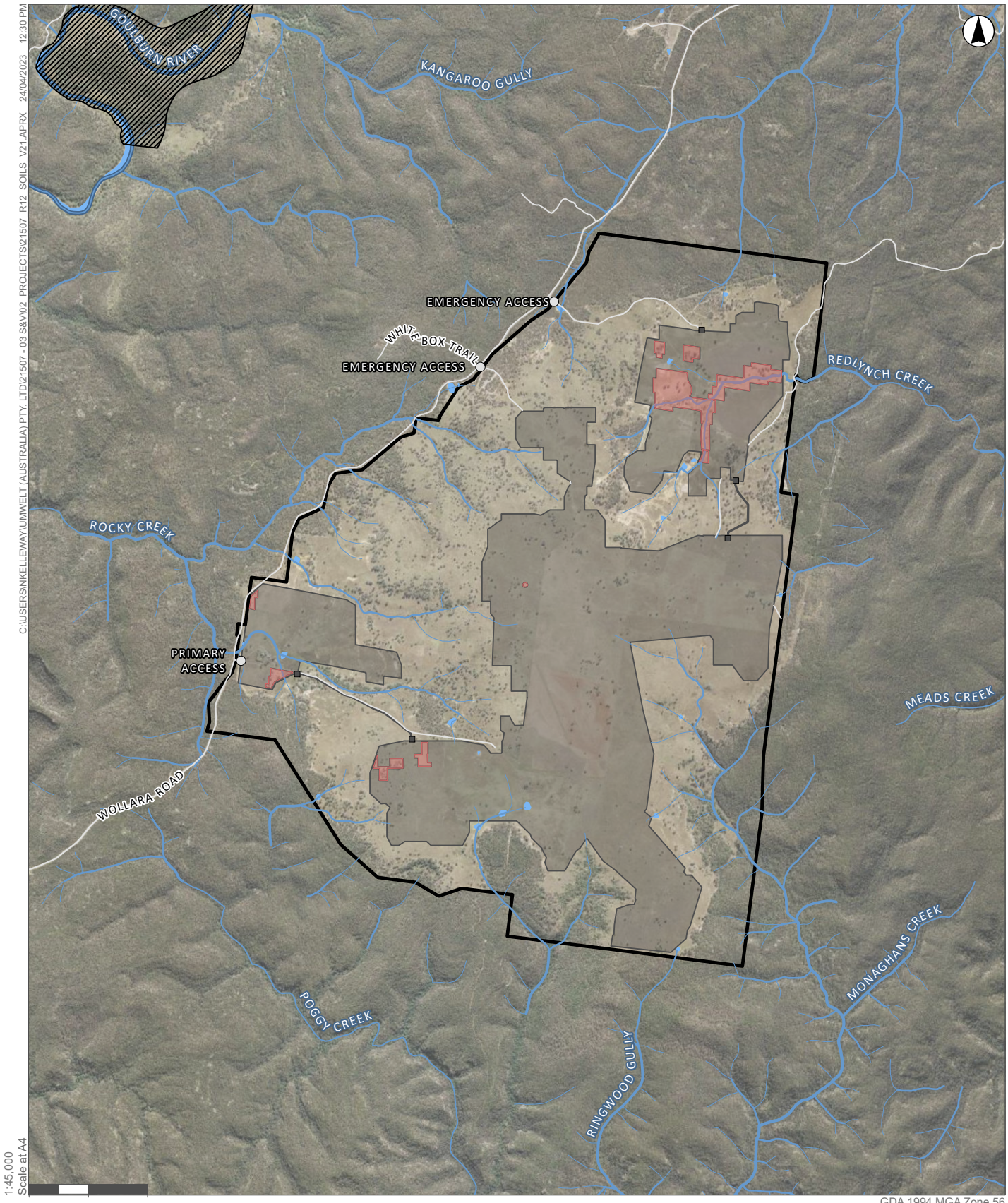


FIGURE 3.6

Mapped Biophysical Strategic Agricultural Land

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

4.0 Assessment Results

4.1 Results of Field Assessment

As shown in **Figure 3.1**, the desktop assessment identified the predominant soil types based on the *Australian Soil Classification* to be ferrosols, tenosols, kurosols, vertosols, dermosols and rudosols, with *Great Soil Groupings* identified as Euchrozoms, Black Earths, Chocolate Soils, Red Podzolic Soils (less fertile) and earthy Sands (shown in **Figure 3.2**).

Following the field survey three predominant soil types (soil mapping units) were identified which included Ferrosols, Dermosols, and Sodosols, with the locations of the identified soil types shown in **Figure 4.1** and discussed below.

Physical soils descriptions, review of key laboratory results, and photographs of each sampling site and soil profile are attached in **Appendix B**. The Laboratory Analysis Parameters and Field Assessment Parameters used for the assessment are shown in **Appendix C**.

4.1.1 Dermosols

Dermosols are soils with structured B2 *Horizon* and lacking a strong texture contrast between the A and B Horizons, and other soils with B2 *horizons* that have grade of pedality greater than weak throughout the major part of the horizon (Australian Soil Classification 2021).

Dermosols identified during the field survey include Petroferric Eutrophic Brown Dermosols (Site 1, 2 and 35), Brown Petroferric Eutrophic Ferric Sodic Dermosol (Site 5 and 29), Petroferric Eutrophic Red Dermosol (Site 4, 10, 12, 13, 15, 16, 17, 19, 20, 23, 24, 25, 27, 33, 34 and 36), Mottled Red Petroferric Eutrophic Dermosols (Site 18, 21, 26, 28), and Humose Mottled Dermosol (Site 3). These soils were derived from weathered basalt and were predominately identified on the hill slopes surrounding the basaltic cap.

4.1.2 Ferrosols

Ferrosols are soils with B2 horizons in which the major part has a free iron oxide content greater than 5% Fe in the fine earth fraction (<2 mm), and do not have a clear or abrupt textural B horizon or a B2 horizon in which at least 0.3 m has vertic properties. These soils are almost entirely formed on either mafic or ultramafic igneous rocks, their metamorphic equivalents, or alluvium derived therefrom (Australian Soil Classification 2021).

Ferrosols identified during the field survey included Leptic Eutrophic Red Ferrosols (Site 8, 9, 11, 14, 30 and 32) limited to the central and south-eastern section of the site. These soils were directly derived from weathered basalt.

4.1.3 Sodosols

Sodosols are soils with strong texture contrast between A horizons and sodic B horizons which are not strongly acid and in which the major part of the upper 0.2 m of the B2 horizon (or the major part of the entire B2 horizon if it is less than 0.2 m thick) is sodic, that being soils with an *Exchangeable Sodium Percentage* (ESP) >6%) (Australian Soil Classification 2021).

Sodosols identified during the field survey included Mottled-Hypernatric Mesotrophic Brown Sodosol (Sites 5, 6, 7 and 31).

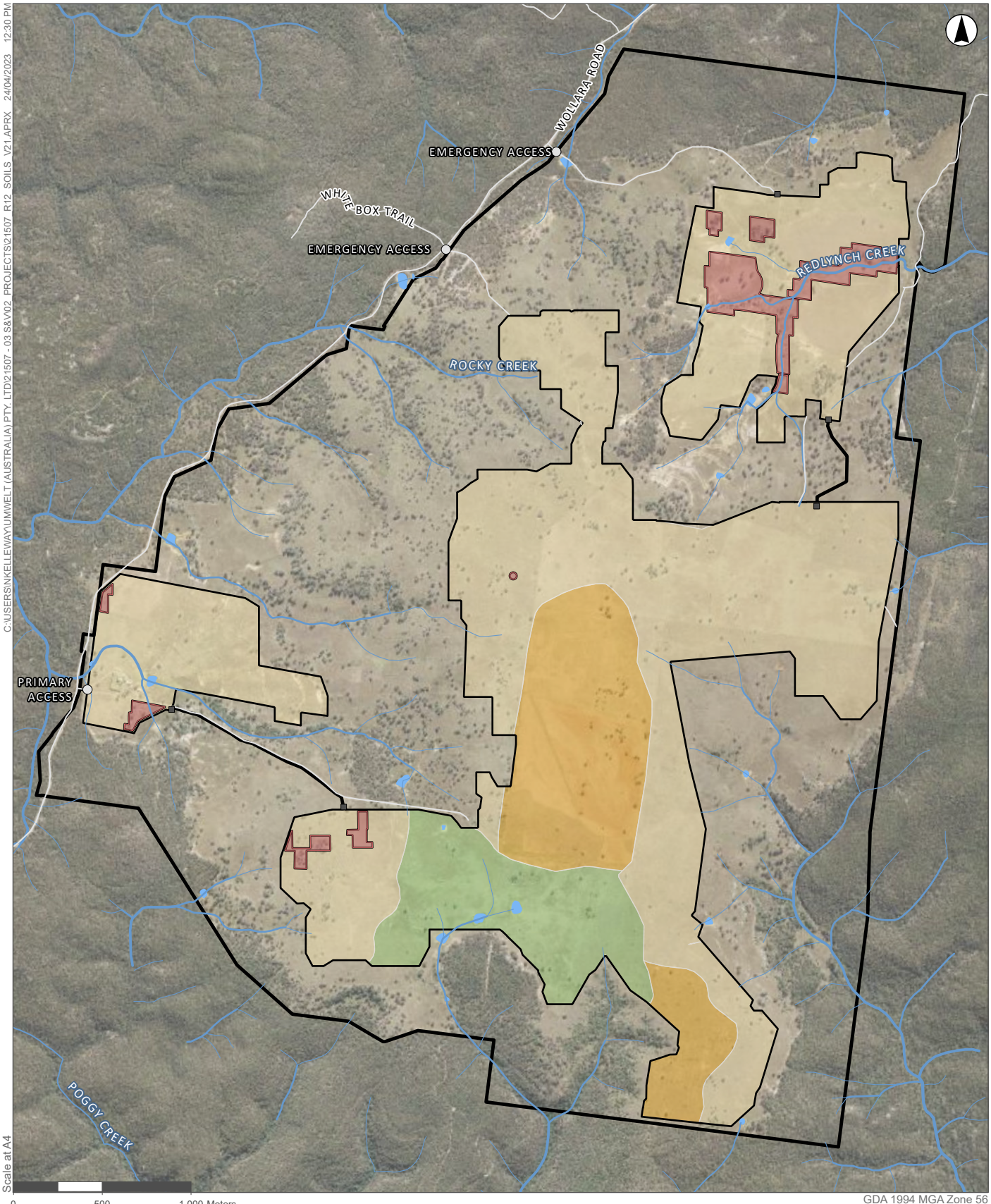


FIGURE 4.1

Ground Truthed Australian Soil Classification Soil Type Mapping

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

4.2 Results of Laboratory Analysis

Topsoil and subsoil analysis was conducted on the 91 samples taken from the 36 sampling locations. Topsoil samples were taken directly from the top 100–150mm, with subsoil samples taken from each soil profile/stratum identified below the topsoil.

The soil profiles and analysis of key laboratory results are presented in **Appendix B**, with the analytical results shown in **Appendix D**.

The key analytical results of the assessment are summarised below.

4.2.1 pH and Electrical Conductivity (EC)

In soils, pH is a measure of alkalinity/acidity which is based on the amount of free hydrogen atoms in a soil solution, the greater the amount the more acidic the soil is. Values <7 are considered acidic, with values >7 considered alkaline (Hazelton and Murphy, 2016).

EC is a measure of salinity and is measured in decisiemens per metre (dS/m). The EC value used is 'EC_E' which is the EC of saturated extracts and is calculated based on the estimated water holding capacities of the soil based on soil texture (approximate percentage of sand, silt, clays).

4.2.1.1 Topsoils

The pH values for the topsoil ranged from 5.45 to 6.66 which is classified as strongly acidic to slightly acidic (Hazelton and Murphy, 2016). These ranges are generally not considered prohibitive to plant growth or likely to impact metal structures.

The EC (ECe) in topsoil samples ranged from 0.22 to 2.74, which is classified as 'non-saline' to 'Slightly-saline' All sample sites were 'non-saline' with the exception of Site 9 which was 'slightly saline'.

4.2.1.2 Subsoils

The pH values in the subsoil ranged from 6.23 to 9.09 which is classified as slightly acidic to strongly alkaline.

The ECe values range from 0.13 to 3.84, classified as 'non-saline' to 'slightly saline' (Hazelton and Murphy, 2016). All sample sites were 'non-saline' apart from the B2 horizon (0.3–0.4 m bgl) at Site 6 which was 'slightly saline'.

4.2.1.3 Summary

The results from both topsoil and subsoil analysis for pH and EC indicate that acidity/alkalinity and salinity do not present a significant constraint to plant growth or to the development of the Project Area.
An exception to this was Site 6 subsoil sample (B2 Horizon) which identified strongly alkaline soils which may present a constraint to plant growth as increased alkalinity reduces plant available nutrients in soils that can inhibit plant growth and health but is not likely to impact construction materials.

It is noted that at the time of sampling significant rainfall had occurred, resulting in wet soils. This may 'dilute' soil salinity, therefore salinity results may be lower under dryer conditions.

Additionally, no acid sulphate soils were identified.

4.2.2 Exchangeable Sodium Percentage (ESP) & Dispersion

ESP is a measure of sodicity which occurs when exchangeable sodium on the cation exchange complex leads to clay dispersion in the soil, and the dispersibility (erosive potential) of the soil is based on the Emerson Aggregate Test (EAT).

The classification of sodic soils is identified as non-sodic (<3%), slightly sodic (3–6%), sodic (6–14%), and strongly sodic (>14%) (Hazelton and Murphy, 2016).

The EAT ranges from Class 1 (highly dispersive) through to Class 6 (non-dispersive).

4.2.2.1 Topsoils

ESP ranged from 0.20% to 8.76%.

The results identified the following:

- Site 3, 6, and 7 topsoils are classified as sodic.
- Sites 2, 5, and 31 topsoils are classified as slightly sodic (<6).
- The remaining sites are classified as non-sodic in their topsoil.

The dispersibility (erosive potential) of the topsoils, based on the *Emerson Aggregate Test* (EAT), ranged from classes 2, 3 and 4, classified as 'moderately dispersive', 'slightly dispersive' to 'negligible/aggregated' (non-dispersive) respectively.

The results identified the following:

- Site 23 is classified as 'moderately dispersive'.
- Sites 1, 2, 3, 4, 5, 7, 10, 11, 12, 13, 17, 19, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, and 36 are classified as slightly dispersive.
- Sites 6, 8, 9, 14, 15, 16, 18, and 20 are classified as not dispersive (negligible/aggregated).

4.2.2.2 Subsoils

ESP range from 0.28% to 37.52%. The results identified the following:

- Sites 3 (>0.1 m bgl), 6 (>0.15 m bgl) and 7 (>0.1 m bgl) subsoils are classified as 'strongly sodic'.
- Sites 5 (>0.2 m bgl) and 31 (entire profile) are classified as 'sodic'.
- Sites 2 (>0.15 m bgl), 13 (>0.55 m bgl), and 22 (>0.5 m bgl) classified as 'slightly sodic'.
- Remaining sites are classified as non-sodic.

The dispersibility of the subsoils, based on the EAT, ranged from classes 2, 3 and 4, classified as 'moderately dispersive', 'slightly dispersive' to 'negligible/aggregated' (non-dispersive).

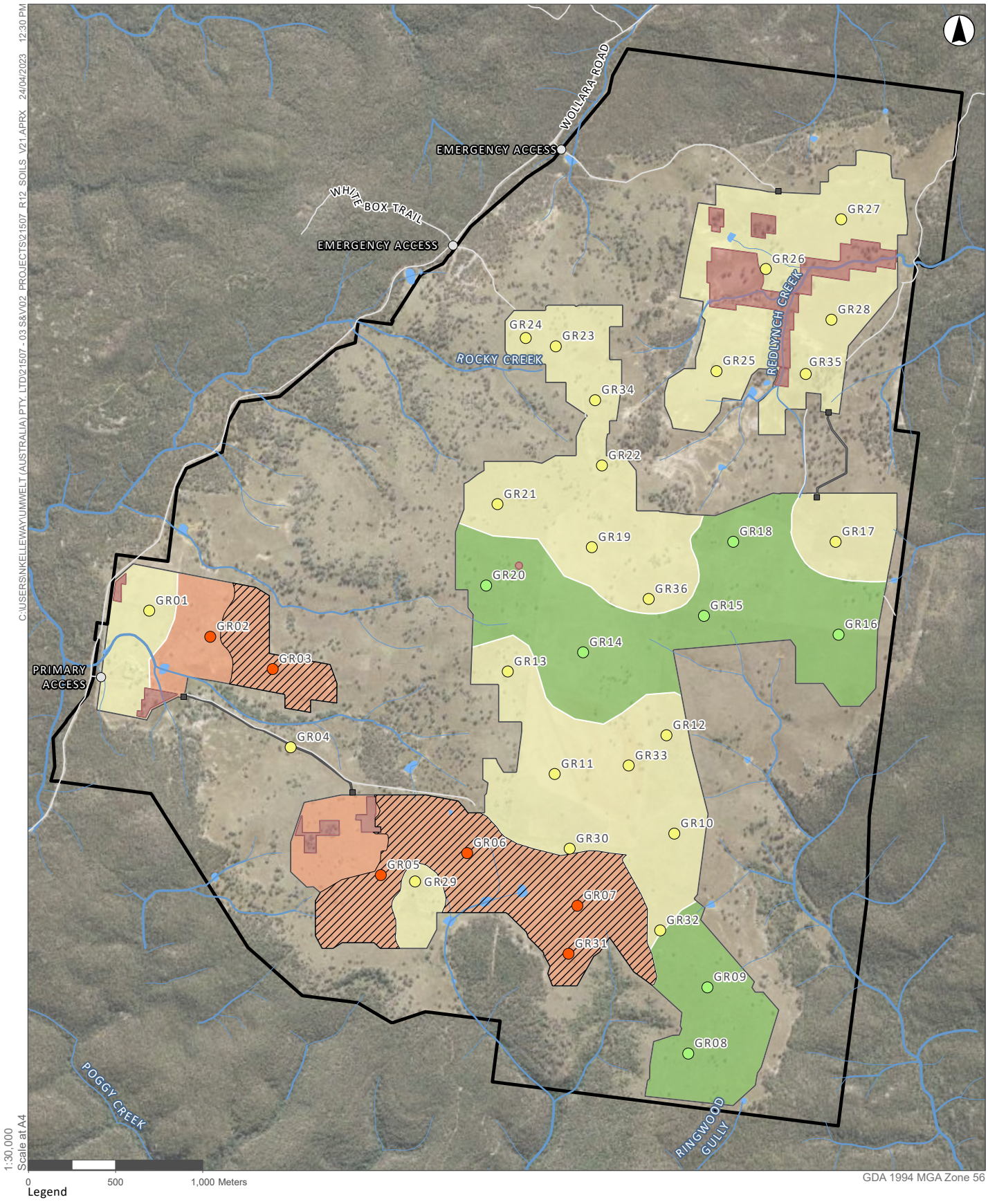
The results identified the following:

- Sites 2 (>0.15 m bgl), 3 (>0.1 m bgl), 6 (>0.15 m bgl), 7 (>0.4 m bgl) and 31 (>0.4 m bgl) contained 'moderately dispersive' subsoils.
- Sites 1 (0.2–0.45 m bgl), 5 (>0.2 m bgl), 10 (0.1–0.2 m bgl), 17 (entire profile assessed), 22 (0.5–0.6 m bgl), 25 (entire profile assessed), 26 (>.01 m bgl), 27 (>0.4 m bgl), 29 (entire profile assessed), 30 (0.2–0.6 m bgl, 32 (entire profile assessed), 33 (entire profile assessed), 34 (entire profile assessed), 35 (entire profile assessed), and 36 (entire profile assessed) contained 'slightly dispersive' subsoils.
- The remaining sites are classified as 'negligible/aggregated' (non-dispersive).

4.2.2.3 Summary

On review of the results, sodic and/or dispersive soils are identified at Sites 2, 3, 5, 6, 7, and 31 with slightly dispersive soils identified at Sites 1, 4, 10, 11, 12, 13, 17, 19, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, and 36. As shown in **Figure 4.2**, 22% of the site soils are *moderately dispersive*, 53% are *slightly dispersive*, and the balance (25%) is *non-dispersive*. The identified sodic soils are shown on **Figure 4.2**, also.

It is to be noted that although results in the 3–6% range are identified as 'slightly sodic', results less than 6% are generally not considered to present a dispersibility or erosion issue unless the EAT results indicate dispersible soils (those identified as *moderately dispersive* soils).



Legend

- Gate
- Access Points
- Watercourse
- Roads and Tracks
- Study Area
- Exclusion Zones - Environmentally Sensitive Areas
- Disturbance Footprint
- Sodic Soils
- Moderately Dispersive
- Slightly Dispersive
- Non-dispersive

Sample Sites

- Moderately Dispersive
- Slightly Dispersive
- Non-dispersive

FIGURE 4.2

Identified Sodic Dispersive Soils Mapping

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

4.2.3 Calcium: Magnesium Ratio (Ca: Mg Ratio)

The Ca: Mg Ratio is assessed to further identify if soil structural issues (resulting in erosion) may occur. A ratio of 5 is classified as 'high' indicating a good soil structure, <5–2 is classified as 'moderate to balanced' indicating some additional Ca may be required but is not susceptible to erosion, and <2 is classified as 'low' indicating the Ca to Mg balance is <2:1, potentially increasing the erosive potential in soils. Further, an imbalance in this ratio may have a potential impact on plant health and yield, although there is no significant quantifiable evidence between Ca: Mg ratio and crop health and yield.

Ca: Mg ratio ideally should be at least 2:1. Higher calcium contents are acceptable however higher magnesium content (calcium deficiency) may result in soil dispersion.

4.2.3.1 Topsoils

The Ca: Mg ratio for the topsoils ranged between 1.0 to 5.3, classified as 'Low' (<2), 'moderate to balanced' (<5 – 2), and 'high' (>5). The results identified the following.

- Sites 4, 5, 6, 7, 23, 28, and 30 had low topsoil results, with the Ca to Mg balance <2:1 which may lead to an increase in erosion potential at these sites.
- The remaining Sites had a moderate to high Ca: Mg ratio (ratio >2:1) indicating moderate to well-structured soil profiles.

4.2.3.2 Subsoils

The Ca: Mg ratio for the subsoils ranged between 0.00 to 17.3, classified as 'Low' (<2), 'moderate to balanced' (<5–2), and 'high' (>5). The results identified the following.

- Sites 1, 3, 4, 5, 6, 7, 23, 24, 28, 29, 30, 31, and 35 had low subsoil results, with the Ca to Mg balance <2:1 which may lead to an increase in erosion potential at these sites.

The remaining Sites had a moderate to high Ca: Mg ratio (ratio >2:1) indicating moderate to well-structured soil which may provide some additional control for erosion.

4.2.3.3 Summary

The results indicate that the sites identified (Sites 1, 3, 4, 5, 6, 7, 23, 24, 28, 29, 30, 31, and 35) have an imbalanced calcium: magnesium ratio that has the potential to lead to an increase in erosion potential. Additionally, this imbalance may result in impaired plant growth which may impact plant establishment following construction and during rehabilitation works.

The application of gypsum (calcium sulphate) is to be considered when disturbing these soils and during vegetation re-establishment.

4.2.4 Effective Cation Exchange Capacity (ECEC)

Cation Exchange Capacity (CEC) is an indication of the amount of negative charges on soil particles and its ability to hold/adsorb and release the positively charged cations into the soil solution where plants can access these nutrients, and is used as a measure of soil fertility. Effective Cation Exchange Capacity (ECEC) refers to the sum of Calcium, Magnesium, Potassium, Sodium, Aluminium and Hydrogen giving a more accurate indication of soil CEC, which is what was measured in this assessment.

A low CEC means the soil has a low resistance to changes in soil chemistry that are caused by land use (Hazelton and Murphy, 2016) such that they may, for example, become acidic more easily in comparison to a soil with a high CEC.

4.2.4.1 Topsoils

The ECEC for the topsoil ranged from 1.6 to 41.6 cmol (+)/kg, classified as low (<5), moderate (5–15), and high (>15). The results identified the following.

- Topsoils at Sites 3,7, 25, 31 had low ECEC, indicating these soils may not be able to buffer against changes in pH, available nutrients, calcium levels and soil structural changes (Hazelton and Murphy 2016).
- The remaining Sites had a moderate to high ECEC.

4.2.4.2 Subsoils

The ECEC for the subsoil ranged from 1.3 to 68.9 cmol (+)/kg, classified as low (<5), moderate (5–15), and high (>15). The results identified the following.

- Subsoils at Sites 7, 31, and 35 had low ECEC, indicating these soils may not be able to buffer against changes in pH, available nutrients, calcium levels and soil structural changes (Hazelton and Murphy 2016).

ECEC was generally higher in the subsoils, likely due to the higher percentage of clays with increasing depths.

4.2.4.3 Summary

The results from both topsoil and/or subsoil analysis identified soils at five Sites (3, 7, 25, 31 and 35) with low ECEC, which indicates that the soils have a low resistance to changes in soil chemistry caused by land uses, particularly agriculture. The remainder and majority of soils across the Project Area had moderate to high ECEC indicating soil fertility generally across the Site was moderate to high, with these soils effectively able to buffer against changes in pH, available nutrients, calcium levels and soil structural changes.

4.2.5 Colwell Phosphorus (P)

Phosphorous (P) is an essential constituent of numerous substances involved in the biochemical reactions of plants. P is used to supply energy in plants, with phosphorous concentrations used as a guide to indicate whether phosphate fertilizers are required for plant growth (Hazelton and Murphy, 2016). The Colwell P test not only gives a measure of the plant-available P, but also some of the less available soil-adsorbed (chemically bound) P in the soil. P is one of the most critical and limiting nutrients in agriculture in Australia.

4.2.5.1 Topsoils

Colwell P (plant available phosphorous) ranged from 5 to 335 mg/kg which is classified as extremely low to very high (Hazelton and Murphy, 2016).

The topsoil results are summarised as follows.

- Sites 8, 9, 10, 11, 12, 13, 14, 16, 18, 17, 20, 22, 24, 32, 34, and 36 contained 'very high' levels of Colwell P.
- Sites 15, 19, 21, 27, 28, and 33 contained 'high' levels of Colwell P.
- Site 1 contained 'very low' levels of Colwell P.
- Sites 2, 3, 4, 5, 6, 7, 23, 25, 26, 29, 30, 31, and 35 contained 'extremely low' levels of Colwell P.

4.2.5.2 Subsoils

Colwell P (plant available phosphorous) ranged from 1 to 196 mg/kg which is classified as extremely low to very high (Hazelton and Murphy, 2016).

The subsoil results are summaries as follows.

- Sites 9, 10, 11, 12, 13, 14, 15, 16, 18, 20, 22, 25, 34 and 36 contained 'very high' levels of Colwell P.
- Sites 17 and 27 contained 'high' levels of Colwell P.
- Site 8 contained 'medium' levels of Colwell P.
- Sites 1, 2, 3, 4, 5, 6, 7, 19, 21, 23, 24, 26, 28, 29, 30, 31, 33, and 34 contained 'extremely low' levels of Colwell P.

4.2.5.3 Summary

The higher levels of Colwell P identified in topsoil samples is predominately due to the broad surface application of phosphorous fertilizers in the sown/cropped paddocks, and those used for heavy grazing. Subsoils contained varying levels of Colwell P, with levels identified in some subsoils potentially indicating the natural/background level of plant available P in the soils is 'high – extremely high' and will not require ameliorants but may also be indicative of long-term historical application of phosphorous fertilizers across the Project Area.

Overall, these results indicated that plant growth in some site soils may be impacted by the identified lower levels of Plant available P.

4.3 Results of Land and Soil Capability (LSC) Assessment

The 36 soil profile sites within the Project Area were assessed in reference to LSC Guideline as discussed in **Section 3.3** to determine the LSC classification. Regional mapping (DPIE 2021) identified the Project Areas as Class 2, 3, 4 and 5 LSC (refer to **Figure 2.2**). However, following field survey and review of the laboratory results, the LSC classes identified in the Project Area are classified as Classes 4 and 6.

The results of the assessment are identified in **Table 4.1** and shown in **Figure 4.3**.

Table 4.1 Land and Soil Capability Assessment Results

Site	Water Erosion Slope Class	Wind Erosion Class	Structural Decline Class	Soil Acidification Class	Salinity Class	Waterlogging Class	Shallow Soil Class	Mass Movement Class	LSC Class
1	3	2	4	3	1	4	4	1	4
2	3	2	4	4	1	3	4	1	4
3	3	2	6	3	3	6	4	1	6
4	4	2	4	3	1	4	6	1	6
5	3	2	4	3	1	4	4	1	4
6	3	2	4	3	1	4	6	1	6
7	3	2	6	3	3	6	4	1	6
8	4	2	3	3	1	4	6	1	6
9	4	2	3	3	1	4	6	1	6
10	3	2	3	3	1	2	4	1	4
11	2	2	3	3	1	4	4	1	4
12	3	2	3	3	1	4	4	1	4
13	3	1	3	3	1	4	4	1	4
14	3	2	3	3	1	2	4	1	4
15	3	2	4	3	1	4	4	1	4
16	3	2	4	3	1	4	4	1	4
17	3	2	4	3	1	4	4	1	4
18	3	2	3	3	1	4	4	1	4
19	2	2	3	3	1	2	4	1	4
20	3	1	3	3	1	4	6	1	6
21	3	1	3	3	1	4	6	1	6
22	3	1	3	3	1	4	4	1	4
23	3	1	3	3	1	4	3	1	4
24	3	1	3	3	1	4	3	1	4
25	3	1	3	3	1	3	4	1	4
26	3	1	3	3	1	3	4	1	4
27	4	1	3	3	1	3	4	1	4
28	3	1	3	3	1	3	4	1	4
29	3	2	4	3	1	4	4	1	4
30	2	2	3	3	1	4	4	1	4
31	3	2	6	3	3	6	4	1	6
32	4	2	3	3	1	4	6	1	6
33	2	2	3	3	1	4	4	1	4
34	3	1	3	3	1	4	6	1	6
35	3	1	3	3	1	4	4	1	4
36	3	2	3	3	1	4	4	1	4

The results of the assessment identified the following land classes, and their limitations.

Class 4 (Sites 1, 2, 5, 10–19, 22–28, 30, 33 and 36)

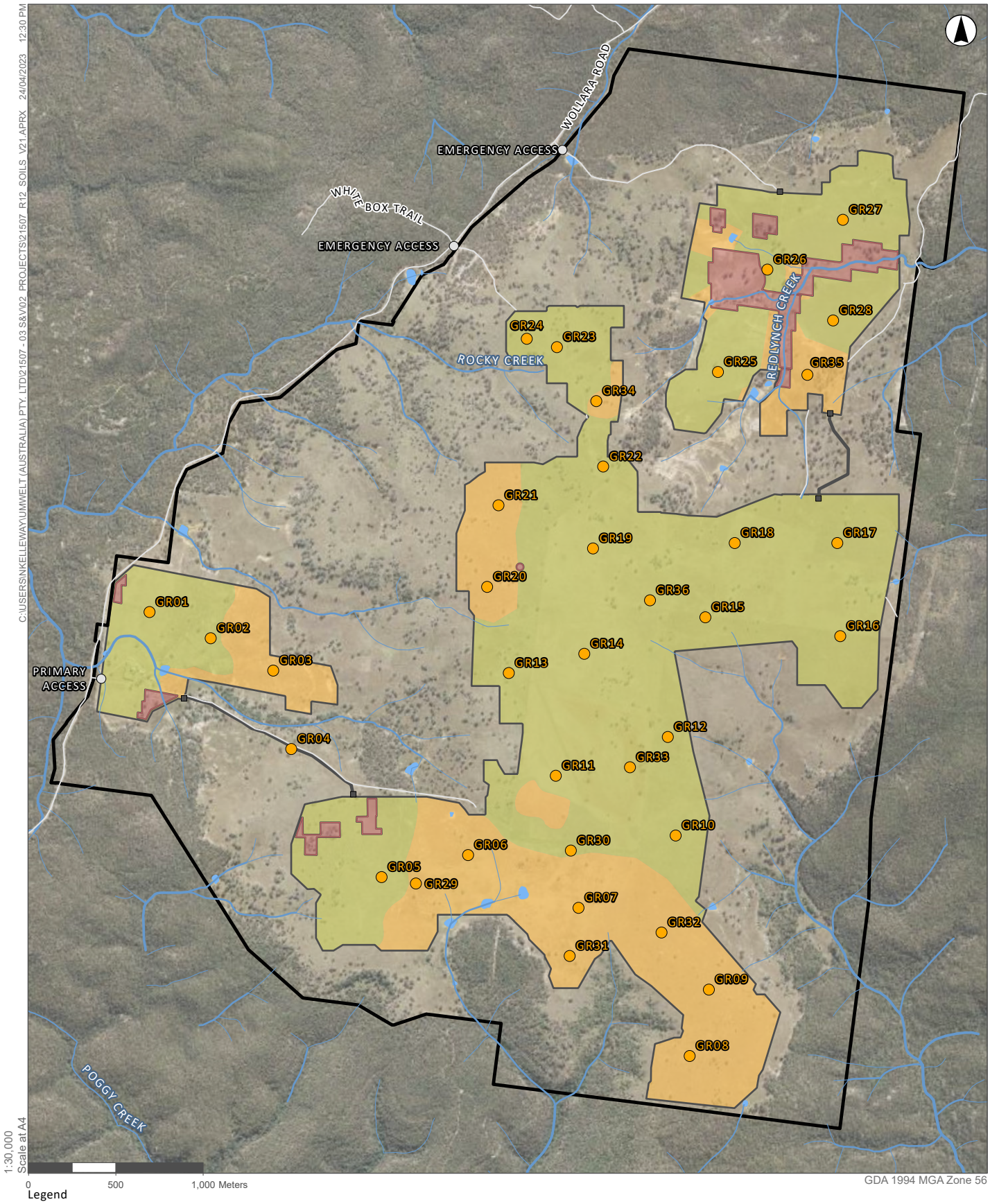
These 23 sites were classified as Class 4 land, and account for approximately 64% of the Project Area. This classification indicates the land has moderate capability with moderate to high limitations for high-impact land uses. This land will restrict land management options for regular high-impact land 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 majority of sites were impacted by some areas of rock outcrop, and a high level of stoniness/rockiness and shallowness of soils. This is the primary reason for the classification of the majority of these Sites as LSC 4 (as opposed to the regionally mapped LSC 2 & 3).

Class 6 (Site 3, 4, 6–9, 20, 21, 29, 31, 32, 34 and 35)

These 13 sites are classified as Class 6 land and accounts for approximately 36% of the Project Area. This classification indicates the land is low capability land with has very high limitations for high-impact land uses. Land use is 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.

Additionally, areas within the Project Site contained rock outcrops, and although they were not assessed in the field would meet the classification of Class 6 Land.



Legend

- Gate
- Access Points
- Roads and Tracks
- Watercourse
- Waterbodies
- Disturbance Footprint
- Study Area
- Exclusion Zones - Environmentally Sensitive Areas
- Soil Sample Sites

Land and Soil Capability

- 4 - Moderate to severe limitations
- 6 - Very servere limitations

FIGURE 4.3

Confirmed Land and Soil Capability

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

4.4 Discussion and Identified Limitations

4.4.1 Agricultural Productivity

The soil analysis identified site soils that are generally considered to be soils associated with good agricultural productivity with the land and soil capability assessment identifying ~ 64% of the Development Footprint as LSC 4, which is land with moderate capability with moderate to high limitations.

As discussed in the **Section 4.3**, there are significant limitations to agriculture predominately arising for the rockiness hazard present across the entire Development Footprint which results in a reduction of the regionally identified LSC (refer to **Section 3.1.1**) from LSC 2 and LSC 3 to LSC 4 and LSC 6 within the Development Footprint.

4.4.2 Erosion

Soil erosion is the loss of soil from the landscape predominately through the action of wind and water, with areas of existing erosion, predominately gully and rill erosion identified in one section of the Project Area (refer to photographs in **Appendix B**).

As discussed below, this erosion is due to the chemical properties of the soil, physical soil properties, and land management practices such as not maintaining ground cover, not maintaining riparian zone vegetation, overgrazing, or the overuse of farm machinery.

To establish the risk of soil erosion, the two primary laboratory tests were conducted (as discussed in **Section 4.2.2**) which included Exchangeable Sodium Percentage (ESP), to measure the soil sodicity, and the Emerson Aggregate Test (EAT), which measures dispersibility of soils. An increased risk of erosion is likely to occur where sodic or dispersive soils (high ESP, low EAT) are identified and are likely to be disturbed by the development. Additionally, erosion risk is increased where there is an imbalance of Ca: Mg ratio is identified.

The laboratory analysis identified both sodic and dispersive soils within the Project Area, with further management and mitigation measures discussed in **Section 6.0**.

4.4.3 Fertility

Following analysis, low ECEC and low Cowell P levels (both indicators of soil fertility) were identified. Although Site soils were generally high in fertility, some areas were low in fertility which may affect the establishment and growth of vegetation in exposed surfaces.

The application of appropriate fertilisers and/or organic materials if growth of vegetation appears limited may be required. These soils should be carefully grazed to maintain vegetation cover.

4.4.4 Compaction

The field survey did not identify any potential clay pans and compaction issues that are likely associated with the long-term use of the Project Area for agriculture production.

During construction, operation and decommissioning of the Solar Farm soil compaction can arise from road construction activities and use of vehicles across the Project Area. This can potentially impact plant growth and will require ripping/tilling to remediate if inhibited vegetation growth is identified.

5.0 Agricultural Impact Assessment

Following a land and capability assessment (discussed in **Section 4.3**) which verified the quality of the land, the highest LSC is Class 4. Under the Solar Guideline (2022), a *Level 2 – reduced* agricultural impact assessment is required to be conducted. Table 6 (represented below in **Table 5.1**) in Appendix A of the Solar Guideline requires the following be included in a *Level 2 – reduced* Agricultural Impact Assessment.

Table 5.1 Requirements for Level 2 (Reduced) Assessment

Assessment Required	Content and Form	Where Covered
Project description	• Project description. • Location. • Duration. • Areas of the site that would be disturbed or temporarily removed from agricultural use.	**Refer to EIS – Section 3.0** • **Section 1.1** • **Section 1.1** • **Section 5.3.1.**
Regional context	• Zoning of the project site. • Climate and rainfall. • Regional landform. • Regional land use including any significant agricultural industries and/or infrastructure.	• **Section 1.0** • **Section 2.2** • **Section 2.1** • **Section 2.6.**
Site characteristics and land use description	• Describe the land subject to the project site. • Describe existing agricultural land uses (i.e. orchards, vineyards, breeding paddocks, intensive livestock areas). • Describe the history of agricultural practices on the project site. • Identify soil type, fertility, land and soil capability. • Provide a map showing the verified LSC class of the project site. • Provide a map showing topography of the site. • Describe the agricultural productivity of the site.	• **Section 1.1** • **Section 5.2** • **Section 5.2** • **Section 4.0** • **Section 4.3** • **Section 2.1** • **Section 5.2.**
LUCRA assessment	• Land use compatibility and conflicts. • Discuss compatibility of the development with the existing land uses on the site and adjacent land (e.g. aerial spraying, dust generation and biosecurity risk) during operation and after decommissioning, with reference to the zoning provisions applying to the land.	**Appendix A.**
Impacts on agricultural land	• Describe project impacts on identified agricultural lands including, but not limited to, potential weeds, pests, dust, bushfire, livestock, crop production. • Consider impacts to the agricultural productivity of the site.	• **Section 5.7 and Section 5.3** • **Section 5.3.2** • **Section 5.3.3** • **Section 5.4.**

Assessment Required	Content and Form	Where Covered
	• Consider project potential to permanently remove agricultural land and/or fragment or displace existing agricultural industries. • Consider cumulative impacts of multiple solar energy projects on agriculture in the region.	
Mitigation strategies	• Outline and consider strategies to mitigate project impacts on agricultural land. • Consider co-location with existing agricultural practices and investigate feasibility of agrisolar where it would result in a meaningful benefit (see *Clean Energy Council's Australian Guide to Agrisolar for Large-Scale Solar*).	• **Section 6.0** • **Section 5.6.**
SEARs	A detailed assessment of the impact on agricultural resources and agricultural productivity, including: • an agricultural impact statement • consideration of potential mitigation measures which may reduce project impacts on agricultural land • detailed economic assessment of impacts on agricultural land, agricultural production and agricultural supply chains • justification for the project considering other alternatives and site design which may have lesser impacts on agricultural land.	• **Section 5.0** • **Section 6.0** • **Section 5.3.2** • **Section 5.7.**

5.1 Site Characteristics and Land Use Description

5.2 Agriculture in the Project Area

The current agricultural activities undertaken within the Project Area is limited to cattle grazing and dry land fodder cropping (currently oaten hay production). The fodder crops are used by the landholder for feeding their own cattle. Historically, the Project Area has been used primarily for grazing cattle, and intermittently used to grow wheat and other grains. No irrigation practices are used across the Project Area.

A proportion of the Project Area is cropped, reportedly 160 ha within the Project Area is used for mixed fodder cropping and grazing, with the balance of the Project Area used exclusively for cattle grazing (not suitable for cropping). Although the Project Area includes mostly soils with moderate to high fertility and land suitable for cropping, cropping activities within the Project Area are severely limited by the rockiness hazard present across the cropped areas, and over the Project Area generally. Access to the northern areas used for cropping are also impacted by weather conditions, with tracks not suitable for heavy machinery during wet conditions.

5.3 Impacts on Agricultural Land

5.3.1 Land to be Temporarily Removed from Agriculture

Lightsource bp (The Proponent) have entered a landholder agreement to purchase 2,000 ha from the current landowners, with approximately 799.5 ha used for the siting of solar panels. After the initial operating period (40 years or more), the solar farm would either be decommissioned, removing all infrastructure and returning to its existing land capability, or repurposed with new PV equipment subject to technical feasibility and planning consents.

During the operational life of the Project, the land will be able to be utilised for sheep grazing within the Development Footprint (as discussed in **Section 5.6**). This has the benefit of allowing continued agricultural activities for local graziers.

During the operation of the Project, Lightsource bp will implement measures to manage the co-existence of farming activities and the operation of the Project. As detailed in **Section 6.0**, an *Operational Environmental Management Plan* (OEMP) will be developed in consultation with DPI Agriculture.

The proposed Solar Farm will remove land available for fodder cropping and cattle grazing, with areas within the Development Footprint designed to be compatible with sheep grazing.

The areas within the Project Area, but outside the Development Footprint are being investigated as a Biodiversity Stewardship Site (BSS) and may be able to host some targeted grazing (cattle only).

5.3.2 Productivity Impacts

The proposed Solar Farm will impact agricultural productivity within the Project Area by removing reportedly 160 ha of marginal cropping land from production and remove cattle grazing from the Project Area. These impacts will be reduced once the Solar Farm is operational, with approximately 799.5 ha Development Footprint being able to support grazing activities (sheep grazing). Cattle grazing outside the Development Footprint (on the remainder of the 2000 ha) is being considered along with the potential for a Biodiversity Stewardship Site (which may allow some cattle grazing in accordance with a detailed plan of management).

To calculate the approximate monetary impact to agricultural productivity, a review of the indicative $/ha values for selected commodities (grazing and cropping) were calculated through utilising land use data available from the *Australian Bureau of Statistics* (ABS), the 2015–16 agricultural census and agricultural productivity data from the *Australian Agricultural Census 2015–16.* The indicative values provide a general indication of land productivity for agricultural land use categories (grazing and cropping) and potential impacts on agricultural productivity associated with the Solar Farm. The calculated value ranged from $151.55–$262.78/ha for grazing and $311.76–$426.38/ha for cropping.

Based on this value range for cropping and grazing, the following productivity estimates are made:

- Productivity of between $49,881.60 to $68,220.80 for cropped land (160 ha).
- Productivity of between $278,852.00 to $483,515.20 (covering 1840 ha representing the balance of land within the Project Area, this is a worst-case scenario as it is currently unknown if grazing will continue on remaining land if it becomes a biodiversity offset site).

- A total productivity range of $328,733.60 to $551,736.00 in annual productivity across the entire Project Area (2000 ha) was calculated. It should be noted that these calculations are not averages and did not consider years of climatic weather conditions, such as drought, where on farm income can be significantly reduced (such as the 2017–2020 drought) through no or reduced cropping and reduced carrying capacity for livestock. Years following drought also can reduce productivity as farms recover.

We note that there will be no impact on land capability, rather access to this land for grazing.

5.3.3 Land to be Returned to Agriculture

Once the Project is decommissioned the Project Area will be remediated to enable agricultural production including grazing and fodder cropping to resume. All land will be rehabilitated and suitable for its previous agricultural purpose.

As detailed in **Section 6.0**, a *Decommissioning and Rehabilitation Management Plan* (DRMP) framework has been developed as part of the EIS.

5.3.4 Soil Erosion

Due to the presence of sodic and dispersive soils within the Project Area, the risk of erosion on site due to construction activities is considered high (mostly limited to the southern section of the Project Area). In these areas, excavation of soils should be limited where possible, and excavated soils should be stockpiled and contained to avoid potential dispersion and sediment transfer. Disturbance to ground cover should be limited where possible. Maintenance of ground cover will also aid in the prevention of topsoil losses from erosive forces (primarily water and wind) and can assist in the prevention of tunnel erosion from occurring.

All construction and decommissioning activities for the Project will be undertaken in accordance with an erosion and sediment control plan (ESCP) as detailed in **Section 6.0**. Post approval, a *Construction Environmental Management Plan* (CEMP) will be prepared by Lightsource bp that identifies erosion and sediment control mitigation measures prior to works commencing.

Similarly, the operation of the Project would be in accordance with an OEMP that will detail measures to limit erosion during the operation of the Project.

5.3.5 Weeds, Pests and Farm Biosecurity

With mitigation measures appropriately in place there is a low potential for weeds and invasive pests to spread or impact neighbouring land.

As detailed in **Section 6.0**, Lightsource bp will prepare and implement an OEMP which would effectively outline the list of mitigation measures and detail any management programs e.g. weed spraying program to effectively manage invasive species.

Biosecurity is defined in the NSW *Biosecurity Strategy 2013–2021* (NSW DPI, 2013) as 'protecting the economy, environment and community from the negative impacts of pests, diseases and weeds'. The strategy provides measures to prevent pest, weeds and disease from entering and establishing in Australia. Ensuring appropriate measures to this risk is important and will be addressed in the OEMP.

Further, the control of weeds will be aided by co-grazing which is proposed as a trial within the fenced Development footprint.

5.3.6 Spraying Impacts

Weed spraying would be undertaken throughout the Project Area to manage and control targeted weed species. Spray drift from weed spraying has the potential to impact the neighbouring Goulburn River National Park. In accordance with the *Pesticides Act 1999* alongside advice provided by the EPA NSW a variety of strategies would be implemented to minimise conflict and/or damage arising from spray drift. These strategies include:

- Monitoring environmental conditions e.g. wind and rainfall before, during and after spraying.
- Only registered pesticides that carry an APVMA-approved label would be used.
- Adjacent areas containing sensitive areas would be checked before spraying.
- Spray applicators would be fully trained and accredited.
- The National Parks and Wildlife Services would be provided with notifications prior to spraying.
- Aerial spray would not be undertaken during a surface temperature inversion.
- All pesticide labels would read and followed prior to use.

The OEMP will consider these management techniques.

5.3.7 Impacts to Travelling Stock Reserves

As shown in **Figure 2.2**, approximately 7.4 ha of land identified as a TSR is within the Development Footprint. Lightsource bp proposes to continue the use of the TSR through the implementation of appropriate management measures including fencing and signage, etc. A portion of the TSR will have some solar infrastructure on it as a result of the Project, this is not considered to impact the ongoing use.

5.4 Socio-Economic Impacts

Socio-economic impacts associated with the agriculture industry as a result of the Project are expected to be negligible. The Development Footprint within the Project Area occupies approximately 799.5 ha of agricultural land accounting for less than 0.001% of the total amount of land associated with agricultural use (1,081,841 ha) within the Upper Hunter Region of NSW (DPI 2013). As such, the change in land use results in a negligible reduction in the overall productivity of the region.

The Project Area currently provides up to 1.25 full time equivalent (FTE). With the introduction of solar generation, up to 350 FTE jobs will be generated over the construction phase, which is expected to be up to 27 months (Ethos Urban 2022). The Project Area will then support 10 direct FTE jobs during operation of the Solar Farm one of which will be a livestock manager for the property.

Furthermore, no other industries have been identified to be negatively impacted by the Project.

5.5 Cumulative Impacts

In the region there are seven approved Solar Farms and six in planning. It is assumed that on average they could occupy similar development footprints (conservative estimates) and as such comprise an estimated cumulative total of approximately 10,400 ha. On the basis that the Upper Hunter Region has 1,081,841 hectares of combined crop and grazing land this accounts for less than 1% of the total amount of land associated with agricultural use in the Upper Hunter Region (DPI June 2013).

As such, the cumulative total area of land utilised for these projects is expected to result in a negligible reduction in the overall productivity of the greater region.

There will be negligible impact to agriculture activity with grazing proposed under the solar arrays (799.5 ha).

Should the remainder of the Project Area be utilised as a BSS and considered not compatible with cattle grazing it will still result in a negligible impact on agricultural production (1200 ha out of 1,081,841 ha = 0.1%.

5.6 Potential for Land Sharing

Once construction has been completed there would be an opportunity to maximise the Project Area's potential and offer a dual purpose for the Development Footprint within the Project Area allowing the area to be grazed by livestock, specifically sheep. Any sheep grazing would occur entirely within the fenced solar farm (within the development footprint), offering protection from wild dogs that may be present in the surrounding National Park.

The *Australian Guide to Agrisolar for Large-Scale Solar, for proponents and farmers* (Agrisolar Guide 2021) was prepared by the Clean Energy Council (March 2021) to act as a guide for co-sharing of agriculture and solar farming in Australia. The *Agrisolar Guide* 2021 identified that there were at least 13 large-scale solar farms successfully grazing sheep (identified as 'solar grazing') in Australia in 2020 and identified a number of successfully trialled positive benefits including.

- Sheep would help control vegetation growth within the Project Area, reducing the need for mowing or spraying, which will reduce grass fire risks in the area.
- Maintenance costs are also reduced as result of vegetation being controlled by sheep.
- Animal welfare conditions are improved, with:
    - the solar panels providing shade and protection from strong winds for sheep resulting in higher quality wool
    - safety from predators is enhanced by the installation of secure boundary fencing
    - cover provided by the panels improves safety from wedge-tailed eagles.
- Reduced wool contamination (from burrs).

The *Agrisolar Guide 2021* provides a number of recommendations to ensure land sharing success, these recommendations will be incorporated into the OEMP to be prepared for the Project. This will include measures for managing stock (sheep), including a requirement to keep the stock in good health, ensuring frequent shearing (to keep wool growth low), ensure mustering is conducted in an agreed safe manner, and that any fatalities are managed by the farmer.

5.7 Justification

It is acknowledged that the proposed Project will result in a minor impact to agriculture through a change in land use resulting in the reduction of land available for agriculture. More specifically a loss of approximately 160 ha of land suitable for cropping (0.01% of the Upper Hunter Region). Furthermore, even if the 2000 ha comprising the Project Area was to no longer be available for agriculture the resulting impact is negligible at a regional scale (0.18% of the Upper Hunter Region).

As discussed throughout **Section 5.0**, the impacts to agriculture on both a regional and state scale are considered negligible (**Section 5.3.2**). Additionally, the Project is identified as having net positive economic benefits as a result of increased investment in the area, and the additional employment opportunities associated with the Solar Farm. This will support other industries, with positive flow on effects to agriculture and the broader economy in the region.

Alternative locations for the Solar Farm were investigated, with the proposed Project Area considered to be the most suitable as it provides the optimal combination of:

- Access to the existing 500 kV high voltage transmission network eliminating the need to construct a new transmission line whilst maximising the current infrastructure.
- Availability of land of a suitable scale for a viable commercial-scale solar farm.
- Isolation from neighbouring residences and properties.
- High quality solar irradiance and ideal climatic conditions for a commercial-scale solar farm.
- Compatible land use zoning within the Project Area.
- Reduced environmental constraints because of historic widespread clearing within the Project Area and ongoing use for agriculture, with potential environmental impacts that can be managed with appropriate mitigation and management. The vegetation with the Development Footprint is generally of low conservation value (refer to the Solar Farm Biodiversity Development Assessment Report, Appendix 6 of the EIS). Although the State LSC mapping classifies the Project Area as 2 and 3, soil survey results and field investigations classify the land as Class 4 and 6, indicating reduced agricultural capacity of the land.
- The implementation of Solar Grazing within the 799.5 ha Development Footprint to offset the potential impacts to agricultural land by allowing continued agricultural production from within the Project Area, by way of sheep grazing.
- Access to the major transport network, namely the Golden Highway.
- Only one adjacent landholder, being the Goulburn River National Park, resulting in appropriate visual screening and negligible impacts to any sensitive receivers in the area.

- Providing community benefits such as road upgrades along Ringwood Rd.
- After decommissioning, the Project Area will be rehabilitated to a similar state as it is now, returning the Project Area to more 'traditional' agriculture.
- Agreements with host landholders.

For these reasons, the Project Area was considered suitable for the proposed solar farm development.

Further, although the site design did not specifically consider minimising impacts to agricultural production, site design has occurred in a manner that will avoid and minimise identified environmental, social and cultural constraints, with the implementation of a trial of solar grazing providing an option to offset the negligible impacts to agricultural land productivity.

Given the negligible regional and state scale impact to agriculture, and limited long term impacts to agricultural land within the Project Area, it is recommended that the proposed Project proceed.

6.0 Management and Mitigation Measures

The key issues identified during the assessment and their management and mitigation measures are discussed below.

6.1 Soil Erosion, Fertility, and Compaction

The management and mitigation measures proposed for soil erosion, fertility and compaction are identified below:

- A CEMP will be prepared by Lightsource bp that identifies erosion and sediment control mitigation measures prior to works commencing, including mitigation measures discussed in **Section 4.4**.
- Erosion risks (including prevention of tunnel erosion) will be managed through an erosion and sediment control plan (ESCP), that will be developed as part of the CEMP for the Project, in accordance with the *Managing Urban Stormwater: Soils and Construction Volume 1* (NSW DPIE, 2004) "The Blue Book".
- The ESCP will be implemented, and consideration of the sodic/dispersive soils identified within the project area will be considered in the project design. In this instance, where sodic/dispersive soils are identified, application of an ameliorate such as gypsum may assist in improving soil structure. Further, the application of gypsum, which contains calcium is recommended to counter the Ca: Mg imbalance.
- The CEMP for the Project will detail requirements to manage erosion, soil fertility and compaction during the operation of the Project.

6.2 Agricultural Productivity

The following mitigation and management measures will be implemented to ensure the agricultural productivity of the site is not significantly impacted to support the ongoing use of the Project Area for agricultural activities. These include:

- Post approval, Lightsource bp will develop an OEMP which will incorporate a *Sheep Grazing Vegetation Management Plan* (SGVMP) that will outline management measures for solar grazing in line with the Agrisolar Guide (2021) as well as other animal health and welfare standards and guidelines.
    - This will include measures to manage the stock appropriately, including a requirement to keep the stock in good health, ensuring frequent shearing (to keep wool growth low), ensure mustering is conducted in an agreed safe manner, and that any fatalities are managed by the farmer.
    - As per the SGVMP to be prepared, Lightsource bp will enter into a *grazing agreement* (agistment contract) with the livestock owner.
- The OEMP will be developed in consultation with DPI Agriculture and future graziers, and will be implemented post construction.
- Areas outside of the Development Footprint but within the Project Area may be established as a Biodiversity Stewardship Site. If determined to be compatible, cattle grazing will be facilitated through this area. If compatible a Cattle Grazing Management Plan will be implemented that will outline management measures for ongoing grazing in these areas.

6.3 Weeds, Pests and Biosecurity

The following mitigation and management measures will be implemented to manage weeds, pests and biosecurity within the Project Area. These include.

- The OEMP will detail the management requirements, including:
    - Inspection of all vehicle and machinery entering the Project Area, cleaned if applicable to remove weeds including seeds.
    - Appropriate weed management practices to be adopted, including regular weed spraying.
    - Appropriate pest management practices to be adopted.
    - Limit vehicle access to the established internal road network.
- Solar grazing will be implemented to assist in the control of ground cover (preventing over growth), which in turn will enable better weed and pest management practices to be maintained.

6.4 Rehabilitation

At the end of the project design life, the Project Area will be rehabilitated to a condition as close as practicable to the condition that existed prior to construction of the project and in consultation with future landholders. This will be achieved through the implementation of the following:

- The rehabilitation of the Project Area will be conducted in accordance with the *Decommissioning and Rehabilitation Management Framework* (refer to **Appendix 18** of the **EIS**) with a *Decommissioning and Rehabilitation Management Plan* to be prepared as part of the OEMP for the Project.
- The Project Area will be rehabilitated to a standard suitable for agricultural activities that were previously undertaken to re-commence. This will include reintroduction of vegetation appropriate for grazing and soil stability (cover crops, legumes and pasture species).

7.0 Conclusion

The key findings of the Soil, Land Capability and Agriculture assessment are:

- Sodic soils are identified within the Project Area, with sodic and/or dispersive soils identified at Sites 2, 3, 5, 6, 7 and 31.
- Based on the *Australian Soil Classification*, soil types were identified as Ferrosols, Dermosols and Sodosols.
- Following field survey and laboratory analysis, the Project Areas are mapped as Class 4 and Class 6 Land (prior to ground truthing, regional mapping indicated Class 2, 3, 4 and Class 5 Land).
    - Class 4 Land is moderate capability land with moderate to high limitations for high-impact land uses.
    - Class 6 Land is low capability land which has very high limitations for high-impact land uses.
- There are negligible impacts at a regional level to agricultural activity with temporary removal of cropped land, and grazing land during construction. Sheep grazing activities will be able to commence within the Development Footprint once the Solar Farm is operational.
- Agricultural activity within the Project Area will be limited to grazing activities during the operational phase and may return to the existing agricultural production (grazing and cropping) following decommissioning and rehabilitation in areas not subject to use for BSS.
- Based on the findings of this report, the long-term risks to soil, land capability and agriculture are low and can be managed by the recommendations provided in **Section 6.0**.

8.0 References

ABARES (2019), Australian Agricultural Census 2015–16 visualisations – Mudgee west, Accessed at: https://www.awe.gov.au/abares/data. Accessed: 14 October 2022.

ABARES 2021a, Catchment scale land use profile dashboard – Mid-Western Regional local government area, Australian Bureau of Agricultural and Resource Economics and Sciences.

ABARES 2021b, About my region – Central West New South Wales, Australian Bureau of Agricultural and Resource Economics and Sciences.

Bureau of Meteorology (2022). Website accessed on 09/09/2022: http://www.bom.gov.au/climate/averages/tables/cw_065103.shtml

Charman P.E.V and Murphy B.W. (Eds) (2007) Soils – Their Properties and Management – A Soil Conservation Handbook for New South Wales: second edition (New South Wales Printing Office, Sydney).

Clean Energy Council (March 2021). Australian Guide to Agrisolar for Large-Scale Solar, For proponents and farmers (Agrisolar Guide 2021).

CSIRO (2006). Australian Soil Fertility Manual. Third Edition.

Ethos Urban (2022). Goulburn River Solar Farm Economic Impact Assessment, 2 September 2022.

Hazelton, P. and Murphy, B. (2016). Interpreting Soil Test Results – What do all the numbers mean? CSIRO Publishing 2016.

Isbell, R.F. (2016) *Australian Soil Classification*. CSIRO Publishing, Australia.

Isbell R.F., McDonald W.S. and L.J. Ashton (1997) *Concepts and Rationale of the Australian Soil Classification* (CSIRO Publishing, Australia).

Kovac M. and Lawrie J.M., 1991, Soil Landscapes of the Singleton 1:250,000 Sheet map and report, Soil Conservation Service of NSW, Sydney.

NCST (2008) Guidelines for surveying Soil and Land Resources. (CSIRO Publishing, Australia).

NCST (2009) Australian Soil and Land Survey Field Handbook, 3rd edition (CSIRO Publishing, Australia).

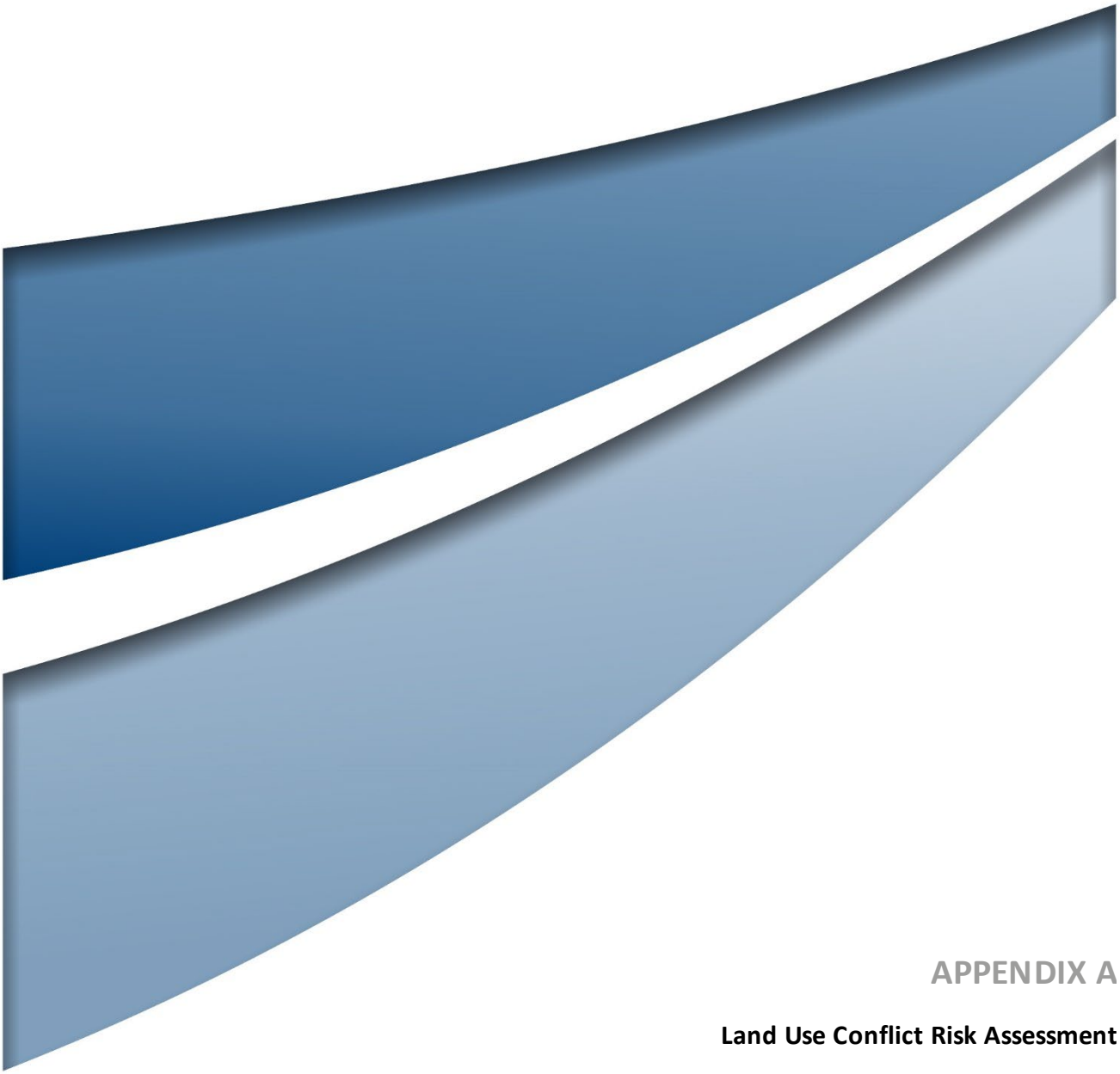
NSW DPE (2022) seed, accessed 2022. https://geo.seed.nsw.gov.au/Public_Viewer/index.html?viewer=Public_Viewer&locale=en-AU&runWorkflow=AppendLayerCatalog&CatalogLayer=SEED_Catalog.79.SALBiophysical

NSW Government (2022) e-SPADE V2.1 website, accessed 2022. https://www.environment.nsw.gov.au/espade2webapp

NSW DPI (2013). New South Wales Biosecurity Strategy 2013 – 2021 (NSW DPI, 2013).

OEH (2012) The land and soil capability assessment scheme: second approximation – A general rural land evaluation system for NSW.

Rasmus P.L., Rose D.M. and Rose G (1969) Singleton 1:250 000 Geological Sheet SI/56-01, 1st edition, Geological Survey of New South Wales, Sydney.



APPENDIX A

Land Use Conflict Risk Assessment

umwelt
Environmental & Social Consultants

lightsource bp

GOULBURN RIVER SOLAR FARM

Land Use Conflict Risk Analysis

FINAL

April 2023

GOULBURN RIVER SOLAR FARM

Land Use Conflict Risk Analysis

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Lightsource bp

Project Director: Malinda Facey
Project Manager: Jessica Henderson-Wilson
Report No. 21507/R12/Appendix A
Date: April 2023

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
V0	Jessica Henderson-Wilson	17/11/2022	Malinda Facey	17/11/2022
V1	Jessica Henderson-Wilson	04/04/2023	Malinda Facey	05/04/2023
V2	Jessica Henderson-Wilson	24/04/2023	Malinda Facey	24/04/2023

Table of Contents

Figures

Tables

1.0 Introduction

Umwelt (Australia) Pty Limited (Umwelt) has been engaged by Lightsource Development Services Pty Ltd (Lightsource bp) to conduct a Land Use Conflict Risk Assessment (LUCRA) to support the Environmental Impact Statement (EIS) that has been prepared as part of the State Significant Development (SSD) Development Application for the proposed Goulburn River Solar Farm located approximately 28 km south-west of the township of Merriwa, New South Wales (NSW) (the 'Project').

1.1 Project Overview

The Project will involve the construction, operation and decommissioning of approximately 550-megawatt peak (MWp) of solar photovoltaic (PV) generation as well as a Battery Energy Storage System (BESS) with 280 MWp / 570-megawatt hour (MWh) capacity. The Project will also include a substation and connection to an existing 500 kilovolt (kV) transmission line. The Project will include various associated infrastructure, including road repairs and upgrades to Ringwood Road, temporary construction facilities, operation and maintenance buildings, internal access roads, civil works and electrical infrastructure to connect the Project to the existing transmission line which passes through the Project Area (refer to **Figure 1.1**).

The Project Area is near the Central West Orana Renewable Energy Zone (REZ) and the recently declared Hunter-Central Coast REZ however it is not related either of these two REZ, nor is it dependent on the REZs establishment. The REZs location was selected because of the benefits of relatively low transmission build costs due to its proximity to the existing transmission network structures. Similarly, the Project Area benefits from the existing 500 kV transmission line crossing the south-east portion of the site, allowing easy connection to the national electricity grid.

The Project Area covers approximately 2,000 ha with a Development Footprint of approximately 799.5 ha. While much of the Project Area consists of agricultural land, which has been subject to land clearing, grazing, cropping and pasture improvement, the whole of the landscape would have previously supported open woodlands and forests like those of the surrounding Goulburn River National Park. The Project Area currently supports a mosaic of exotic vegetation where cropping and pasture improvement has taken place, along with derived native grasslands in a range of conditions, isolated paddock trees, areas of thinned woodland and forest, and areas of intact woodland and forest, parts of which are consistent with the definitions of Threatened Ecological Communities and provide habitat for threatened fauna species.

The Project is expected to operate for 40 years or more. After the initial 40-year operating period, the solar farm would either be decommissioned, removing all infrastructure, and returning the site to its existing land capability, or repurposed with new PV equipment subject to technical feasibility and planning consents.

1.2 Purpose and Scope of Works

1.2.1 Purpose

The purpose of a LUCRA is to identify and assess the potential for land use conflicts with neighbouring land uses and implement mitigation measures to minimise potential impacts. The aims of a LUCRA, as defined by the Department of Primary Industries (DPI) are to:

- Accurately identify and address potential land use conflict issues and risk of occurrence before a new land use proceeds or a dispute arises.
- Objectively assess the effect of a proposed land use on neighbouring land uses.
- Increase the understanding of potential land use conflict to inform and complement development control and buffer requirements.
- Highlight or recommend strategies to help minimise the potential for land use conflicts to occur and contribute to the negotiation, proposal, implementation and evaluation of separation strategies.

1.2.2 Scope of Works

This LUCRA has been prepared in accordance with the *Land Use Conflict Risk Assessment Guide* (DPE 2011) fact sheet provided by the NSW DPI. This assessment has also been prepared to meet the DPE Secretary's Environmental Assessment Requirements (SEARs) for the Project, issued on 1 February 2022. The SEARs required the *'completion of a Land Use Conflict Risk Assessment in accordance with the Department of Industry's Land Use Conflict Risk Assessment Guide'*.

The guidelines set out four steps in undertaking the assessment:

Step 1: Gather information – including describing the proposed land use change, the proposed development, and activities associated with it as well as understanding the site history and other land uses and environmental considerations.

Step 2: Evaluate the risk level of each activity – using the risk assessment matrix to identify the level of risk of a land use conflict arising from the activity.

Step 3: Identify risk management strategies – including the identification and prioritisation of management strategies for each activity, and the re-assessment of risk based on these strategies, with performance targets for each activity.

Step 4: Record the results of the LUCRA – summarising the key issues, their risk level, and the recommended management strategies.

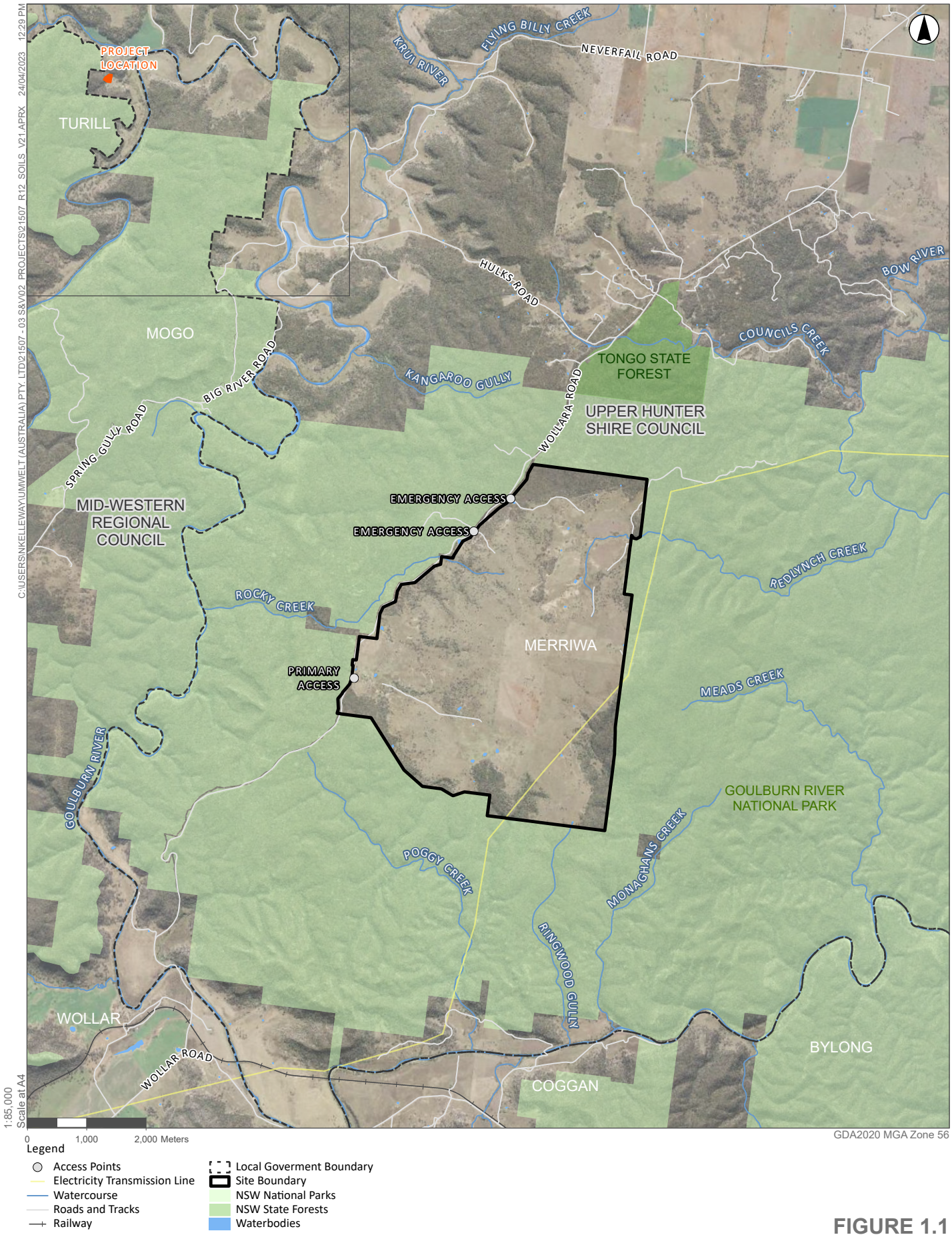


FIGURE 1.1

Location and Local Context

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

2.0 Background Information

2.1 Location and Zoning

The Project will be located approximately 28 km south of Merriwa within the Upper Hunter Local Government Area (LGA) as shown on **Figure 1.1**. The Project Area is zoned RU1 Primary Production under the *Upper Hunter Local Environmental Plan 2013* (Upper Hunter LEP). Electricity generating works are not expressly permitted in this zone however the provisions of the *State Environmental Planning Policy (Transport and Infrastructure) 2021* (Transport and Infrastructure SEPP) prevail over the LEP in this instance. Section 2.36(1) of the Transport and Infrastructure SEPP provides that development for the purposes of 'electricity generating works' (which includes battery storage) may be carried out by any person with development consent on a prescribed rural zone, which includes land zoned RU1 under a LEP.

The objectives of the RU1 Primary Production zone are:

- *To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.*
- *To encourage diversity in primary industry enterprises and systems appropriate for the area.*
- *To minimise the fragmentation and alienation of resource lands.*
- *To minimise conflict between land uses within this zone and land uses within adjoining zones.*
- *To protect the agricultural value of rural land.*
- *To maintain the rural landscape character of the land in the long term.*
- *To ensure that development does not unreasonably increase demand for public services or public facilities.*
- *To ensure that development for the purposes of extractive industries, underground mines (other than surface works associated with underground mines) or open cut mines (other than open cut mines from the surface of the flood plain) will not:*
    a. *destroy or impair the agricultural production potential of the land or, in the case of underground mining, unreasonably restrict or otherwise affect any other development on the surface, or*
    b. *detrimentally affect the quantity, flow and quality of water in either subterranean or surface water systems, or*
    c. *visually intrude into its surroundings, except by way of suitable screening.*

The Project Area is considered suitable for the Project, noting that agricultural land use (sheep grazing) will continue to be viable for the site after construction as the design is compatible with sheep grazing. The Project is therefore considered to remain consistent with the objectives of the RU1 Primary Production land use zone.

The Project Area is located across 44 freehold cadastral lots, which are listed in **Appendix 4** of the EIS. Lightsource bp have options to purchase the land from the two landholders (hereafter referred to as host landholders) allowing Lightsource bp to lease the land for a maximum term of 42 years.

No part of the Project Area is subject to a mining/exploration lease.

2.2 Existing Land Use

The Project Area has been subject to extensive vegetation clearing associated with historic agricultural land uses. The land within the Project Area is primarily used for agriculture (primarily grazing and some cropping), with some scattered paddock trees and areas with remnant timbered and bare rocky outcrops and deeper drainage lines.

There is one residential dwelling, referred to as the Post-War House (currently inhabited) within the Project Area, and other agriculture-based infrastructure such as sheds, yards (timber and steel), and stock feeding and watering equipment. The Project Area is fenced into paddocks with a mix of barbed wire, plain wire, netting and electric wire, and some wooden fencing. A heavily dilapidated residential dwelling is located in the northern section of the Project Area and is not inhabited and is not considered a residential receiver.

The Project Area contains a number of farm dams and drainage lines flowing into the Goulburn River and Bow River. Refer to the Water Resources Impact Assessment (**Appendix F11** of the EIS) for further details.

2.3 Proposed Land Use

The Project will change the current land use from agricultural to electricity generation. Following the construction period, it is proposed that grazing activities (sheep) could be reinstated within the fenced solar farm once pasture is re-established as the design is compatible with sheep grazing. This would be undertaken on a trial basis.

2.4 Regional Land Use

Surrounding the Project Area, adjacent lands are associated with the Goulburn River National Park. The National Park is of high conservation value due to its unique topography and geology which support a diverse number of plant communities and animal species (NPWS, 2003).

Other key land uses and features in the area surrounding the Project include:

- the Goulburn River, located approximately 2.75 km from the western boundary of the Project Area and a number of smaller drainage lines including Redlynch Creek, Rocky Creek and Bow River
- Wilpinjong Mine (open cut coal mine), located approximately 20 km to the southwest of the Project Area
- Moolarben Coal Complex (open cut and underground coal mine) and Ulan Coal Complex (underground coal mine), located approximately 30 km to the southwest of the Project Area
- the township of Merriwa, located approximately 26 km northeast of the Project Area.

The nearest residential receivers outside the Project Area are located approximately 3 km to the north, as shown in **Figure 2.1**. There are no residential receivers within 1 km of the Project Area.

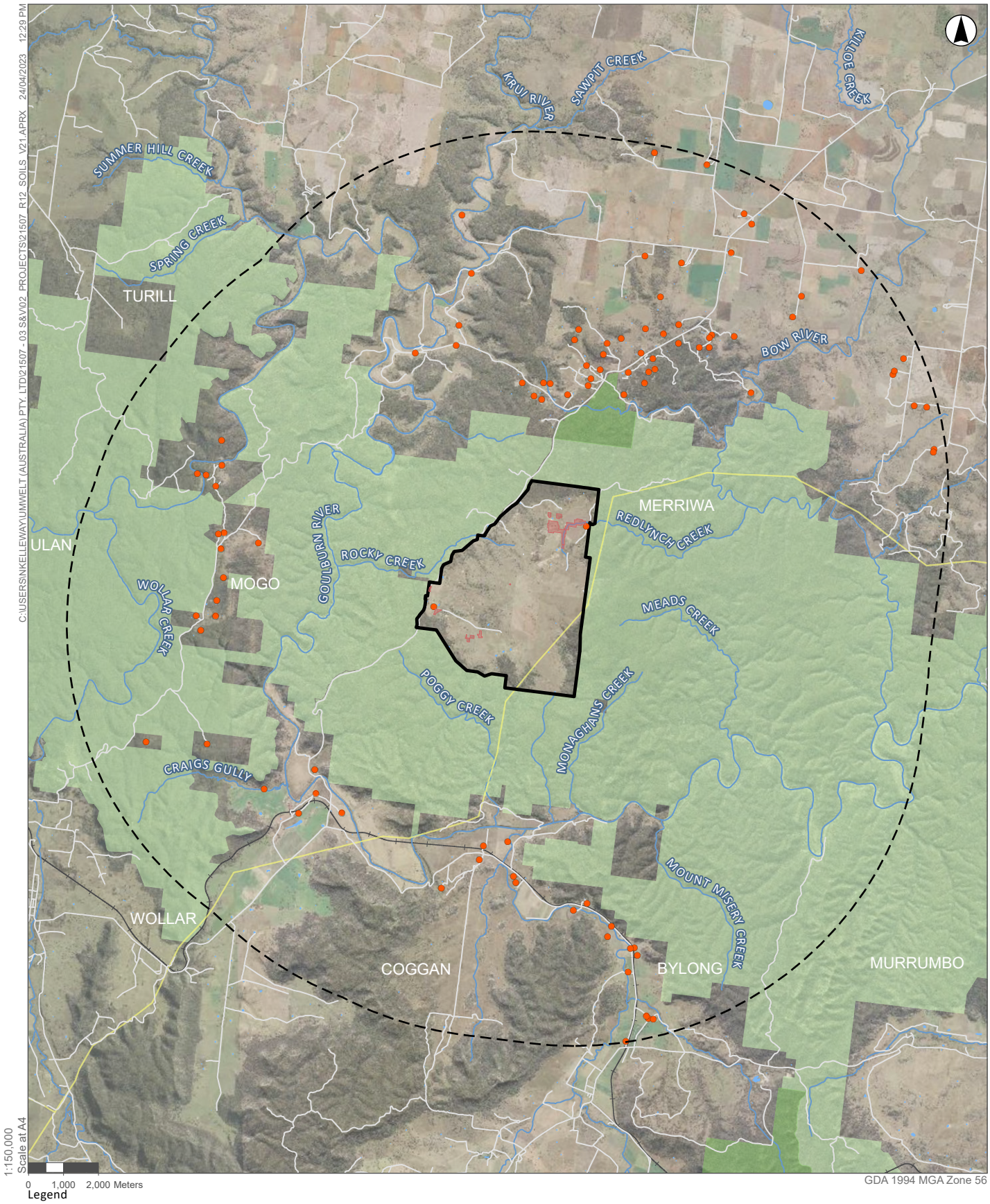


FIGURE 2.1

Location of Nearest Receivers

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

2.5 Site Selection

Lightsource bp selected the proposed Project Area as it provides the optimal combination of:

- Isolated location (surrounded by Goulburn River National Park), minimal impacts on neighbouring residents, visual amenity, aquatic biodiversity, hazards including bushfire and agriculture, vegetation screening.
- Close proximity to high voltage transmission network, with a 500 kV transmission line running through a portion of the eastern Project Area.
- Generally flat terrain, with some minor undulation in the landscape, high quality solar irradiance and ideal climatic conditions for a commercial-scale solar farm.
- The 2,000 ha Project Area provides flexibility in the design to prioritise avoidance of high biodiversity values.
- Compatible land use zoning both on the Project Area and in adjacent land holdings.
- Environmental constraints that can be managed with appropriate mitigation and management.
- The generally flat landscape is suitable for minimising the risk of substantial soil erosion during earthworks.
- Access to the major transport network, namely the Golden Highway, to the north of the Project Area.
- Purchase agreements with host landholders.

2.6 Site History

The Project Area has historically been used for agricultural purposes, including cropping and grazing livestock.

2.7 Site Inspection Outcomes

A site inspection was undertaken in August 2022, with a soil survey also completed at this time. Additional soil surveys were completed in January 2023 to supplement the 2022 assessment. The outcomes of the soil survey, land capability assessment and other agricultural aspects are covered in the Soil, Land and Agricultural Assessment (Umwelt, 2023). It was observed that the majority of the Project Area is located on a long, open undulating ridge, which slopes off in all directions.

The Project Area comprises large paddocks that are fenced and used predominantly for grazing cattle, with some cropping occurring. Except for some timbered rocky outcrop areas and drainage lines the majority of the Project Area is cleared with some scattered paddock trees remaining. At the time of the site inspection, portions of the Project Area were recently cropped and harvested (fodder crops: for oaten hay).

2.8 Consultation

2.8.1 Landholder Consultation

The *Land Use Conflict Risk Assessment Guide* (DPE 2011) generally requires engagement with nearby landholders to assess the potential land use conflicts that may arise between the proposed Project and the landholders. Consultation with nearby landholders has included potential visual impacts from the Project and well as more general updates on the development of the Project.

2.8.2 Agency Consultation

Consultation with the Department of Primary Industry (DPI) – Agriculture was conducted throughout 2021 and 2022 to introduce the Project and present the draft outcomes of the LUCRA. This is further discussed in **Section 3.6** of the Soils, Land and Agriculture Assessment.

Two meetings were held with NSW National Parks and Wildlife Service (NPWS), one on the 15 September 2021, and the second on 2 August 2022. During the first of these meetings, it was confirmed that NPWS have no in-principle concerns regarding the presence of a solar farm within the Project Area. The focus of discussions was subsequently on identifying locations that may have suitable habitat as offset additions to the Goulburn River National Park. It was also confirmed that access through the Project Area would be maintained for NPWS, once the Project is operational, for management and emergency purposes (Consultation is described as well in **Appendix 6** and **Appendix 12** of the EIS). Engagement with NPWS has continued throughout preparation of the EIS including to provide comment on the proposed Landscape Plan.

2.9 Compatibility with Existing Land Uses

The Project will modify the existing land use on the Project Area. This change of land use could be considered incompatible with the current surrounding land uses without mitigation. The sections below identify the potential incompatibilities (in the absence of mitigation measures as required by the LUCRA assessment guidelines) between the surrounding land use and the proposed land use.

2.9.1 Construction

During construction the main incompatibilities identified (without mitigation) are:

- increased noise from construction vehicles (additional to what is reasonably expected from agricultural production)
- dust generated by construction vehicles and during construction activities such as land clearing and site preparation, but predominantly due to additional vehicles using the unsealed sections of Wollara Road to access the Project Area
- visual impacts during construction activities (for passing motorists)
- erosion and sediment runoff and impacts on surface water quality
- damage to local roads from vehicles, including light vehicle and trucks
- road incidents with livestock and/or farm machinery crossing or using roads at slow speeds.

The need for heavy earthworks and compaction during construction will be minimised as much as practicable although some grading and levelling is likely to be required for the substation and Battery Energy Storage System (BESS).

2.9.2 Operation

During operation the main incompatibilities identified (without mitigation) are:

- inadequate management of invasive weeds and feral pests
- potential loss of local amenity and visual amenity (for passing motorists)
- altered bushfire risk profile for surrounding lands due to the presence of the Project.

2.9.3 Decommissioning

During and following decommissioning, the main risks identified (without mitigation) are:

- inadequate removal of infrastructure including commercial and industrial waste
- land is not left in an acceptable condition to be able to be utilised for agricultural production
- increased noise from vehicles (additional to what is reasonably expected from agricultural production) associated with decommissioning activities
- damage to local roads from vehicles, including light vehicle and trucks
- road incidents with livestock and/or farm machinery crossing or using roads at slow speeds, and
- dust generated by vehicles/machinery during decommissioning activities (such as site rehabilitation).

3.0 Land Use Conflict Risk Assessment

3.1 Introduction

The LUCRA assessment process based on the *Land Use Conflict Risk Assessment Guide* (DPI, 2011) utilises a 'probability and consequence' risk assessment matrix (**Table 3.1**) to estimate the potential for land use conflicts. It assesses the environmental, public health and amenity impacts according to the *probability of occurrence* and *consequence of the impact*.

Table 3.1 LUCRA Risk Rating Matrix

Consequence	Probability				
	A	B	C	D	E
1	25	24	22	19	15
2	23	21	18	14	10
3	20	17	13	9	6
4	16	12	8	5	3
5	11	7	4	2	1

The risk rating matrix yields a risk ranking from 25 to 1. It covers each combination of five levels of 'probability' (a letter A to E as defined in **Table 3.2**) and five levels of 'consequence', (a number 1 to 5 as defined in **Table 3.3**) to identify the risk ranking of each impact. For example an activity with a 'probability' of D and a 'consequence' of 3 yields a risk rank of 9.

Table 3.2 Probability Descriptions

Level	Descriptor	Description
A	**Almost Certain**	Common or repeating occurrence
B	**Likely**	Known to occur, or 'it has happened'
C	**Possible**	Could occur, or 'I've heard of it happening'
D	**Unlikely**	Could occur in some circumstances, but not likely to occur
E	**Rare**	Practically impossible

Table 3.3 Consequence Descriptions

Level	Descriptor	Description
1	**Severe**	• Severe and/or permanent damage to the environment. • Irreversible. • Severe impact on the community. • Neighbours are in prolonged dispute and legal action involved.
2	**Major**	• Serious and/or long-term impact to the environment. • Long-term management implications. • Serious impact on the community. • Neighbours are in serious dispute.
3	**Moderate**	• Moderate and/or medium-term impact to the environment and community. • Some ongoing management implications. • Neighbour disputes occur.
4	**Minor**	• Minor and/or short-term impact to the environment and community. • Can be effectively managed as part of normal operations. • Infrequent disputes between neighbours.
5	**Negligible**	• Very minor impact to the environment and community. • Can be effectively managed as part of normal operations. • Neighbour disputes unlikely.

3.2 Initial Risk Identification and Risk Ranking

Table 3.4 contains an initial risk evaluation of activities that may cause potential land use conflict, and a risk rating generated in the absence of mitigation or management measures as described in **Section 2.8**.

Table 3.4 Initial Risk Evaluation

Activity	Identified Potential Conflict	Risk Rating (unmitigated)
Construction	Generation of dust on site due to site preparation and other construction related activities as well as increased traffic movements on unsealed roads which can impact human and environmental health.	8
Construction	Increased traffic movements to and from the Project Area resulting in traffic hazard for neighbouring land holders (including Ringwood and Wollara Road).	**17**
Construction	Excess noise generated during construction of the Project above relevant criteria – impacting amenity. Sources limited to increased vehicle movements from decommissioning traffic.	8
Construction	Land erosion as a result of construction activities resulting in sediment runoff entering nearby water bodies, impacting water quality and beneficial use of the water (irrigation or stock water).	8
Construction	Increased traffic volumes potentially impacting/degrading the physical condition of local roads, particularly Wollara Road, used to access the Project Area.	**17**

Activity	Identified Potential Conflict	Risk Rating (unmitigated)
Construction	Livestock entering the Project Area causing potential damage to infrastructure.	5
Construction	Possibility of vehicles during construction or operation being involved in an accident with livestock or farm machinery on roads.	9
Operation	Poor weed and invasive pest management on the Project Area that may spread or impact neighbouring land.	5
Operation	Loss of local amenity and visual amenity from the Project.	2
Operation	Increase bushfire risk from within the Project area due to mechanical failure.	**15**
Operation	Poorly maintained boundary fences resulting in livestock, native animals or pests accessing the Project Area or neighbouring land.	5
Decommissioning	Increased traffic volumes potentially impacting/degrading the physical condition of local roads, particularly Wollara Road, used to access the Project Area.	8
Decommissioning	Increased traffic movements to and from the Project Area resulting in traffic hazard for neighbouring land holders.	**13**
Decommissioning	Excess noise generated during decommissioning of the Project above relevant criteria – impacting amenity. Sources limited to increased vehicle movements from decommissioning traffic.	8
Decommissioning	Generation of dust on site due to site rehabilitation and other decommissioning related activities as well as increased traffic movements on unsealed roads which can impact human and environmental health.	5
Decommissioning	Inadequate removal of infrastructure including commercial and industrial wastes.	9
Decommissioning	Land is not in an acceptable condition to be able to be utilised for agricultural production following decommissioning.	9

3.3 Risk Mitigation Measures

A range of risk management strategies (mitigation measures) have been identified in **Table 3.5** to reduce the risk rating of the land use incompatibilities highlighted in **Table 3.4**, and thus reduce the risk associated with land use conflicts for the Project.

It is to be noted that in some instances the risk profile will not reduce further, despite appropriate and significant mitigation measures being applied. This is in principle due to the risk probability being at its lowest pre-mitigation measure application, with neither the risk probability or consequence able to reduce further following mitigation measures being applied.

Table 3.5 Revised Risk Rating

Activity	Identified Potential Conflict	Risk Rating (unmitigated)	Risk Reduction Management Strategy (mitigation measures)	Risk Rating (mitigated)	Performance Target
Construction	Generation of dust on-site and increased traffic movements along internal unsealed tracks resulting in dust generation which can impact human and environmental health.	**8**	The management of dust impacts will be detailed in the Construction Environmental Management Plan (CEMP). As part of the CEMP, develop and implement protocols to minimise the air emissions during construction, including: • Water suppression on exposed areas, unsealed roads and stockpile areas when required (if visible dust emissions are observed). • The location and scale of activities which generate dust emissions would be modified and limited during periods of dry and windy weather. • Engines to switch off when not in use for prolonged periods. • Development of a complaints procedure to promptly identify and respond to complaints. • Once construction has been completed, establish and maintain ground cover in accordance with the OEMP.	**5**	No exceedances of adopted dust criteria.
Construction	Noise generated during the construction of the solar farm, above relevant criteria – impacting human amenity. Sources primarily associated with increased vehicle movements to and from site but can include earth moving equipment and physical construction of the PV panels.	**8**	• Preparation and implementation of a *Noise and Vibration Management Plan* for the Project. The plan will include details on measures to mitigate noise during the construction, operational and decommissioning phase of the Project. • Ensure potentially affected sensitive receivers have access to a site contact to report noise issues and are consulted as to the potential noise from the Project. • Ensure noise does not exceed the criteria in the adopted *Interim Construction Noise Guidelines* (DECC 2009). • Reduce speed of vehicles accessing the site (covered in the NVMP). • Noise impacts are anticipated to be temporary and manageable, with agreed construction hours.	**5**	No exceedances of the project noise trigger levels.
Construction	Increased traffic movements to and from the Project Area resulting in traffic hazard for neighbouring land holders.	**17**	• Preparation and implementation of a Traffic Management Plan (TMP) in consultation with Transport for NSW and Upper Hunter Shire Council. • Ensure reduced speeds along affected roads. • Ensure construction workers are aware of the potential to encounter increased traffic. • Engagement with surrounding road user, including but not limited to agricultural land holders. • Ensure TMP includes safety inclusions surrounding children catching school buses.	**9**	No traffic incidents or near misses during construction that are directly related to the solar farm.
Construction	Land erosion as a result of construction activities resulting in sediment runoff entering nearby water bodies, impacting the surrounding landholder water quality and beneficial use of the water (irrigation or stock water).	**8**	• Preparation and implementation of the CEMP to ensure groundcover is maintained. • Given the method of construction, erosion is expected to be limited and manageable. • Erosion sediment control plans developed as part of the CEMP. • Groundcover would be reinstated as soon as practicable following surface disturbance.	**5**	Groundcover is maintained where possible and practical. Identified erosion areas do not become further eroded with groundcover able to be maintained in reference to the site's CEMP.
Construction	Increased traffic volumes potentially impacting/ degrading the physical condition of local roads, particularly Wollara Road.	**17**	• Liaising with TfNSW, Upper Hunter Shire Council and key road users regarding the ongoing maintenance of Wollara Road during the construction phase to ensure the road surface are maintained. • Dilapidation surveys. • Road repairs and upgrades along Ringwood Road. • Reduced speed limits.	**9**	Any damaged or degraded roads caused by increased construction traffic is to be repaired in a timely fashion.
Construction	Livestock entering the solar farm site – causing potential damage to infrastructure.	**5**	• Install livestock proof boundary fence (perimeter 2.4 m chain link security fence or similar) and ensure boundary fence is maintained to a suitable standard by regular inspection of the fences. • If livestock enter the Project Area, the surrounding landowners should be contacted to ascertain who own the livestock. • Efforts should be made to ensure the animal is not distressed, and not let out onto public roads.	**3**	Fence repaired immediately following breach, and neighbours contacted immediately.
Construction	Possibility of vehicles during construction or operation being involved in an accident with livestock or farm machinery on roads.	**9**	• Preparation and implementation of a Traffic Management Plan highlighting the potential for livestock and or farm machinery (e.g. tractors) to be on or surrounding Wollara Road, including appropriate driving around livestock (e.g. reduce speeds when approaching and travelling past loose stock). • Increased number of road warning signs. • Reduction of speed limits in high-risk areas.	**5**	No incidents with livestock.

Activity	Identified Potential Conflict	Risk Rating (unmitigated)	Risk Reduction Management Strategy (mitigation measures)	Risk Rating (mitigated)	Performance Target
Operation	Poor weed and invasive pest management on the Project Area that may spread or impact neighbouring land.	**8**	• Preparation of an Operational Environmental Management Plan for the Project. The plan should detail the frequency of weed spraying required to manage targeted weed species, preferable completed by an external weed management contractor. • Vehicles entering and exiting the site are checked for invasive weed species, and have them removed if identified (e.g. with a stiff broom). • Feral animal management (trapping) to be used if required. • Once operational, re-introduction of sheep grazing to control weeds and maintain ground cover (within the Development Footprint only).	**3**	Invasive weed species are managed so that no weeds from the site spread. No complaints from neighbours. Feral animal populations are kept under control.
Operation	Loss of local amenity and visual amenity from solar farm.	**2**	• A landscaping plan will be prepared to minimise visual impacts of the Project. • PV panels will be constructed from low reflective material and in a manner that will minimise opportunity for glare and reflectivity for nearby viewers.	**2**	Implementation of the landscape plan within a reasonable time frame.

Operation	Increase bushfire risk from within the Project area due to mechanical failure.	**15**	• A Bushfire Emergency Management Plan will be developed and implemented for the Project in accordance with PBP 2019 and in consultation with the RFS. The plan will identify all relevant bushfire risks and mitigation measures associated with the construction and operation of the Project, including:
			  ○ detailed measures to prevent or mitigate fires igniting, outlining:
			  ○ APZ locations and management requirements
			  ○ access locations, passing bays and any alternate emergency access
			  ○ water supply and any other bush fire suppression systems (including any drenching systems, static water supply, natural water sources)
			  ○ work that should not be carried out during total fire bans.
			• Sheep grazing to control the amount of potential vegetation fuel under the panels (within the Development Footprint only).
			• Non-combustible fencing.
			• Roads will be maintained in the Project Area to allow for safe and accessible travel of emergency vehicles (if required).
			• Preventative maintenance of mechanical and electrical equipment.
				10	No fires caused by the construction, operation and decommissioning of the Project Area.

Operation	Poorly maintained boundary fences resulting in livestock or feral animals accessing the site or neighbouring land.	**2**	• Ensure boundary fence is maintained to a suitable standard. • Regular inspection of fences should be conducted to assess the condition of the fence, and any issues rectified as soon as practical.	**2**	Fences are repaired immediately following any identified damage.
Decommissioning	Increased traffic volumes potentially impacting / degrading the physical condition of local roads, particularly Wollara Road, used to access the Project Area.	**8**	• Liaising with TfNSW, Upper Hunter Shire Council and key road users regarding the ongoing maintenance of the Castlereagh Highway during the decommissioning phase to ensure the road surface are maintained. • Reduced speed limits.	**5**	Any damaged or degraded roads caused by increased traffic is to be repaired in a timely fashion.
Decommissioning	Increased traffic movements to and from the Project Area resulting in traffic hazard for neighbouring land holders.	**13**	• Preparation and implementation of a Traffic Management Plan in consultation with Transport for NSW and Upper Hunter Shire Council. • Ensure reduced speeds. • Ensure construction workers are aware of the potential to encounter increased traffic. • Engagement with surrounding road user, including but not limited to school bus routes and agricultural land holders.	**9**	No traffic incidents during decommissioning that are directly related to the solar farm.
Decommissioning	Noise generated during decommissioning of the Project above relevant criteria – impacting amenity. Sources include increased vehicle movements to and from the Project Area, earth moving equipment and physical dismantling of the PV panels, transmission line and substations.	**8**	• Continued implementation of a Noise and Vibration Management Plan for the Project. The plan will include details on measures to mitigate noise during the construction, operational and decommissioning phase of the Project. • Ensure potentially affected sensitive receivers have access to a site contact to report noise issues and are consulted as to the potential noise from the Project. • Ensure noise does not exceed the criteria in the adopted *Interim Construction Noise Guidelines* (DECC 2009). • Reduce speed of vehicles accessing the site (covered in the NVMP). • Noise impacts are anticipated to be temporary and manageable, with agreed construction hours.	**5**	No exceedances of the project noise trigger levels.

Activity	Identified Potential Conflict	Risk Rating (unmitigated)	Risk Reduction Management Strategy (mitigation measures)	Risk Rating (mitigated)	Performance Target
Decommissioning	Generation of dust on site(s) due to site rehabilitation and other decommissioning related activities as well as increased traffic movements on unsealed internal tracks and on the unsealed Wollara Road which can impact human and environmental health.	**5**	The management of dust impacts will be detailed in a Decommissioning and Rehabilitation Management Plan (DRMP) for the decommissioning phase. As part of the relevant EMP, develop and implement protocols to minimise the air emissions during construction, including: • Water suppression on exposed areas and unsealed internal access roads when required (if visible dust emissions are observed). • The location and scale of activities which generate dust emissions would be modified and limited during periods of dry, hot and windy weather. • Engines to switch off when not in use for prolonged periods. • Development of a complaints procedure to promptly identify and respond to complaints. • Once decommissioning has been completed, (re)establish and maintain ground cover in accordance with the EMP.	**3**	No exceedances of adopted dust criteria.
Decommissioning	Inadequate removal of infrastructure including commercial and industrial wastes.	**9**	• Removal of infrastructure and remediation of project area to an agreed standard is stipulated in land contracts with project landowners. • Removal of infrastructure and remediation of project area will be a condition of project approval/ consent. • The adequacy of removal will be as required through relevant legislation, such as the POEO Act 1997 prior to returning the site back to the landowners.	**6**	All project wastes are removed from the decommissioned Solar Farm. Materials are recycled where feasible and practical.
Decommissioning	Land is not in an acceptable condition to be able to be utilised for agricultural production.	**9**	• Development of a Rehabilitation Management Plan (RMP) prior to decommissioning which ensures the Project Area will be rehabilitated to a condition that it was in previous to the construction of the Solar Farm.	**6**	Rehabilitation completed to the criteria identified in the RMP

3.4 Key Potential Land Use Conflicts

Following a review of the potential land use conflict risk identified in **Table 3.4** and **Table 3.5,** the key potential land use conflicts that have been identified are discussed below. Additionally, the land use conflicts identified are highlighted in the technical assessment reports appended to the EIS.

3.4.1 Traffic

Road Upgrades

Prior to the construction of the solar farm, road repairs and upgrades on Ringwood Road would be completed. These works include upgrades to culverts at Bow River and Killoe Creek located on Ringwood Road and the widening and resealing of 1.8 km of Ringwood Road between Bow River and Killoe Creek. These works would impact vehicles that travel on these roads (through delays), however the impacts are anticipated to be minor given the low volume of traffic using this road. Road repairs and upgrades would be completed prior to the commencement of the construction of the solar farm. Further details on these upgrades including mitigation and management measures are provided in the *Traffic and Transport Impact Assessment* (Turnbull Engineering, 2022).

Neighbouring Landholder Hazard

The construction period is expected to generate the largest increase in traffic accessing the Project Area, with management strategies to mitigate potential conflicts with surrounding landholders outlined in the *Traffic and Transport Impact Assessment* (Turnbull Engineering, 2022) and a subsequent *Traffic Management Plan* (to be developed).

Following mitigation measures being implemented (as discussed in **Table 3.5**), the potential for conflict with surrounding landholders due to increased traffic volumes generated during the construction phase of the Project are considered low. Prior to the commencement of construction, a Traffic Management Plan (TMP) would be prepared in accordance with relevant guidelines and in consultation of TfNSW, Upper Hunter Shire Council, National Parks and Wildlife Service and any other relevant stakeholders. The TMP would outline how construction activities would avoid, mitigate and manage risks involving construction activities, users of the traffic and transport network and residents. This risk will further decrease during the operational phase, as the operation is only expected to employ approximately 10 full time employees. Workers using the Project Area route will be required to comply with the Project's Traffic Management Plan (for construction and operation) and local road rules.

Traffic Impacts to Local Road Conditions

During the construction phase, there is a risk that increased traffic volumes may impact on the physical condition of the access road (Wollara Road) resulting in land use conflicts. Various measures, including management practices, and physical measures such as road improvements will be implemented to mitigate these risks.

3.4.2 Bushfire Risk

Following the risk review and implementation of mitigation measures (refer to **Table 3.4** and **Table 3.5**), it was determined that although the likelihood of bushfire being started from within the Project Area from mechanical faults or other was inherently 'rare' (from the risk ranking matrix) , the consequence was major (from the measures of consequence table) with appropriate and extensive mitigation measures being implemented.

Lightsource bp will implement a *Bushfire Emergency Management Plan* and implement the mitigation measures such as positioning of BESS further than 80 m from vegetation, maintaining asset protection zones (APZs), controlling the amount of potential vegetation fuel under and surrounding the panels (through either mowing and/or sheep grazing), use of non-combustible fencing, sprinkler system set up, and maintaining access tracks within the Project Area to allow for safe and accessible travel of emergency vehicles (if required).

3.4.3 Dust

Dust generation during the construction of the Project is expected to occur. The main source of dust and air borne particulates are expected to be from traffic accessing the Project Area along Wollara Road (unsealed), construction activities (i.e. site preparation and minor earthworks), and vehicle movements over the Project Area along unsealed internal tracks.

The use of heavy vehicles, equipment and machinery would be largely limited to the construction period and emissions would be localised.

The nearest sensitive receiver is located approximately 3 km north of the Project Area off Wollara Road with substantial set back from Wollara Road (closest is 70 m). Given the temporary nature of the construction activities, the physical distance between the receiver and the Project, and Wollara Road, it is expected that any impacts from dust and exhaust emissions would be minimal.

With the implementation of air quality controls and mitigation measures consistent with the Construction Environmental Management Plan, it is expected that the construction and decommissioning activities would have a negligible impact on local air quality.

3.5 Limitations and Assumptions

The following limitations and assumptions have been made through the preparation of this report:

- The technical reports prepared by the technical specialists for the EIS are based on the same Project description and proposed Project Area.
- We have relied on information provided by the current landholders in the identified locations. Should these landholders change the views, engagement outcomes may also change.

3.6 Key Documents

The following documents have been prepared to support the EIS. The assessments are designed to identify and mitigate the potential environmental, social and economic impacts of the Project. The performance targets noted in **Table 3.5** are also in the assessments below.

- Water Resources Impact Assessment.
- Visual and Landscape Impact Assessment.
- Noise and Vibration Impact Assessment.
- Traffic Impact Assessment.
- Social Impact Assessment.
- Economic Impact Assessment.
- Biodiversity Impact Assessment.
- Preliminary Hazard Assessment.
- Historical Heritage Impact Assessment.
- Aboriginal Cultural Heritage Assessment.
- Land and Agricultural Impact Assessment.

To ensure compliance and establish performance monitoring of the mitigation and management strategies, the following management plans will be established:

- Construction Environmental Management Plan.
- Operational Environmental Management Plan.

The following standalone subplans would be incorporated into the CEMP and OEMP

- Noise and Vibration Management Plan.
- Biodiversity Management Plan (Aquatic and Terrestrial Ecology).
- Emergency Management Plan.
- Heritage Management Plan (Aboriginal and Historic Cultural Heritage).
- Traffic Management Plan (for construction and operation).
- Construction Soil and Water Management Plan (CSWMP).
- Waste Management Plan.
- Decommissioning and Rehabilitation Management Plan.

3.7 Conclusions and Recommendations

This assessment has examined the potential land use conflicts that may arise from the Project located near Merriwa NSW within the Upper Hunter LGA. It has considered three phases of the development including construction, operations, and decommissioning.

The Project is proposed to be constructed on land deemed to LSC 4 and LSC 6 land. The Project will change the land use from agricultural to electricity generation. As noted in this assessment, following construction, the Development Footprint is designed to be compatible with sheep grazing.

There are, however, land use conflicts that may arise through the development. A risk identification and ranking process has been undertaken in accordance with DPI Guidelines. Key risks include those associated with traffic during construction and decommissioning, and bushfire. The specialists' reports that have been developed to assess the impact for the EIS have recommended management/mitigation measures. Should these mitigation measures be implemented the potential impact of the change in land use on the surrounding land use and land users will be minimal. Additionally, following decommissioning the Project Area will be able to return to agricultural production at the predevelopment production capacity.

4.0 References

Bureau of Meteorology (2022), Climate statistics for Australian locations (bom.gov.au) 2022 (BoM, 2022).

Learmonth, R., Whitehead, R., Boyd, B., & Fletcher, S., (2007). *Living and Working in Rural Areas. A handbook for managing land use conflict issues on the NSW North Coast*, Centre for Coastal Agricultural Landscapes.

Kovac M. and Lawrie J.M., (1991). Soil Landscapes of the Singleton 1:250,000 Sheet map and report, Soil Conservation Service of NSW, Sydney.

NSW Department of Primary Industries (2011). *Land Use Conflict Risk Assessment Guide 2011* (LUCRA Guide, 2011).

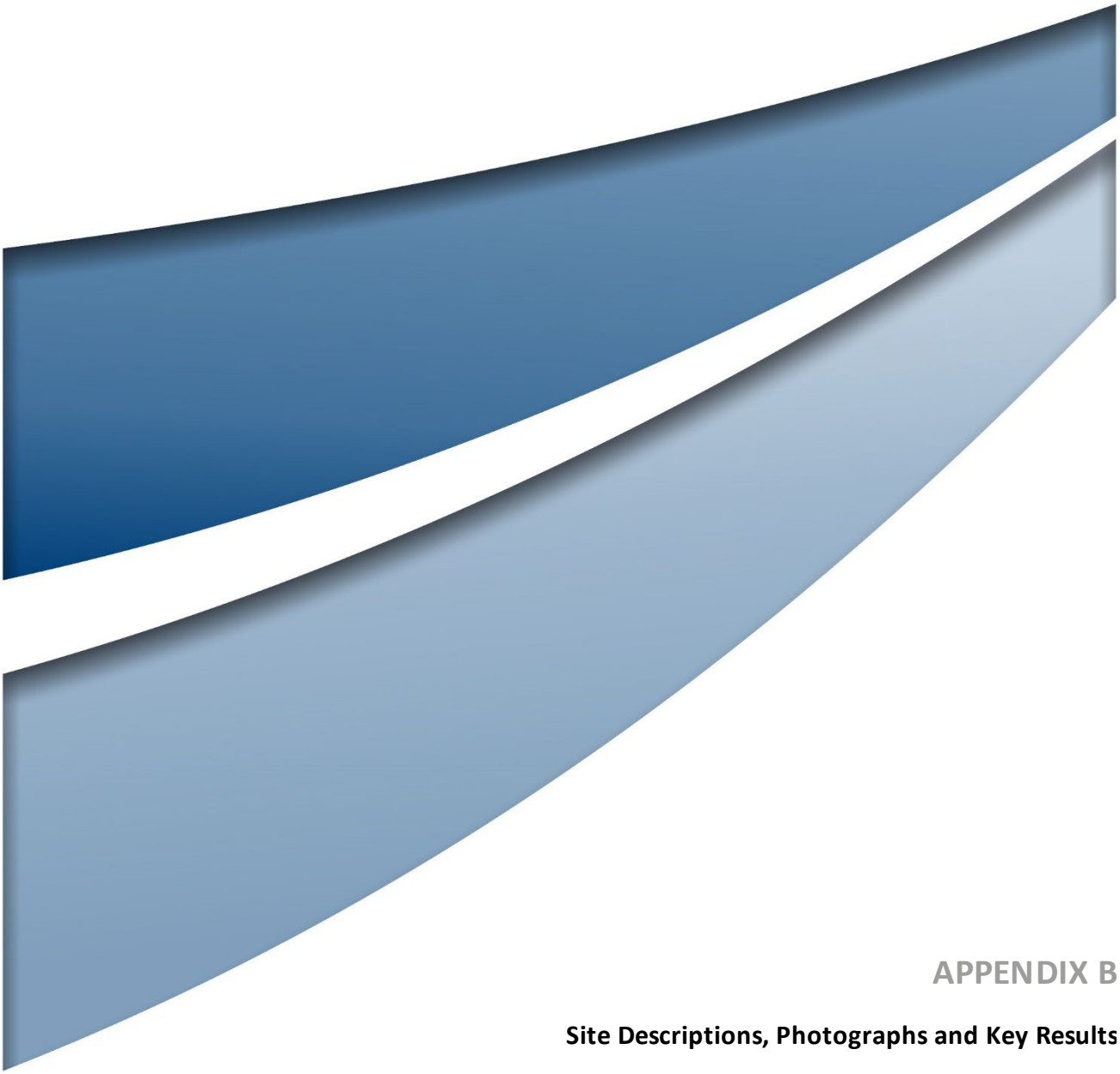
Landcom (2004). Managing Urban Stormwater: Soils and Construction (Landcom, 2004).

Interim Construction Noise Guidelines (2009). *Department of Environment & Climate Change NSW* (DECC, 2009).

Umwelt (2023). *Soils, Land Conflict and Agricultural Assessment*.

Umwelt (Australia) Pty Limited

T| 1300 793 267 E| info@umwelt.com.au www.umwelt.com.au



APPENDIX B

Site Descriptions, Photographs and Key Results

Description: Site 1 (GR01)					
Site Reference	GR01	**ASC Name**	Petroferric Eutrophic Brown Dermosols (mapped as Ferrosol)	**Coordinates**	
Average Slope	Gently Inclined (5%)	**Soil Fertility**	Moderate	**Lat:** -32.281371	**Lon:** 150.074942
Land Use	Agriculture (grazing)	**LSC Class**	4	**General observations**	
Landform Element	Lower Hillslope	**Micro-Relief**	None	Good vegetation cover; no pan presence	
Surface Condition	Grazing	**Vegetation**	Native and improved pastures		

Soil Horizon:	Depth (m)	Description
A1	0.0-0.1	Munsell Colour: Dark brown (7.5 YR 3/3), clayey silt with crumb structure, friable, low plasticity, nil course fragments and some roots detected. Moist and good drainage with loose consistency. Non-saline, non-sodic, slightly dispersive, slightly acid pH, and moderate CEC.
A2	0.2-0.3	Munsell colour: Dark brown (7.5 YR 3/4) clayey silt (more clay than A1) with crumb structure, friable, low plasticity, nil course fragments and some roots detected. Moist and good drainage with loose consistency. Non-saline, non-sodic, slightly dispersive, slightly acid pH, and moderate CEC.
A22	0.3-0.45	Munsell colour: Strong brown (7.5 YR 4/6), sandy clay/loam with crumb structure, high firmness and low strength and sticky. Low percentage of fine gravel, and minor roots detected. Moist and fair drainage with loose consistency. Non-saline, non-sodic, slightly dispersive, slightly acid pH, and high CEC.
B1	0.45-0.55	Munsell Colour: Strong brown (7.5 YR 4/6), clay with massive structure, firm with high strength. Nil course fragments and nil roots. Moist with poor drainage and rigid consistency. Non-saline, non-sodic, negligible/aggregated dispersibility, slightly alkaline pH, and high CEC.
B2	0.7-1.2	Brown to grey, red, silty clay with massive structure, mottled and gleyic. Firm, strong, low stickiness, medium plasticity. Minor basalt fragments and no roots detected. Moist and poor drainage. No sample.

Key Results of Analysis

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$		CEC	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.073	Non-saline	1.48	Non sodic	3	Slightly dispersive	6.20	Slightly Acid	13.6	Moderate
0.2-0.3	0.032	Non-saline	2.25	Non sodic	3	Slightly dispersive	6.27	Slightly Acid	9.4	Moderate
0.3-0.45	0.022	Non-saline	1.6	Non sodic	3	Slightly dispersive	6.82	Slightly Acid	17.6	High
0.45-0.55	0.032	Non-saline	1.90	Non sodic	4	Negligible / aggregated	7.05	Slightly Alkaline	22.5	High

Photo 1 – Site 1 Landscape (facing northeast)

Photo 2 – Landscape (facing south)

Photo 3 – Soil Profile

Photo 4 – Surface (lower layers)

Description: Site 2 (GR02)					
Site Reference	GR02	**ASC Name**	Petroferric Eutrophic Brown Dermosols (mapped as Dermosols)	**Coordinates**	
Average Slope	Gently Inclined (5%)	**Soil Fertility**	Low	**Lat:** -32.282808	**Lon:** 150.078611
Land Use	Agriculture (grazing)	**LSC Class**	4	**General observations**	
Landform Element	Hillslope	**Micro-Relief**	None	Pasture used for open grazing with mix of improved pasture and native vegetation. No pan and 100% ground cover observed.	
Surface Condition	100% ground cover	**Vegetation**	Native and improved pastures		

Soil Horizon:	Depth (m)	Description
A1	0.0-0.15	Munsell Colour: very dark brown (7.5YR 2.5/3), silty with granular structure, low firmness, and strength. Not sticky and low plasticity. Low percentage of course fragments and roots present. Moist, free drainage with loose to medium consistency. Non saline, slightly sodic and dispersion can only occur under raindrop impact in surface soils, slightly dispersive, strongly acidic pH and moderate CEC.
B1	0.15 -0.7	Munsell colour: strong brown (7.5YR 3/4) clayey silt with massive structure, firm, and strong, low stickiness, medium plasticity. Low percentage of course fragments and some roots detected. Moist and medium consistency. Non saline, slightly sodic, moderately dispersive, slightly alkaline pH and moderate CEC.
B2	0.7 – 1.2	Brown to grey, red, silty clay with massive structure, mottled and gleying. Firm, strong, low stickiness, medium plasticity. Low level of basalt fragments and no roots detected. Moist and poor drainage. No sample.

Key Results of Analysis

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$		CEC	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
0–0.1	0.033	Non-saline	3.1	Slightly sodic	3	Slightly dispersive	5.45	Strongly Acid	6.4	Moderate
0.15–0.2	0.022	Non-saline	4.0	Slightly sodic	2	Moderately dispersive	7.33	Slightly Alkaline	6	Moderate

Photo 5 – Site Landscape (facing northeast)

Photo 6 – Landscape (facing southwest)

Photo 7 – Soil Profile

Photo 8 – Test Pit and Landscape (facing northwest)

Description: Site 3 (GR03)					
Site Reference	GR03	**ASC Name**	Humose Mottled Dermosol (mapped as Dermosols)	**Coordinates**	
Average Slope	Sloped (9%)	**Soil Fertility**	Low	**Lat:** -32.284563	**Lon:** 150.082354
Land Use	Agriculture (grazing)	**LSC Class**	6	**General observations**	
Landform Element	Hillslope	**Micro-Relief**	None	Pasture used for open grazing with mix of improved pasture and native vegetation.	
Surface Condition	100% ground cover	**Vegetation**	Native and improved pastures		

Soil Horizon:	Depth (m)	Description
A1	0.0-0.1	Munsell Colour: Dark brown (7.5YR 3/4), coarse sandy silt, low firmness and strength with some stickiness and low plasticity. Low levels of fine gravel and roots detected. Moist, well drained, and loose consistency. Non-saline, sodic, slightly dispersive, moderately acid pH, and low CEC.
A2	0.1-0.2	Munsell Colour: Strong brown (7.5YR 4/6), silty clay with massive structure, firm and strong with medium plasticity with some stickiness. Some small stone fragments and low level of roots detected. Moist, poor drainage, and rigid consistency. Non-saline, sodic, moderately dispersive, slightly acid pH, and moderate CEC.
B1	0.4-0.5	Munsell Colour: Yellowish brown (10YR 5/4) with 40% yellowish red (5YR 4/6) and 1% olive yellow (2.5Y 6/6) mottling, gravely clay with massive structure, medium firmness and strength and medium plasticity. Low level of roots detected and no course fragments. Wet and perched water discovered at 0.85m, poor drainage, and medium consistency. Non-saline, strongly sodic, moderately dispersive, moderately alkaline pH, and moderate CEC.

Key Results of Analysis

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$		CEC	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.041	Non-saline	6.6	Sodic	3	Slightly dispersive	5.63	Moderately Acid	5	Low
0.1-0.2	0.038	Non-saline	8.1	Sodic	2	Moderately dispersive	6.23	Slightly Acid	5.6	Moderate
0.4-0.5	0.114	Non-saline	26	Strongly Sodic	2	Moderately dispersive	8.65	Moderately Alkaline	11	Moderate

Photo 9 – Site 3 Landscape (facing southeast)

Photo 10 – Landscape (facing northeast)

Photo 11 – Soil Profile

Photo 12 – Landscape (facing north west)

Description: Site 4 (GR04)					
Site Reference	GR04	**ASC Name**	Petroferric Eutrophic Red Dermosol	**Coordinates**	
Average Slope	Sloped (15%)	**Soil Fertility**	High	**Lat:** -32.288633	**Lon:** 150.083317
Land Use	Agriculture (grazing)	**LSC Class**	6	**General observations**	
Landform Element	Maximum upper slope	**Micro-Relief**	None	100% grazing grass vegetation cover with open grazing near roadway. Hilly area.	
Surface Condition	100% ground cover	**Vegetation**	Native and improved pastures		

Soil Horizon:	Depth (m)	Description
A1	0.0-0.1	Munsell Colour: Dark reddish brown (5YR 3/2), silt with granular structure, low firmness and strength, with no stickiness or plasticity. High levels of basalt rock fragments and roots detected. Moist, free drainage, and loose consistency. Non-saline, non-sodic, slightly dispersive, moderately acid pH, and high CEC.
B1	0.2-0.3	Munsell Colour: Yellowish red (5YR 4/6), clay with massive structure, high firmness and strength and sticky with high plasticity. Fine to medium rock fragments and low levels of roots detected. Moist, poor drainage with rigid consistency. Non-saline, non-sodic, negligible dispersiveness, moderately alkaline pH, and high CEC.
B2	0.6-0.9	Light red with grey sandstone and massive structure, clay with weathered rock, medium strength and medium to high firmness. Low stickiness and plasticity. Nil roots detected and weathered rock fragments approx. 10mm detected. Moist and medium consistency. No sample.

Key Results of Analysis

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$		CEC	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
A1	0.100	Non-saline	2	Non sodic	3	Slightly dispersive	5.72	Moderately Acid	19	High
B1	0.174	Non-saline	2	Non sodic	4	Negligible / aggregated	8.25	Moderately Alkaline	47	High

Photo 13 – Site 4 Landscape (facing northwest)

Photo 14 – Landscape (facing south towards rock outcrop)

Photo 15 – Soil Profile

Photo 16 – Excavated soil showing high rock content

Description: Site 5 (GR05)					
Site Reference	GR05	**ASC Name**	Brown Petroferic Eutrophic Ferric Sodic Dermosol	**Coordinates**	
Average Slope	Gently Inclined (6%)	**Soil Fertility**	High	**Lat:** -32.295364	**Lon:** 150.088590
Land Use	Agriculture (grazing)	**LSC Class**	4	**General observations**	
Landform Element	Rolling, undulating hill	**Micro-Relief**	None	Good vegetation cover with some surface rock	
Surface Condition	100% ground cover.	**Vegetation**	Native and improved pastures		

Soil Horizon:	Depth (m)	Description
A1	0.0-0.1	Munsell Colour: Very dark brown (7.5YR 2.5/3), silty loam with massive structure, low firmness and strength with no stickiness or plasticity. Large gravel fragments present and high level of roots detected. Moist, free drainage and loose consistency. Non-saline, slightly sodic and dispersion can only occur under raindrop impact in surface soils, slightly dispersive, slightly acid pH, and high CEC.
B1	0.2-0.32	Munsell Colour: Dark reddish brown (5YR 3/4), loose clay with massive structure, very firm and very strong and rigid with medium stickiness and plasticity. Gravel fragments throughout increasing with depth and some roots detected. Moist, medium drainage and rigid consistency. Non-saline, sodic, slightly dispersive, moderately alkaline pH, and high CEC.
B2	0.9-1.1	Light brown, firm gravely clay with massive structure, high firmness and strength, sticky with high plasticity. High levels of basalt gravel fragments and nil roots detected. Moist, free drainage, and rigid consistency. No sample.

Key Results of Analysis

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$		CEC	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.054	Non-saline	3.2	Slightly sodic	3	Slightly dispersive	6.48	Slightly Acid	26.6	High
0.2-0.3	0.067	Non-saline	8.5	Sodic	3	Slightly dispersive	8.25	Moderately Alkaline	39.7	High

Photo 17 – Site 5 Landscape (facing northeast)

Photo 18 – Landscape (facing southwest)

Photo 19 – Soil Profile

Photo 20 – Excavated soil material

Description: Site 6 (GR06)					
Site Reference	GR06	**ASC Name**	Mottled-Hypernatric Mesotrophic Brown Sodosol (mapped as Sodosols)	**Coordinates**	
Average Slope	Gently Inclined (5%)	**Soil Fertility**	Low	**Lat:** -32.294350	**Lon:** 150.093877
Land Use	Agriculture (grazing)	**LSC Class**	6	**General observations**	
Landform Element	Minimal mid slope	**Micro-Relief**	None	Rock present across surface, typically 'floating rock'.	
Surface Condition	100% ground cover	**Vegetation**	Native and improved pastures		

Soil Horizon:	Depth (m)	Description
A	0.0-0.15	Munsell Colour: Very dark brown (10YR 2/2), silt with massive structure, low firmness and strength and loose with no stickiness or plasticity. Some stone fragments present, and roots detected. Moist and free drainage. Non-saline, sodic, negligible/aggregated dispersiveness, moderately acid pH, and moderate CEC.
B1	0.15-0.25	Munsell Colour: Yellowish brown (10YR 5/4) with strong brown (7.5YR 5/6) mottling, silty clay, firm and strong with medium stickiness. Some minor gravel fragment and roots detected. Moise, medium drainage, and rigid consistency. Non-saline, sodic, moderately dispersive, slightly acid pH, and moderate CEC. Gleying evident.
B2	0.3-0.4	Munsell Colour: Pale brown (10YR 6/3), firm clay, high firmness and strength. No gravel fragments and no roots detected. High moisture content, poor drainage and rigid consistency. Gleying evident. Non-saline, strongly sodic, moderately dispersive, strongly alkaline pH, and high CEC.

Key Results of Analysis

Sample Depth	ECe		ESP		EAT		$pH_{(1-5water)}$		CEC	
	dS/m	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
0.0-0.1	0.037	Non-saline	8.0	Sodic	4	Negligible / aggregated	5.98	Moderately Acid	7.0	Moderate
0.15-0.25	0.051	Non-saline	10.5	Sodic	2	Moderately dispersive	6.62	Slightly Acid	15.0	Moderate
0.3-0.4	0.447	Slightly saline	22.3	Strongly Sodic	2	Moderately dispersive	9.09	Strongly Alkaline	32.0	High