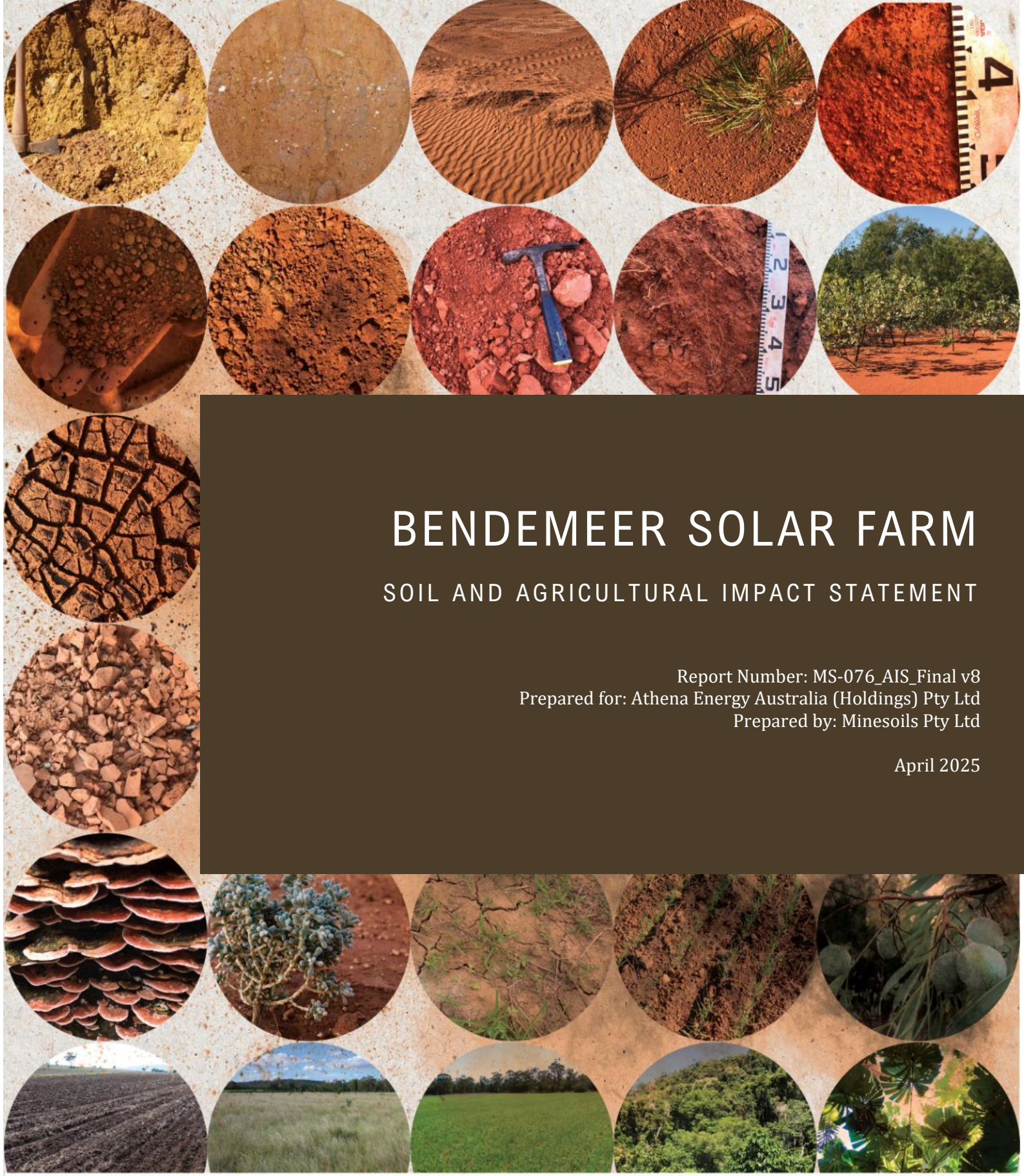
APPENDIX J UPDATED SOIL AND AGRICULTURAL IMPACT ASSESSMENT



BENDEMEER SOLAR FARM

SOIL AND AGRICULTURAL IMPACT STATEMENT

Report Number: MS-076_AIS_Final v8
Prepared for: Athena Energy Australia (Holdings) Pty Ltd
Prepared by: Minesoils Pty Ltd

April 2025

MINESOILS
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DOCUMENT CONTROL

Reference	Date	Prepared by	Approved
MS-079_ Draft 1	12 December 2022	Matt Hemingway and Clayton Richards	Clayton Richards
MS-079_ Draft 2	22 December 2022	Matt Hemingway and Clayton Richards	Clayton Richards
MS-079_ Draft 3	6 March 2023	Matt Hemingway and Clayton Richards	Clayton Richards
MS-079_ Draft 4	20 April 2023	Matt Hemingway and Clayton Richards	Clayton Richards
MS-079_ Final	29 May 2023	Matt Hemingway and Clayton Richards	Clayton Richards
MS-079_ Final v2	6 June 2023	Matt Hemingway	Clayton Richards
MS-079_ Final v3	9 June 2023	Matt Hemingway	Clayton Richards
MS-079_ Final v4	3 July 2023	Matt Hemingway	Clayton Richards
MS-079_ Final v5	20 November 2023	Matt Hemingway	Clayton Richards
MS-079_ Final v6	30 January 2025	Matt Hemingway	Matt Hemingway
MS-079_ Final v7	27 March 2025	Matt Hemingway	Matt Hemingway
MS-079_ Final v8	4 April 2025	Matt Hemingway	Matt Hemingway

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1. INTRODUCTION

1.1 OVERVIEW

Minesoils Pty Ltd (Minesoils) was engaged by ERM Australia Pty Ltd (ERM) to conduct a Soil and Agricultural Impact Assessment of the Bendemeer Solar Farm (the Project) for Athena Energy Australia (Holdings) Pty Ltd (the Applicant). The baseline soil and agriculture resources are detailed within this report. The impacts on these resources from the proposed construction, operation and decommissioning phases of the Project are addressed in this report in accordance with relevant regulatory requirements and guidelines.

This report supports a State Significant Development (SDD) Development Consent approval under Part 4, Division 4.7 of the *Environmental Planning and Assessment Act 1979* (SSD-36651552), as part of the Amendment Report for the Project.

Secretary's Environmental Assessment Requirements (SEAR's) have been issued for the Applicant to address. The objective of this report is to address the following items included in the SEAR's for the Project:

- *A soil survey to determine the soil characteristics and consider the potential for erosion to occur; and*
- *A detailed assessment of the impact on agricultural resources and agricultural productivity, including:*

  - consideration of potential mitigation measures which may reduce project impacts on agricultural land; and

  - justification for the project considering other alternatives and site design which may have lesser impacts on agricultural land
- *Completion of a Land Use Conflict Risk Assessment in accordance with the NSW Department of Industry's Land Use Conflict Risk Assessment Guide (NSW DPI, 2011).*

The Bendemeer Solar Farm EIS was submitted to the (then) NSW Department of Planning and Environment (DPE; now Department of Planning, Housing and Infrastructure (DPHI)) and publicly exhibited between 27 July 2023 and 23 August 2023. Following the public exhibition of the EIS, a total of 244 submissions relating to the Project EIS were received from government agencies, local council, organisations and members of the public. A Submissions Report has been prepared to respond to matters raised in these submissions and agency advice, as well as an Amendment Report to assess impacts associated with the amended Project.

1.2 PROJECT DESCRIPTION

The Project will involve the construction, operation and decommissioning of a photovoltaic (PV) solar farm, Battery Energy Storage System (BESS) and associated infrastructure. The Project includes:

- Solar Arrays with a Capacity of approximately 255 megawatts (MW) Direct Current (DC) and registered connection capacity of 200 MW Alternating Current (AC);
- BESS with a capacity of up to 150 MW / 300 MWh;
- Electricity infrastructure:
  - Power Conversion Units (PCU) housing up to 60 inverters;
  - One 33/330 kV collector substation and associated internal structures;
  - Substation and switching station;
  - Electrical reticulation infrastructure including underground and overhead 33 kV cables;
  - Direct grid connection to existing 330 kV line 85 Armidale-Tamworth Transmission line;
- On-site permanent supporting infrastructure:
  - Site access road, entry and internal access tracks;

  - Operations and Maintenance (O&M) Facility including control room, meeting facilities, storage facilities, SCADA facilities, workshop, parking, ablutions buildings, septic, static water supply, waste management facilities, lighting and maintenance facility, fencing and asset protection zones;
- Off-site supporting infrastructure:
  - Tamworth waste and wastewater disposal facilities;
  - Existing public road network; and
- 24 hours a day, seven days per week operation with up to 15 Full Time Equivalent (FTE) personnel.

1.3 PROJECT AREA

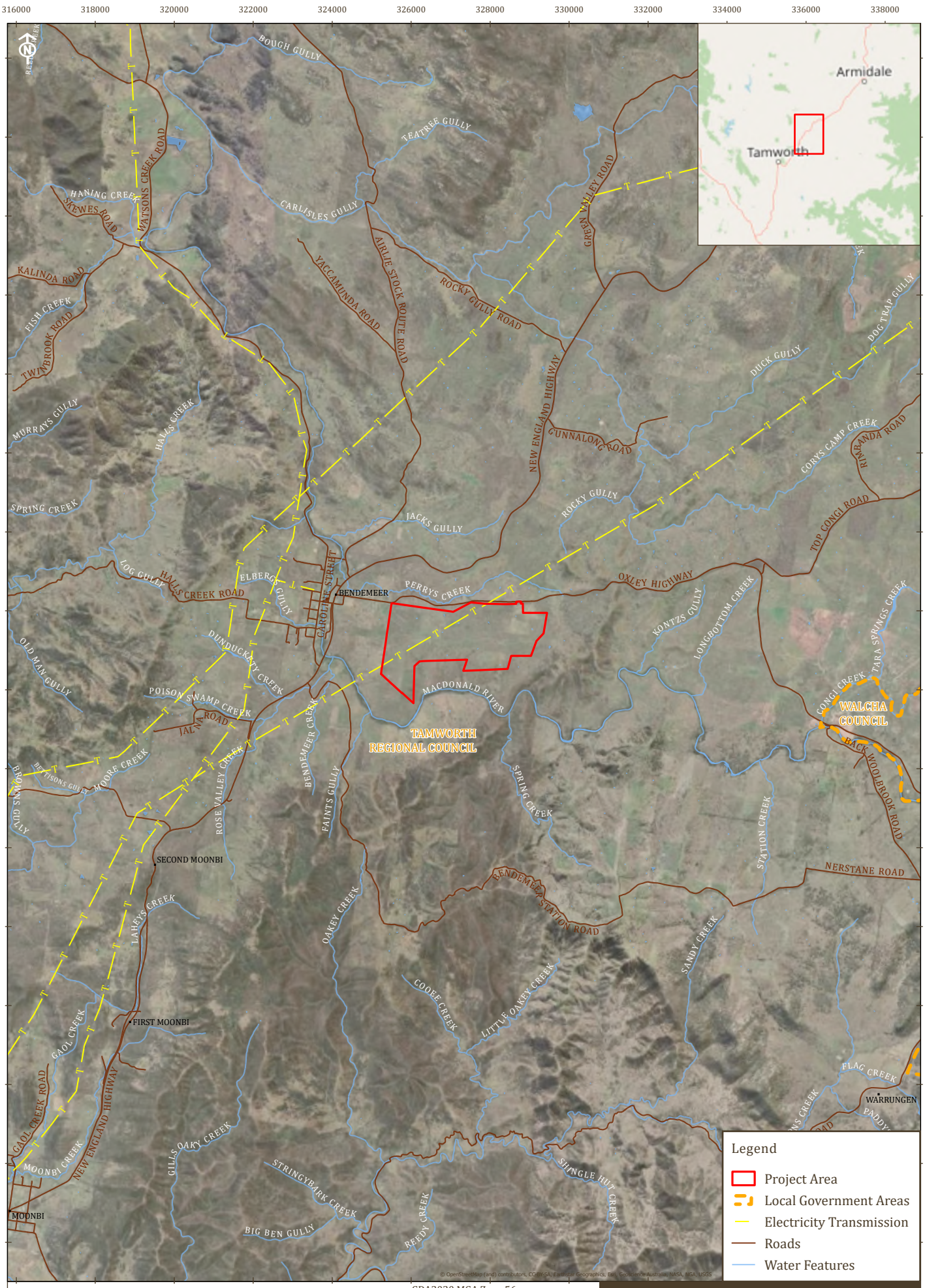
The Project Area is located approximately 1.8 kilometres (km) east of Bendemeer town centre, represented by the Bendemeer Hotel, and approximately 46 kilometres (by road) north-east of the Tamworth Post Office to the Project access. The Project is in the New England North West Region of NSW and covers an area of approximately 606.9 ha (refer **Figure 1**). The Amended Project Layout is shown in **Figure 2**. The Oxley Highway borders the Project Area to the north and the Macdonald River to the south.

The site has historically been utilised for agricultural practices with evidence of broad native vegetation modification resulting from extensive clearing and agricultural land use. Current land use consists of cattle and sheep grazing enterprises and is consistent with the Project locality (the local area equivalent to approximately 5km radius around the Project area).

It is anticipated that livestock grazing will continue throughout the operation of the solar farm, as a key land management tool, as well as to maintain agricultural production for the duration of the Project (approximately 30 years).

1.4 ASSESSMENT APPROACH

The assessment has been undertaken in accordance with the *Large-Scale Solar Energy Guidelines* (LSSE Guidelines) (NSW DPIE, 2022) which includes requirements to undertake a soil survey and verify land and soil capability (LSC) in accordance with *Land and Soil Capability Assessment Scheme* (LSC Scheme) (EOH 2012). The results of the site verification, as presented in Section 3.2, determined the level of agriculture impact assessment as Level 2 – Reduced, as per the LSSE Guidelines. The assessment requirement pathway is presented in **Figure 3**. The requirements for this level of assessment, and where these items are addressed in this report, are presented in **Table 1**.



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Project Locality

FIGURE 1

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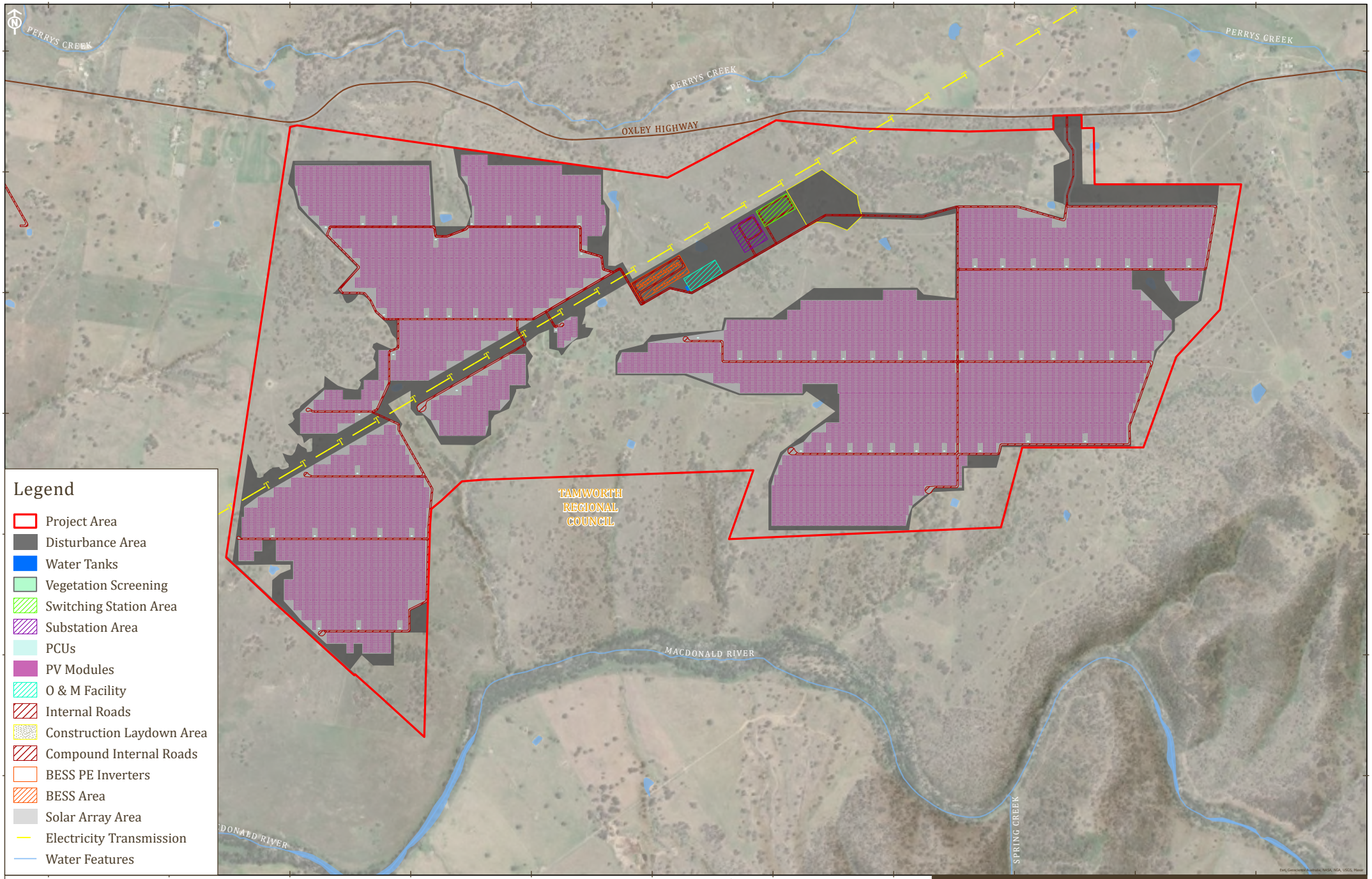

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GDA2020 MGA Zone 56

0 500 1000 1500 Meters

Scale 1:20,000 at A4

Project Area and Development Footprint

FIGURE 2

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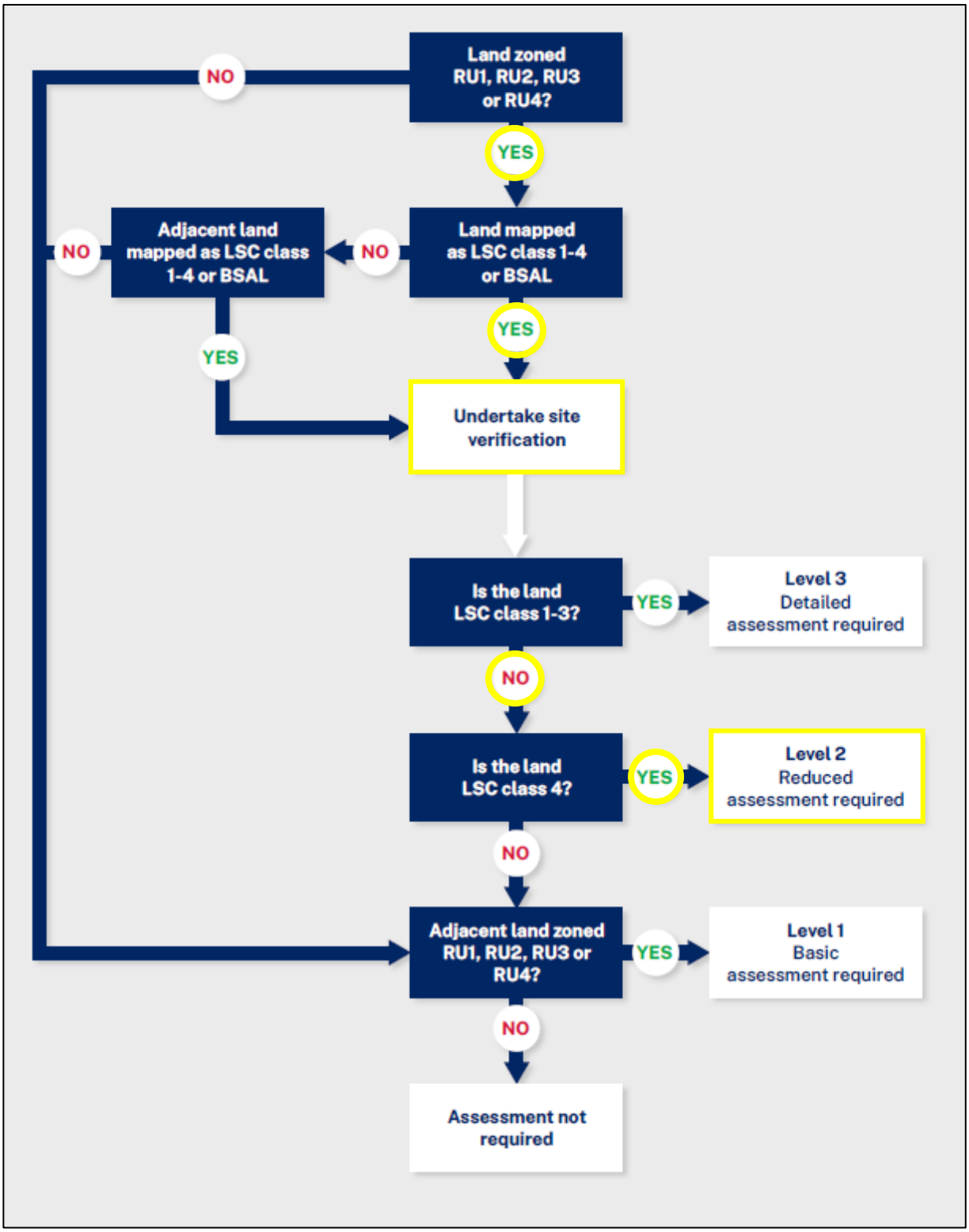
Figure 3. Agricultural Assessment Requirement Pathway



(NSW DPIE, 2022)

Table 1: Requirements of 'Level 2 - Reduced' Assessment and Section Addressed

Assessment	Content and form	Section Addressed
Project description Describe the nature, location, intensity and duration of the project and include a map of the project area.	• project description • areas of the site that would be disturbed or temporarily removed from agricultural use • location • duration	**1**
Regional context Describe the regional context.	• property zoning • climate and rainfall • regional landform • regional land use including any significant agricultural industries and/or infrastructure	**2**
Site characteristics and land use description Describe the nature and location of agricultural land with the potential to be impacted by the development. Describe the current agricultural status and productivity of the proposed development area and surrounding locality including the land capability as per Office of Environment and Heritage's (OEH) Land and Soil Capability Assessment Scheme.	• describe the land subject to the Project Area • describe existing agricultural land uses (i.e., orchards, vineyards, breeding paddocks, intensive livestock areas) • describe the history of agricultural practices on the Project Area • identify soil type, fertility, land and soil capability • provide a map showing the verified LSC class of the Project Area • provide a map showing topography of the site • describe the agricultural productivity of the site	**3**
LUCRA assessment Conduct an assessment of potential land use conflicts, including completion of an assessment in accordance with the Department of Industries' Land Use Conflict Risk Assessment Guide	• 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	**4** **(Appendix 1)**
Impacts on agricultural land Identify and describe the nature, duration and consequence of any potential impacts on agricultural land subject to the Project Area and in the wider region	• describe project impacts on identified agricultural productivity and enterprises including but not limited to livestock, cropping activities, orchard production., etc. • consider impacts to the agricultural land of the site • consider project potential to temporarily and/or permanently remove agricultural land and/or fragment or displace existing agricultural industries • consider cumulative impacts of multiple solar projects	**5**
Mitigation strategies Outline strategies which may be adopted to mitigate potential impacts on agricultural land and minimise land use conflict.	• 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	**6**

2 REGIONAL CONTEXT

2.1 ZONING

The Project Area is contained within Lots 1 - 3 of DP1211502 and is zoned as RU1 (Primary Production) under the *Tamworth Regional Local Environmental Plan 2010* (LEP) (refer **Figure 4**). The objectives of this 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 permit subdivision only where it is considered by the Council to be necessary to maintain or increase agricultural production.
- To restrict the establishment of inappropriate traffic generating uses along main road frontages.
- To ensure sound management of land which has an extractive or mining industry potential and to ensure that development does not adversely affect the extractive industry.
- To permit development for purposes where it can be demonstrated that suitable land or premises are not available elsewhere.

The *State Environmental Planning Policy (Transport and Infrastructure) 2021* (NSW) permits works relevant to those proposed for the Project, within the prescribed RU1 zone.

The Project is located within the New England Renewable Energy Zone (REZ). The New England REZ was chosen following a detailed state-wide geospatial mapping exercise undertaken by the NSW Government in 2018. This initial analysis sought to identify optimal locations to host renewable energy generation around the State, including areas with strong renewable energy resource potential, proximity to the existing electricity network, and consideration of potential interactions with existing land uses, including agricultural lands and biodiversity conservation.

2.2 CLIMATE AND RAINFALL

The New England North West region has a diverse range of climates from the cooler and more temperate Northern Tablelands through to the dryer and hotter North West Slopes and Plains in the west (NSW Office of Environment and Heritage, 2014).

In summer, average temperatures range from 16–18°C along the Great Dividing Range to 26–28°C in the north-west. In winter, average temperatures range from 4–6°C along the Great Dividing Range, to 12–14°C on the north-west plains. Average maximum temperatures in summer range from 36°C in the west of the region to 20°C along the higher areas of the New England Tablelands. The winter average minimum temperature ranges from –2–0°C on the Tablelands to 4–6°C on the north-west plains. The maximum summer and minimum winter temperatures increase away from the Great Dividing Range. The average monthly temperatures range from around 9°C in July to just over 23°C in January.

Rainfall varies considerably across the region. This variability is due to the complex interactions between regional weather patterns, the influence of larger-scale climate patterns such as El Niño Southern Oscillation and the topography of the Great Dividing Range and the north-west plains. Average annual rainfall ranges from 1200–1600 mm along parts of the New England Tablelands through to 400–800 mm on the North West Slopes and Plains. Rainfall decreases as you move west. More rain falls in summer than other seasons. Winter is the driest season with the plains west of Moree seeing less than 100 mm rain during June, July and August. The seasonal variations are uniform throughout the North West Slopes, which receives 100–200 mm during autumn, winter and spring, with more rainfall in summer (200–300 mm).

The closest Bureau of Meteorology (BOM) weather station to the Project Area is Woolbrook (055136). This station is located approximately 22 km south east of the site and has a data range from 1970 to present (BOM, 2022). The annual average rainfall is 779.1 mm, with the highest average rainfall of 191.6 mm falling in December, and the lowest average rainfall of 40.3 mm falling in April. Rain generally falls over approximately 85 days.

The annual average maximum temperature recorded at the station is 20.6°C and the annual average minimum temperature is 5.7°C. The highest average maximum temperature of 27.8°C is recorded in January, while the lowest average minimum temperature of -0.1°C is recorded in July.

2.3 REGIONAL LANDFORM

The New England North West region covers an area of 98,600 square kilometres. It comprises the Armidale, Glen Innes Severn, Gunnedah, Gwydir, Inverell, Liverpool Plains, Moree, Narrabri, Tamworth, Tenterfield, Uralla and Walcha LGAs. Landscapes in the region range from volcanic rainforest tablelands and cliffs in the east, to the highly productive broad floodplains on west-flowing rivers, including the Namoi, Gwydir and Macintyre, in the west.

The Project Area is part of the New England fold belt in the northeast of NSW and is composed of sedimentary rock of Carboniferous Permian age that were extensively faulted during a period of rapid continental plate movement associated with granite intrusions in the late Carboniferous age (**Figure 5**). Much of the bedrock within the region is now overlain by Tertiary basalt flows rarely exceeding 100 m in thickness that overlie river gravels and sands or lake sediment. In certain areas, the basalt has been eroded and exposed the underlying sedimentary layer. The geology has a considerable influence on the topography and vegetation of the landscape.

Extensive national parks occur along the escarpment and other large parks include Mount Kaputar and Torrington on the tablelands and the Pilliga Community Conservation Areas on the western plains; however, most other national parks in the region are small and scattered, and many ecosystem types are not represented in reserves.

The region's wetlands support a diversity of flora and fauna that mostly depend on fluctuating water regimes of wetting and drying. The region contains some major floodplain wetlands including the internationally significant Gwydir Wetlands (Gingham and Lower Gwydir [Big Leather] watercourses) and Little Llangothlin Lagoon.

2.4 REGIONAL LAND USE

2.4.1 AGRICULTURAL LAND USE

The region's population is over 176,000, with about half of the population living in the main urban areas of the region, including the two major regional centres of Armidale and Tamworth and the five major towns of Glen Innes, Inverell, Moree, Narrabri and Gunnedah.

The region plays a significant role in international exports of Australian agricultural products, containing several significant animal industries including sporting equine, cattle, poultry, sheep, wool and pig industries, as well as multiple large feedlots and abattoirs.

The New England North West region is part of the Murray–Darling Basin which covers approximately 100,000 square kilometres across Queensland, NSW, Victoria and South Australia. Productive agricultural land of the Murray Darling Basin occupies 67,000 square kilometres , or 67% (NSW Department of Planning and Environment, 2015). The most common land use by area is grazing which occupies approximately 70 % of agricultural land. The remaining productive land is mostly used for broadacre cropping and comprises approximately 30 % of the agricultural land area).

The New England North West region includes 13 local government areas (LGAs). For the Tamworth Regional LGA, in which the Project Area lies, 95% of the total LGA area of 729,929 ha is land mainly used for agricultural production (Australian Bureau of Statistics (ABS), 2022a).

The majority of the Tamworth Regional LGA area has been cleared for agricultural uses, with the main land use being cattle grazing. Rotational grazing of moderate stocking rates over large areas is a standard management practice for the area.

The area of land use for of the agricultural types for the Tamworth Regional LGA is presented in **Table 2**, which shows grazing activities represent 89 % of the agricultural land use, followed by cropping at 10 %, and forestry and other land uses totalling less than one per cent.

Table 2: Tamworth Regional LGA Agricultural Land Use 2020 – 2021 (ABS, 2022a)

Agricultural Land Use	Area	
	ha	%
Livestock Grazing	618,816	89
Cropping	70,719	10
Forestry	3,332	<1
Other	2,345	<1
Total	695,213	100

2.4.2 AGRICULTURAL ENTERPRISES

Employment in the Tamworth Regional LGA is driven by agribusiness and service industries, with a total 700 agriculture related businesses recorded in the 2020 – 2021 census. The Agriculture, Forestry and Fishing industry had the largest number of total registered businesses in Tamworth Regional Council, comprising 25.8% of all total registered businesses, compared to 6.5% in New South Wales (ABS, 2022).

The communities of the New England North West region have a high dependence on the success of agricultural production and related industry. The region's farmers have a demonstrated capacity to adapt to change, despite sharp falls in some commodities, falling terms-of-trade and seasonal challenges faced. The decline in the wool industry has led to an increased focus on sheep for meat throughout the region. It has also led to increased areas cropped and increasing areas dedicated to cattle production.

Increased focus on breeding and finishing sheep and cattle for domestic and export meat markets has been supported by a growth in feed-lotting, on farm feed-supplementation and high-capacity, technologically advanced meat-processing. Opportunities for increasing production and productivity have been seized in the region as agricultural production has diversified from agriculture dominated by grazing, to grazing and cropping and then further to include both intensive summer and winter cropping (including irrigation).

Beef cattle are now the established and dominant agricultural industry in the region. The industry defines the rural character of the region, contributes significantly to the economy and facilitates the ongoing management of rural resource lands.

Factors in favour of cattle grazing and the region's beef industry include the:

- Suitability of the climate, pasture types and landscape.
- Available service suppliers (e.g., produce merchants, contractors).
- Proximity to infrastructure (abattoirs, saleyards, transport etc) and a range of markets.
- Potential for higher returns from group marketing activities.

- Increasing adoption of Industry standards, such as Meat Standards Australia (MSA) grading, which provide a tool for producers to identify and differentiate their products.
- Strong international and domestic market prospects and the opportunity for professional beef producers to increase productivity and become more competitive.

ABS (2022b) data shows that livestock consist primarily of sheep and lambs, with both dairy and meat cattle. Pigs and poultry (chicken) represent a more limited agricultural land use by area. Lands used for cropping are dominated by cereals, including wheat, oats, and barley for grain. Cotton, oilseeds (canola), legumes (lentils, lupins) and cropping for hay and sileage is also common.

Gross value is a measure of size or net wealth generated by the local economy and can be measured by industry and enterprise. The gross value of agriculture for the Tamworth Regional LGA for 2020 – 2021 is estimated as $305,462,242 (ABS, 2022). **Table 3** highlights the dominance of livestock slaughter as 75% of the total gross value for agriculture in the LGA for 2020 – 2021. Within this category, cattle and calves represent 52% of the total value of livestock slaughter, as shown in **Table 4**, and 40% of the total agricultural gross value.

This data highlights the dominance of cattle grazing as the leading agricultural enterprise for the LGA, not just in terms of area of land used but also in terms of estimated gross value generated.

Table 3: Tamworth Regional LGA Agricultural Gross Value 2021 – 2022 by Enterprise (ABS, 2022b)

Agricultural Enterprise	Gross Value	
	$	%
Livestock slaughter	230,394,999	75
Cropping	41,987,458	14
Livestock Products	33,079,785	11
Total	**305,462,242**	**100**

Table 4: Tamworth Regional LGA Agricultural Gross Value 2021 – 2022 by Livestock Slaughter (ABS, 2022b)

Agricultural Enterprise	Gross Value	
	$	%
Cattle and Calves	120,620,367	52
Poultry	96,168,155	42
Sheep and Lambs	13,460,356	6
Pigs	96,604	<1
Other	49,517	<1
Total	**230,394,999**	**100**

At a scale of the locality, agricultural enterprises and land use surrounding the Project Area largely consist of cattle and sheep grazing on native and improved pastures, including the Nerstane Merino Stud approximately 5 kilometres south-east of the Project Area. A large portion of the locality to the south of the Project Area is uncleared native vegetation not subject to agriculture use. These areas are associated with partially cleared lands used for very low intensity grazing.

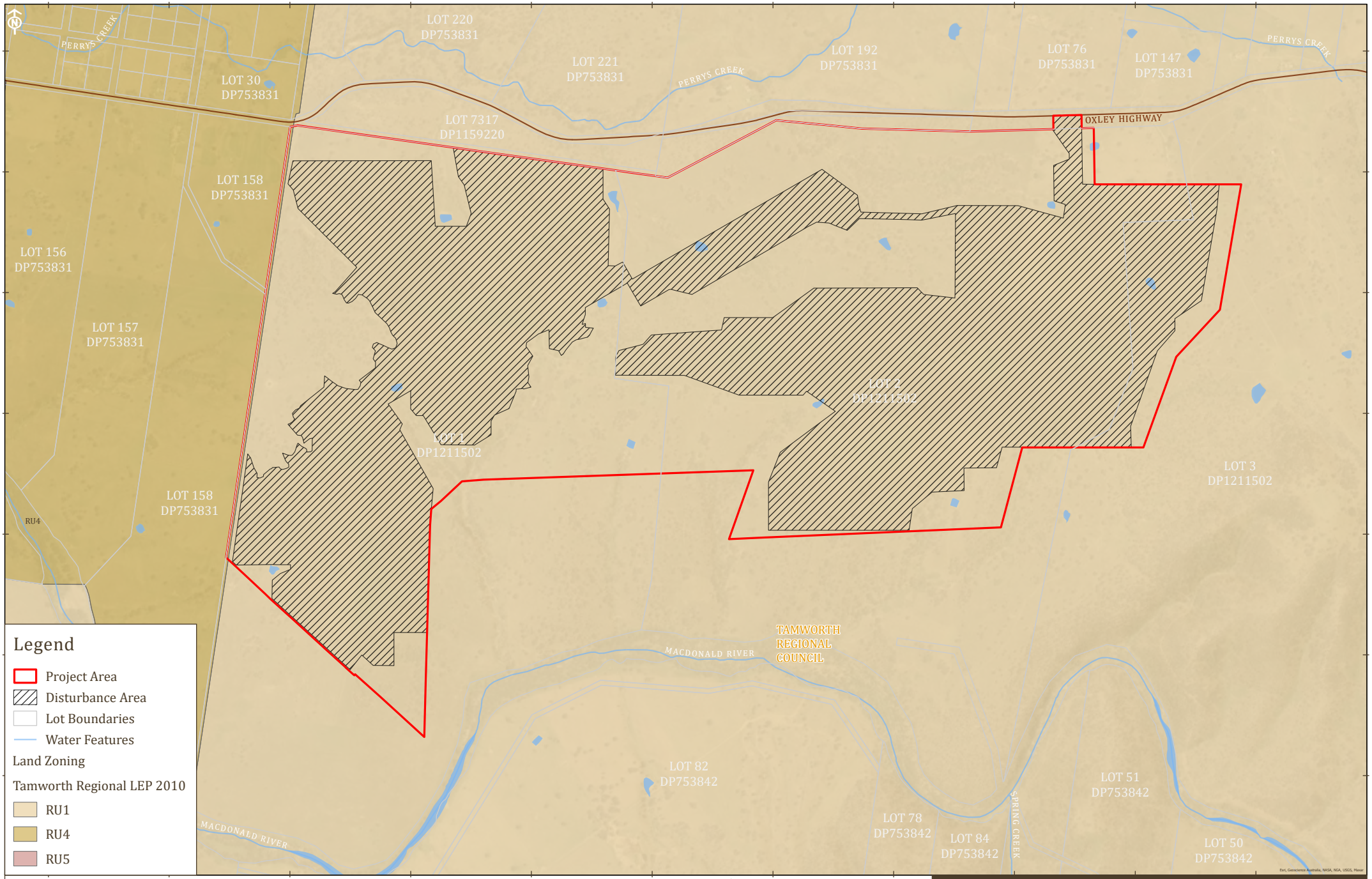
2.4.3 AGRICULTURAL INFRASTRUCTURE

The key infrastructure item assisting agricultural market access and cost of production is the transport network servicing the New England North West Region. Underlining the importance of this issue, total freight costs from farm to port can be as much as 30% of the value of the crop being marketed depending on Australian and world commodity prices in each season. The region is well serviced with rail access into the main NSW bulk shipping port at Newcastle, and two key highways in the region, the Newell Highway and the New England Highway, have both been beneficiaries of significant upgrades in the last 30 years enabling safer and faster travel times for an increasing proportion of agricultural freight along these key routes.

In proximity to the Project Area, the large agricultural service centres of Tamworth (approximately 46 km via road to the south west) and Armidale (approximately 70 km north east) allow access to businesses providing agricultural equipment and supplies, including animal fencing, animal vaccinations, livestock ID, stock supplements, seed, fertiliser and crop protection.

The Tamworth Regional Livestock Exchange is located approximately 45 km south west of the Project Area and is one of NSW's strongest store markets, drawing livestock from as far south as Dubbo, the Hunter Valley and as far North as Tenterfield and Goondiwindi.

Other infrastructure critical to agricultural production include energy needs (gas and electricity), telecommunications services, irrigation water infrastructure and urban water and wastewater services. General agricultural improvements such as stock fences, shedding, dams and access tracks are widespread throughout the locality, which reflects the historical and current development of the local lands for livestock grazing.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LOT 51
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Disturbance Area
Lot Boundaries
Water Features
Land Zoning
Tamworth Regional LEP 2010
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RU4
RU5
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Land Zoning
FIGURE 4
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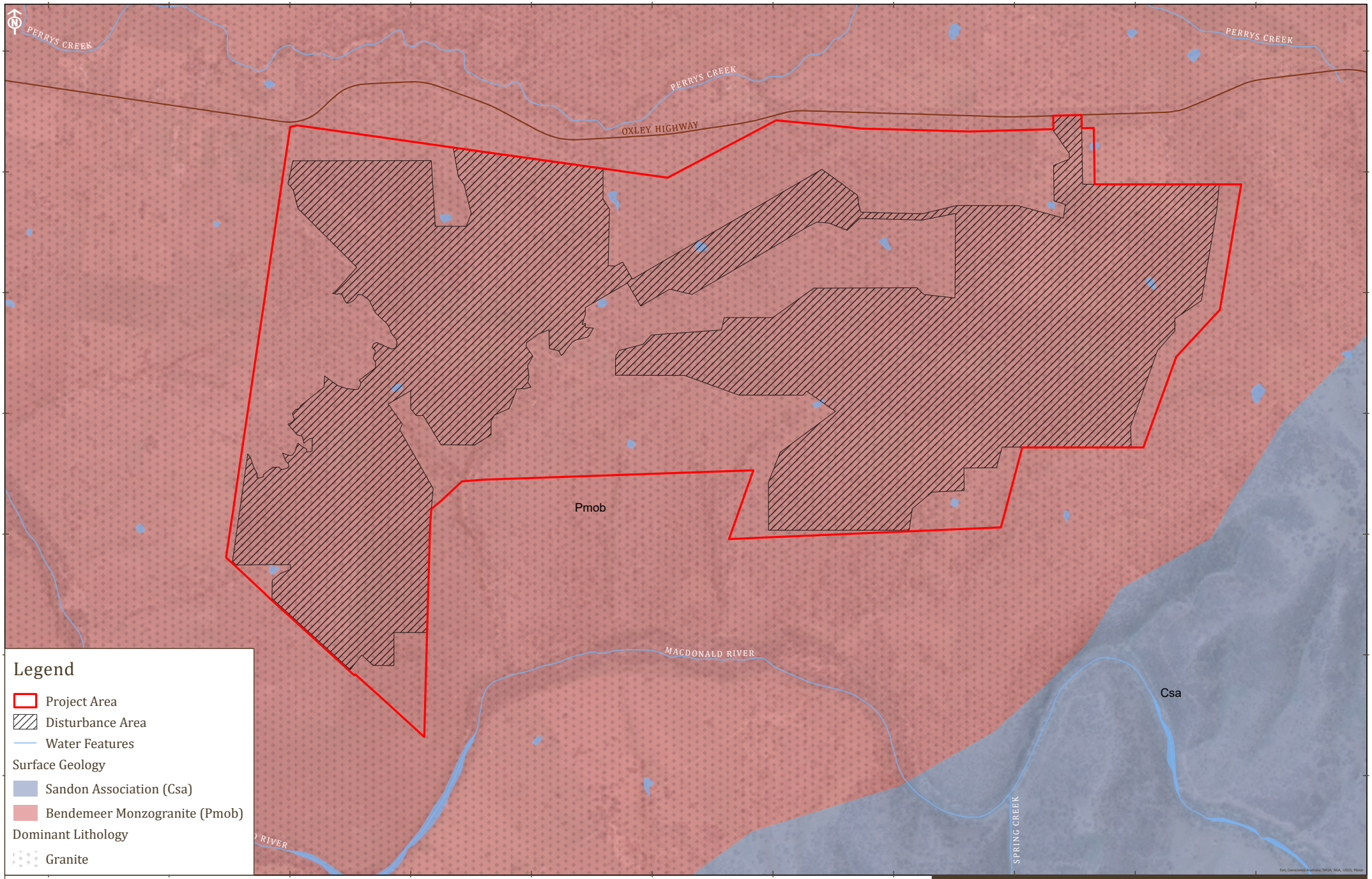
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Surficial Geology
FIGURE 5
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3 SITE CHARACTERISTICS AND LAND USE

3.1 SITE CHARACTERISTICS

3.1.1 LANDSCAPE

A site inspection was undertaken by Minesoils in October 2022. The Project Area was determined to be a stable, free draining landform with 90 - 100% surface cover that has been highly disturbed in the past by land clearing for agriculture. The site is now dominated by sustainable pasture with isolated areas of native trees on some hill crests, lower slopes and drainage lines (**Plate 1**).

The Project Area is situated on a ridge with the top of the ridge running east to west through the Lots. The lowest elevation is approximately 860 m in the south-west corner and rises to 970 m in the south-east corner noting this is across approximately 4 km distance (refer **Figure 6**). The northern half of the Project Area slopes down to the Oxley Highway, with areas that have been sown with exotic pasture species and is generally heavily grazed. The southern half of the Project Area slopes down more steeply to the Macdonald River (7th order stream), it is generally less heavily grazed with granite boulders scattered throughout. Watercourses within the Project Area are ephemeral and only first and second order streams.

An existing 330 kV transmission line passes through the Project Area.

3.1.2 AGRICULTURAL LAND USE

The Project Area is subject to grazing of sheep and cattle as the primary land-use. Livestock are grazed on rotation for breeding and fattening and are watered through surface dams or pumped in water. Currently, no additional feeding is carried out, the Project Area is not fertilised, and there is no ongoing use of herbicides. General agricultural improvements are present, including dams (**Plate 2**) cattle yards and shedding (**Plates 3**), and stock fences and gates (**Plate 4**), water pumps, and unsealed access tracks.

Similar agricultural improvements (e.g., stock fences and existing access tracks) are widespread throughout the locality which reflects the historical and current development of the local lands for livestock grazing.

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

Based on satellite imagery, site observation, soil and land capability, and discussions with the host landholder, it is determined that cleared areas of land within the Project Area have historically been primarily used for livestock grazing on native and improved pastures. Some cropping has been previously undertaken within the Project Area; however, none was observed at the time of the site inspection and anecdotal evidence suggest cropping has not occurred within the last 10 years.

As of December 2022, the Project Area is stocked with approximately 800 fine wool Merino breeding ewes and 100 head of mixed breed cattle including Brahman, Angus, Charolais and Hereford Cross (refer **Plates 5** and **6**).

3.1.3 AGRICULTURAL PRODUCTIVITY

Agricultural productivity is subject to long term climate and rainfall variables, as well as changes in economic, social and policy frameworks, often at a scale well beyond the Project Area. There is no set agricultural productivity value for land under agricultural use.

The NSW Department of Primary Industries (2019, 2022) Gross Margin Budgets for Livestock can be used to provide a broad estimation of the productivity of the land for grazing within the Project Area. Based on the DPI cattle and sheep enterprise options of 'Growing-out Steers (240 – 460 kgs)' and 'Merino Ewes (20 micron) – Merino Rams,' the estimated productivity of the Project Area ranges from $242,608 to $250,067 per annum as summarised in **Table 5**.

Plate 1: Lands cleared for grazing on sustainable pastures with sporadic presence of native trees

Plate 2: Agricultural infrastructure within the Project Area includes a series of farm dams

Plate 3: Agricultural infrastructure includes livestock yards and shedding

Plate 4: Agricultural infrastructure includes fencing and gates.

Plate 5: Grazing cattle observed during site assessment

Plate 6: Grazing sheep observed during site assessment

Table 5: Estimated Productivity of Grazing Land within the Project Area

Enterprise	Estimated Gross Margin ($/ha/year)	Grazing Land (ha)	Project Area Gross Margin ($/year)
Growing-out Steers 240 – 460kg	412.04	606.9	250,067.08
Merino Ewes (20 micron) – Merino Rams	399.75	606.9	242,608.28

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

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

- Agronomy services.
- Input providers (chemical, fertilisers, etc).
- Machinery sales and mechanical support.
- Grain and livestock transport.
- Production marketing.
- Fencing, harvest and other contractors.

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

3.2 SOIL SURVEY AND SITE VERIFICATION

3.2.1 EXISTING SOILS INFORMATION

The following section presents the NSW state government regional mapping data for soil types, inherent soil fertility and LSC as applied to the Project Area (NSW and Department of Planning, Industry and Environment, 2022).

Soil Types

The NSW regional soil mapping indicates the dominant soil types within the Project Area are Tenosols, as per Australian Soil Classification (ASC) (Isbell, R. F.,2021) (refer **Figure 7**).

Tenosols are defined as soils that do not fit the requirements of any other soil orders and generally with one or more of the following:

- A peaty horizon.
- A humose, melacic or melanic horizon, or conspicuously bleached A2 horizon, which overlies a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials.
- A horizons which meet all the conditions for a peaty, humose, melacic or melanic horizon except the depth requirement, and directly overlie a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials.
- A1 horizons which have more than a weak development of structure and directly overlie a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials.

- An A2 horizon which overlies a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials.
- B2 horizon with 15% clay (SL) or less, or a transitional horizon (C/B) occurring in fissures in the parent rock or saprolite which contains between 10 and 50% of B horizon material (including pedogenic carbonate).
- A ferric or bauxitic horizon >0.2 m thick.
- A calcareous horizon >0.2 m thick.

Inherent Soil Fertility

NSW regional mapping provides an estimation of the inherent fertility of soils in NSW. It uses the best available soils and natural resource mapping developed for LSC dataset. The mapping describes soil fertility in NSW according to a five-class system: Low (1), Moderately low (2), Moderate (3), Moderately high (4), High (5).

The Project Area is dominated by soils with Low fertility (1) (refer **Figure 8**).

Land and Soil Capability

Land capability, as detailed in LSC Scheme, is the inherent physical capacity of the land to sustain a range of land uses and management practices in the long term without degradation to soil, land, air and water resources. Failure to manage land in accordance with its capability risks degradation of resources both on- and off-site, leading to a decline in natural ecosystem values, agricultural productivity, and infrastructure functionality.

The scheme uses the biophysical features of the land and soil to derive detailed rating tables for a range of land and soil hazards. The scheme consists of eight classes, which classify the land based on the severity of long-term limitations. The LSC classes are described in **Table 6** and their definition has been based on two considerations:

- The biophysical features of the land to derive the LSC classes associated with various hazards.
- The management of the hazards including the level of inputs, expertise and investment required to manage the land sustainably.

The biophysical features of the land that are associated with various hazards are broadly soil, climate and landform, specifically noted as slope, landform position, acidity, salinity, drainage, rockiness; and climate. The eight hazards associated with these biophysical features that are assessed by the LSC scheme are:

1. Water erosion
2. Wind erosion
3. Soil structure decline
4. Soil acidification
5. Salinity
6. Water logging
7. Shallow soils and rockiness
8. Mass movement

Each hazard is assessed against set criteria tables, as described in the LSC Guideline, with each hazard ranked from 1 through to 8 with the overall ranking of the land determined by its most significant limitation.

Table 6: Land and Soil Capability Classification

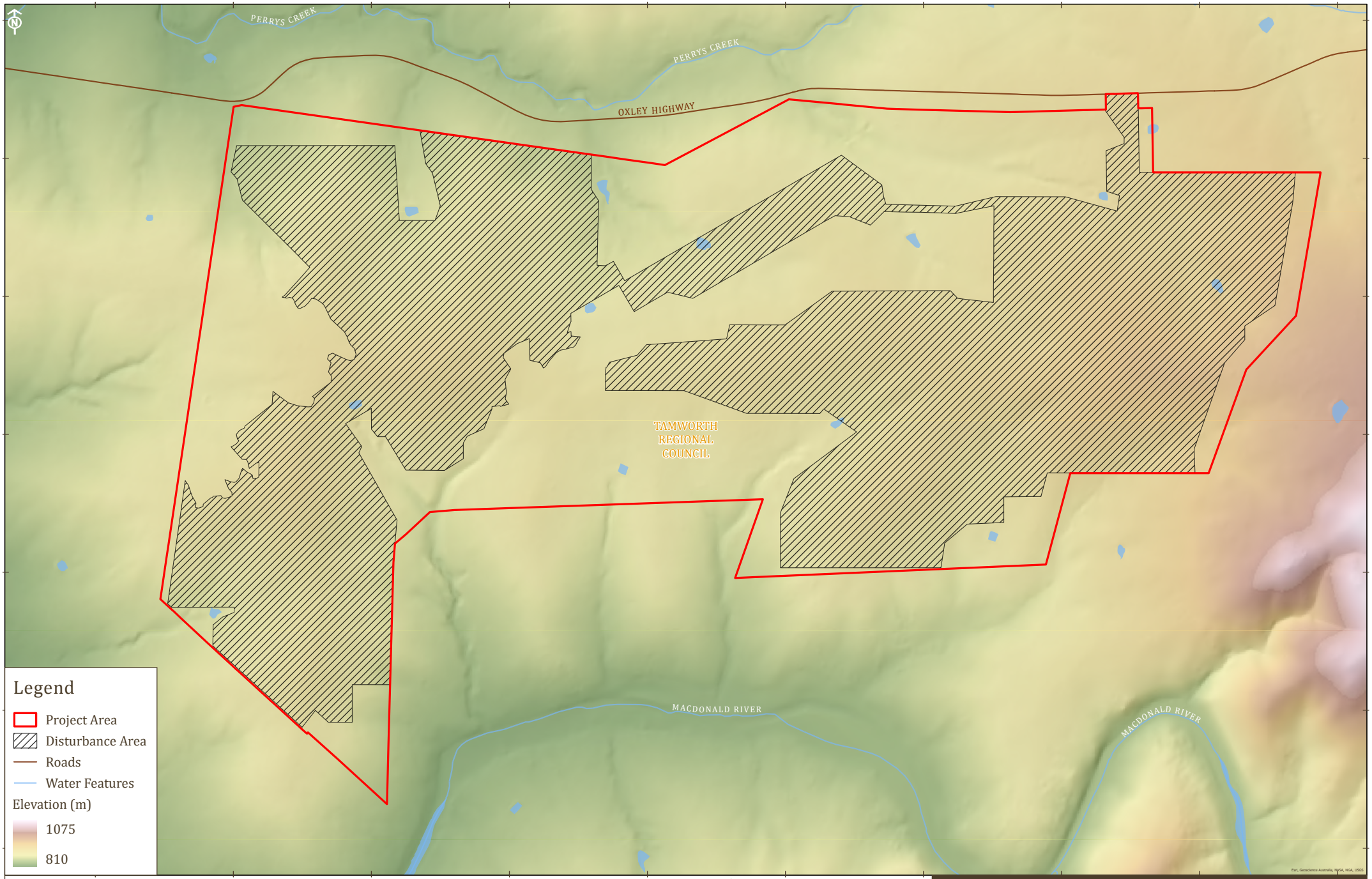
Class	Land and Soil Capability
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management 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.

The NSW regional based maps of LSC indicate the Project Area consists of land capable of a variety of land uses and characterised by LSC class 4: Moderate capability land and LSC class 5: Moderate-low capability land (refer **Figure 9**).

Strategic Regional Land Use Policy Mapping

The 'NSW Government's Strategic Regional Land Use Policy' (the Policy) defines and identifies strategic agricultural land across NSW. Strategic agricultural land includes land with unique natural resource characteristics, known as biophysical strategic agricultural land (BSAL), and clusters of significant agricultural industries known as critical industry clusters (CICs). The Policy has been developed to achieve balanced land use outcomes, particularly between mining, coal seam gas and agriculture.

There is no BSAL or CICs mapped within the Project Area or the Project locality. The nearest BSAL is located approximately 15 km south of the Project Area in association with Cockburn River.



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LAND & REHABILITATION SPECIALISTS

GDA2020 MGA Zone 56

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Topography

FIGURE 6

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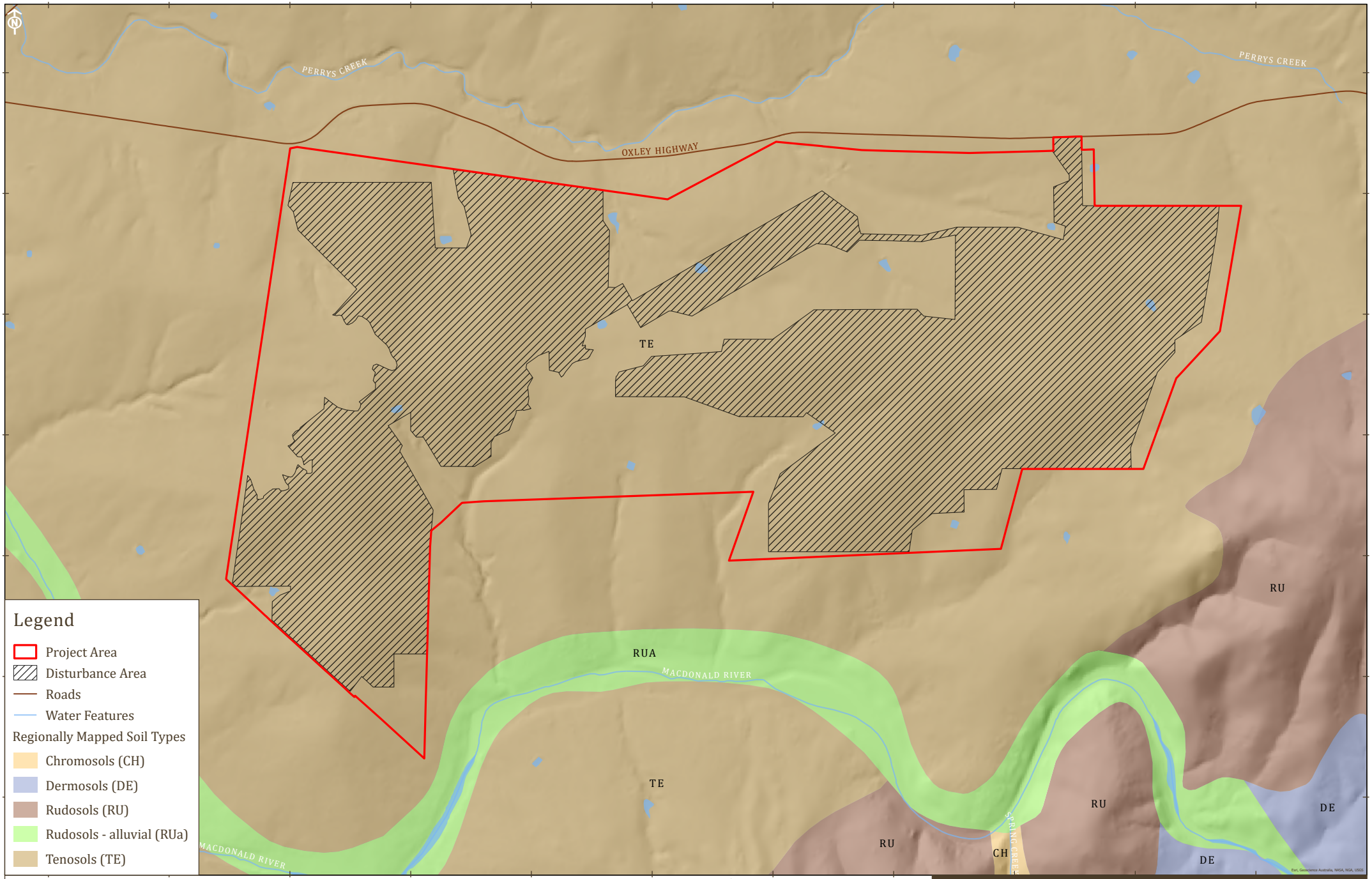

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Regionally Mapped Soil Type

FIGURE 7

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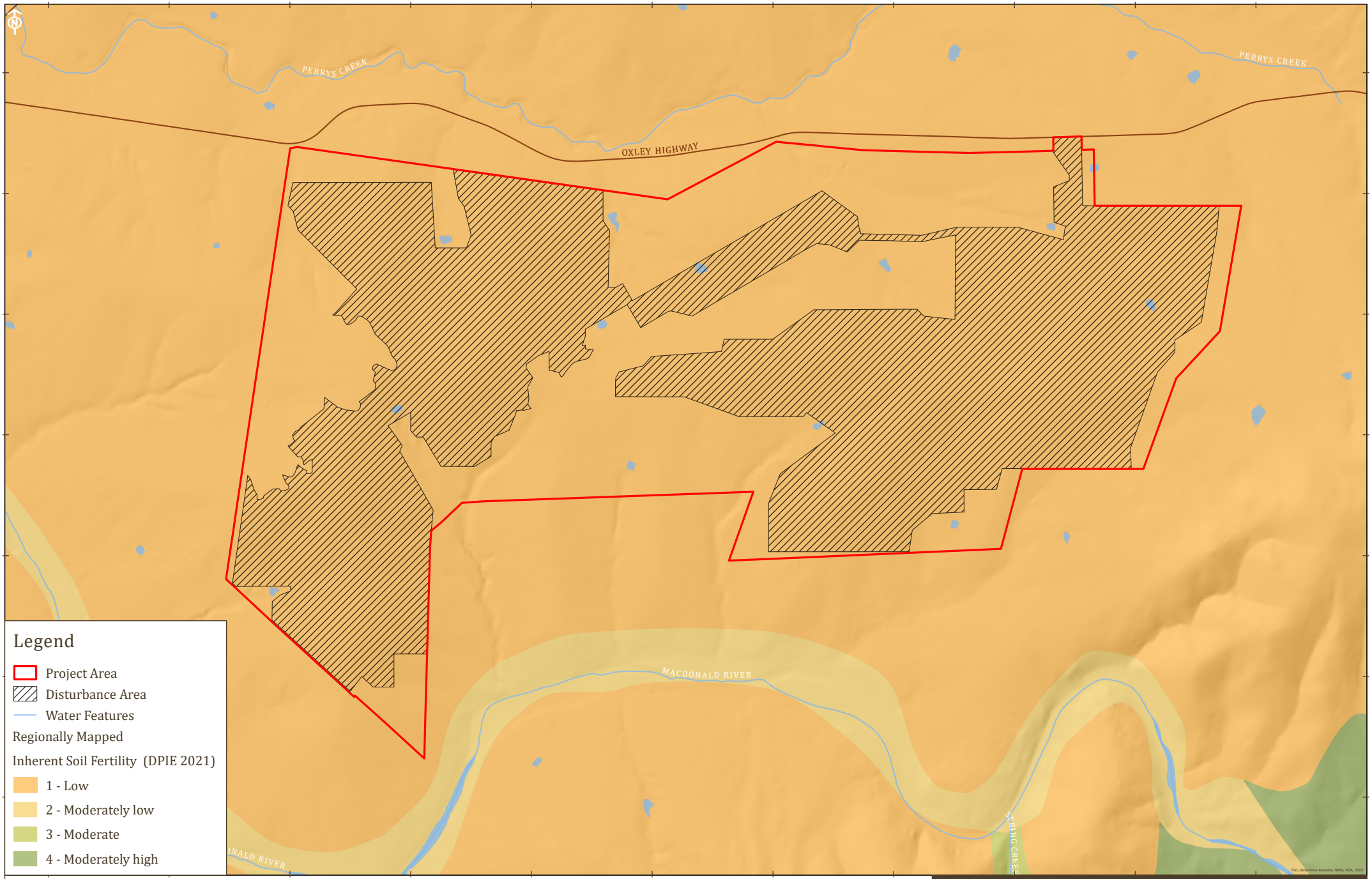

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Regionally Mapped Inherent Soil Fertility

FIGURE 8

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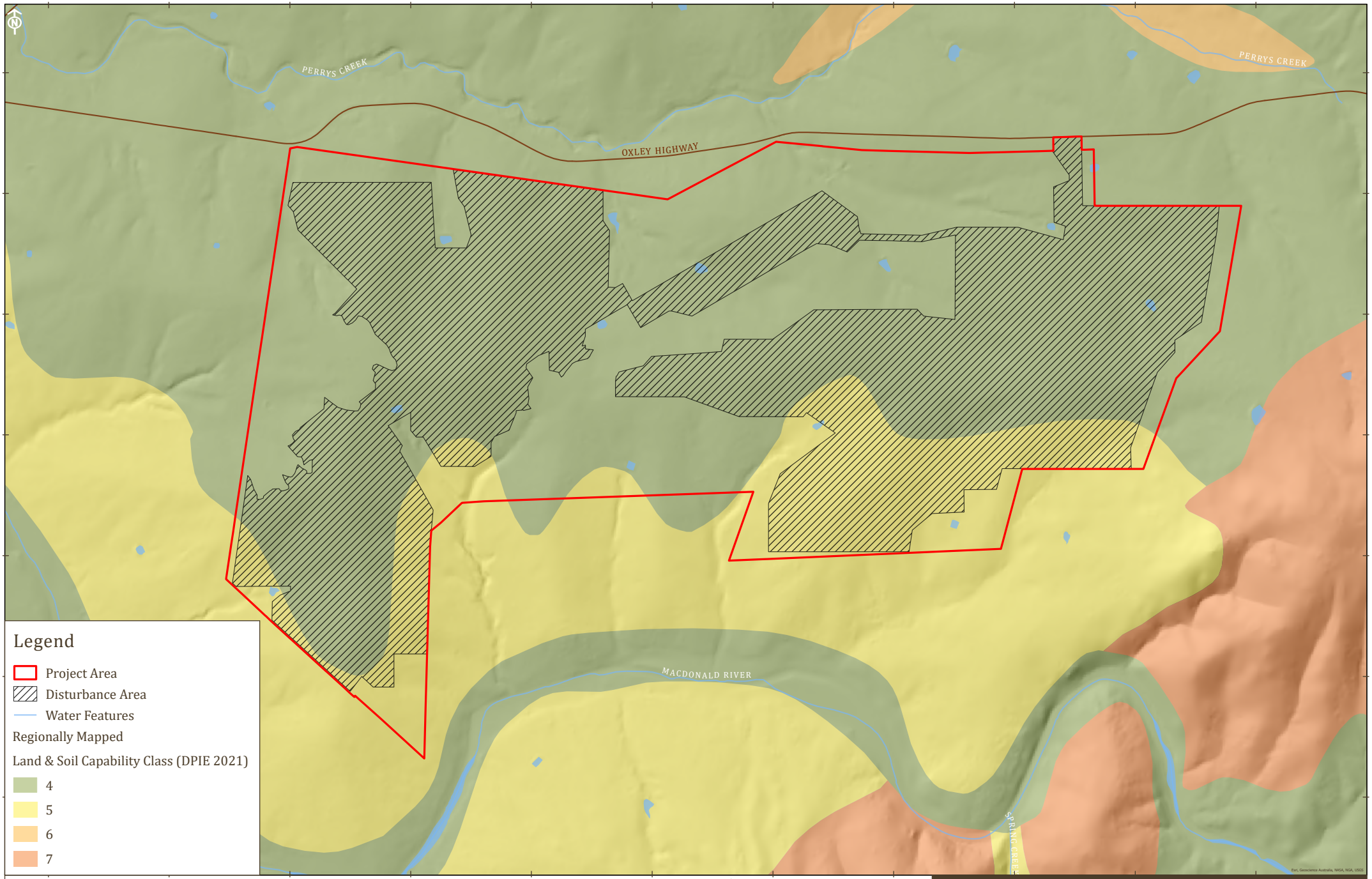
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PERRYS CREEK
OXLEY HIGHWAY
MACDONALD RIVER
Legend
Project Area
Disturbance Area
Water Features
Regionally Mapped
Land & Soil Capability Class (DPIE 2021)
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7
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LAND & REHABILITATION SPECIALISTS
Regionally Mapped
Land and Soil Capability
FIGURE 9
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3.2.2 SOIL SURVEY METHODOLOGY

Minesoils undertook a soil and land resource survey to inform the following tasks to be undertaken throughout the EIS process:

- Soil assessment, identifying soil units, soil qualities and risks including erosion, acid sulfate soils risk and salinity.
- Land and soil capability (LSC) verification.
- Management and mitigation measures for mitigating soil erosion during construction, operations and decommissioning.

The objective of the Minesoils fieldwork program was to satisfy the field assessment, sampling and testing requirements related to soil and land resources of the LSSE Guideline. The fieldwork plan outlined below was designed to satisfy the following requirements:

- Soil survey and mapping: This was undertaken at a 1:25,000 survey intensity (1 site every 25 ha), and requires collection of landform pattern and element information, soil profile data, and taxonomic parameters to distinguish soil units according to the Australian Soil Classification criteria, within the Project Area.
- LSC verification: The information required for the LSC assessment was collected during both the desktop assessment and verified on the ground during the field program. The LSC system requires data on biophysical features from in situ measurements regional mapping.
- Soil qualities and risks: Additional information was recorded in the field on erosion and evidence of potentially erosive soils including tunnelling, rill, gully and sheet erosion, which may require specific handling and management techniques during construction or operational activities, and the consequences of this on stripping and rehabilitation. Observations were made on risks of ASS and salinity.

The field program was designed as an integrated free survey. An integrated survey assumes that many land characteristics are interdependent and tend to occur in correlated sets (NSCT, 2008). Survey points are irregularly located according to the survey teams' 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 variation. Soil pits were excavated by an excavator to a depth of 0.8 – 1.0 m. Site clearances and dial before you dig (DBYD) plans were undertaken as part of the safety planning requirements and found underground service running through the centre of the Project area which were avoided during excavation activities.

The survey area encompassed the 606.9 ha of the Project Area. A total of 25 sites were assessed, resulting in a survey intensity of 1 site per <25 ha. Soil profiles within the Project Area (refer to **Figure 10**) were assessed in accordance with the 'Australian Soil and Land Survey Field Handbook soil classification procedures' (NCST, 2009). Detailed soil profile descriptions were recorded covering the major parameters specified in **Table 7**. Soil profile logging was undertaken in the field using Minesoils' soil data sheets, including GPS recordings and photographs of the landforms and soil profiles. Soils were keyed out in accordance with the Australian Soil Classification (ASC) Third Edition (2008) (Isbell, R. F.,2021).

Soil samples were collected at each of the assessment site's soil horizons to a depth of 0.8 m, with a total of 70 samples collected. Minesoils chose 36 of these samples that were considered representative and subject to laboratory testing. The laboratory testing suite for these sites is detailed in the **Table 8**.

Duplicate samples at every site were collected during the fieldwork and stored until the EIS is finalised.

Table 7: Detailed soil profile description parameters

Detailed Field Assessment Parameters	
Horizon depth including distinctiveness and shape	Pan presence and form
Field texture grade	Permeability and drainage
Field colour (Munsell colour chart)	Field pH
Pedality structure, grade and consistence	Field moisture
Soil fabric and stickiness	Surface condition
Stones (abundance and size)	Landform pattern / element
Mottles (amount, size and distinctiveness)	Current land use and previous disturbance
Segregations (abundance, nature, form and size)	Vegetation

Table 8: Soil Sample Laboratory Analysis

Lab Analysis	
Analyte	**Methodology**
pH (1:5 water & CaCl)	Rayment & Lyons 2011-4A1
Electrical Conductivity (EC) and Chloride	Rayment & Lyons 2011-3A1
Cation Exchange Capacity (CEC) & ESP and Ca:Mg Ratio	Rayment & Lyons 2011-15J1
Particle Size Analysis (PSA)	ISSS Hydrometer plus 0.2 and 2.0 mm Sieving (CSIRO 'Yellow Book')
Emerson Aggregate Test (EAT)	AS1289.3.8.1-2017

3.2.3 SOIL SURVEY FINDINGS

Soil Mapping Units

The soil survey undertaken by Minesoils found the Project Area to contain two dominant soil mapping units, as shown on **Figure 10**, and presented in **Table 9**:

- Soil Unit 1: Chromosols – covering 405.7 ha.
- Soil Unit 2: Sodosols – covering 201.2 ha.

Soil Unit 1 is characterised by Chromosols, which are defined as soils with a clear or abrupt textural B horizon 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 not sodic and not strongly acid. Soils with strongly subplastic upper B2 horizons are also included even if they are sodic.

Representative sites for this unit, which include detailed laboratory data, consist of sites 1, 4, 6, 9, 15, 18 and 25.

Soil Unit 2 is characterised by Sodosols, which are defined as soils with a clear or abrupt textural B horizon 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 and not strongly acid. Soils with strongly subplastic upper B2t horizons are excluded.

Representative sites for this unit, which include detailed laboratory data, consist of sites 7, 12, 16, 21 and 22.

Fill soil profile descriptions are included as **Appendix 2**. Laboratory certificates of analysis are included as **Appendix 3**.

Table 9: Soil Mapping Units and Soil Units Summary

Site #	Soil Mapping Units		Soil Profile - Australian Soil Classification	ASC Family Criteria
	#	Name		
1	1	Chromosols	Bleached-Mottled Eutrophic Brown Chromosol	BELOVNR
2	1	Chromosols	Brown Chromosol	-
3	1	Chromosols	Brown Chromosol	-
4	1	Chromosols	Mottled Eutrophic Gray Chromosol	BELOVNR
5	1	Chromosols	Brown Chromosol	-
6	1	Chromosols	Mottled Eutrophic Brown Chromosol	BELOVNR
7	2	Sodosols	Eutrophic Mottled-Subnatric Grey Sodosol	BEKOVNR
8	1	Chromosols	Grey Chromosol	-
9	1	Chromosols	Bleached-Mottled Brown Chromosol	BEKOVNR
10	1	Chromosols	Brown Chromosol	-
11	1	Chromosols	Brown Chromosol	-
12	2	Sodosols	Eutrophic Mottled-Subnatric Brown Sodosol	BEKOVNR
13	2	Sodosols	Brown Sodosol	-
14	2	Sodosols	Brown Sodosol	-
15	1	Chromosols	Bleached-Mottled Eutrophic Gray Chromosol	BEKOVNR
16	2	Sodosols	Eutrophic Mottled-Subnatric Gray Sodosol	BELOVNR

Site #	Soil Mapping Units		Soil Profile - Australian Soil Classification	ASC Family Criteria
	#	Name		
17	1	Chromosols	Gray Chromosol	-
18	1	Chromosols	Bleached-Mottled Eutrophic Yellow Chromosol	BEKOVNR
19	1	Chromosols	Brown Chromosol	-
20	2	Sodosols	Brown Sodosol	-
21	2	Sodosols	Eutrophic Mottled-Subnatric Gray Sodosol	BELOVNR
22	2	Sodosols	Eutrophic Mottled-Subnatric Gray Sodosol	BEKOWNR
23	2	Sodosols	Red Sodosol	-
24	1	Chromosols	Red Chromosol	-
25	1	Chromosols	Mottled Eutrophic Brown Chromosol	BELOWNR

Soil Erodibility

Soil aggregate stability refers to the stability of soil structural units (aggregates) when immersed in water. Instability may be indicated by slaking or clay dispersion. A soil with low aggregate stability is likely to be less resilient to mechanical impacts, more likely to be compacted and poorly structured, or be susceptible to tunnelling if used for earthworks.

The Emerson Aggregate Test (EAT) classifies the behaviour of soil aggregates, when immersed, on their coherence in water. **Table 10** shows the EAT class and the dispersion degree during testing and resulting risk of dispersion for that soil.

Table 10: Dispersion Degree and Risk Correlation to EAT Class

EAT Class	Dispersion	
	Degree	Risk
1	Complete dispersion	Very High
2	Partial dispersion	High
3	Complete or partial dispersion after remoulding	Moderate
4 - 8	Well aggregated with no dispersion after remoulding	Negligible

Source: Adapted from Hazelton and Murphy (2011)

Emerson Class Numbers of 1 and 2 indicates a high to very high potential for the soil to disperse when inundated with water. These classes represent the greatest erosion and sediment control hazard to surface disturbance works.

Emerson Class Numbers of 3 indicate that while the soil is only slightly dispersive, the remoulding and breaking down of soil bonds can result in increased dispersive behaviour. Remoulding of the soil at a moisture content near the optimum for compaction (simulating the use of these soils in a filling and compaction operation) does not increase the potential for dispersive behaviour; however, further breakdown of the soil may occur, by water turbulence or concentrated rapid water flow. Under these circumstances this class of soil may disperse.

Emerson Class Numbers greater than 4 have a low potential for dispersive behaviour. Some swelling or slaking may occur but generally such soils are not readily dispersive.

Table 11 highlights the lowest Emerson Class Number recorded for select laboratory data representative sites of the Project Area, as an indicator of highest potential risk during disturbance activities.

Table 11: Potential Dispersion Risk

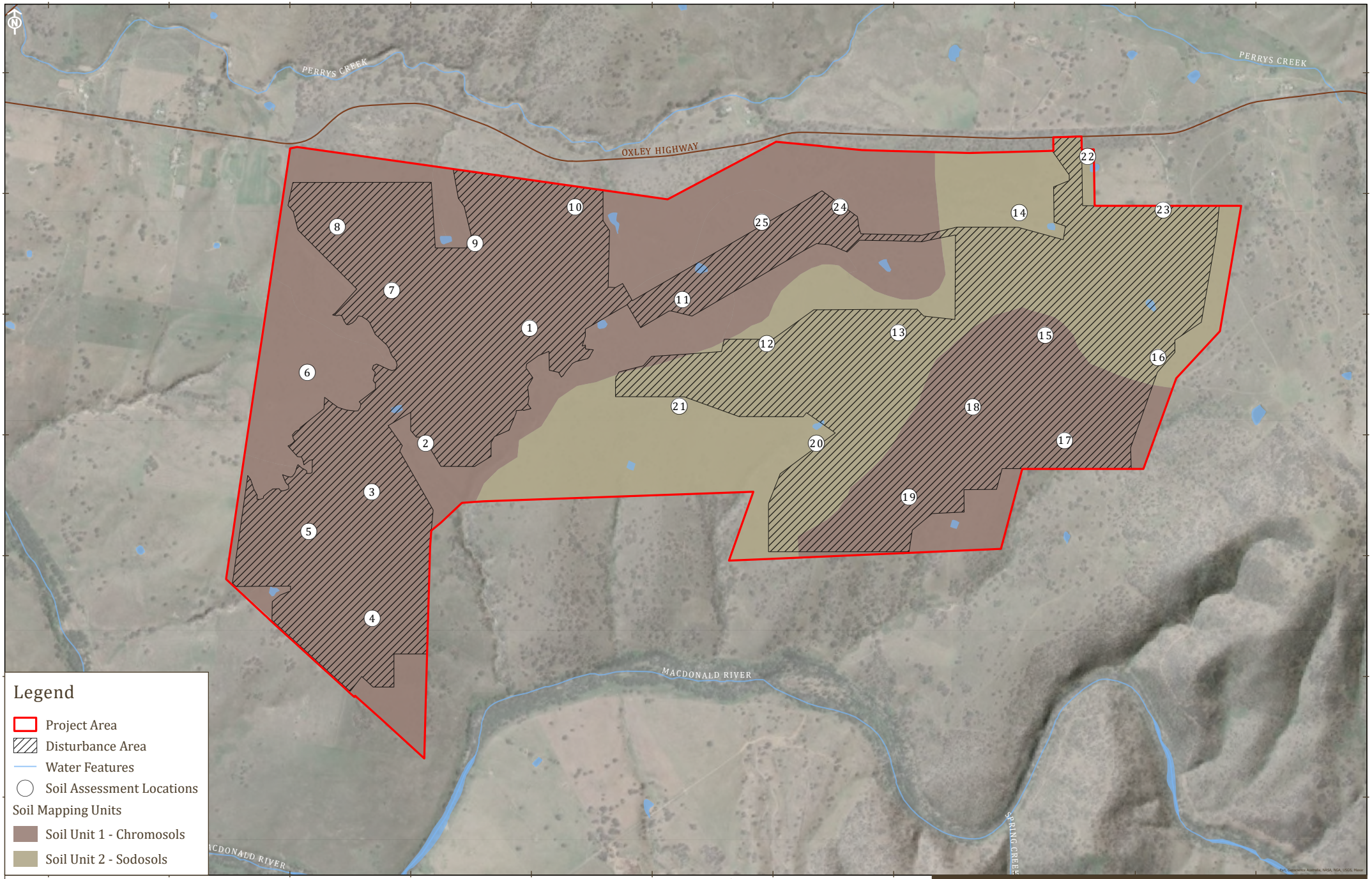
Site No.	ASC	Soil Depth	EAT	Potential Risk
1	Bleached-Mottled Eutrophic Brown Chromosol	0.00 – 0.10	4	Low
		0.40 – 0.50	2	High
9	Bleached-Mottled Brown Chromosol	0.00 – 0.10	4	Low
		0.45– 0.55	4	Low
10	Eutrophic Mottled-Subnatric Brown Sodosol	0.40 – 0.50	2	High
16	Eutrophic Mottled-Subnatric Gray Sodosol	0.35 – 0.45	2	High
18	Bleached-Mottled Eutrophic Yellow Chromosol	0.40 – 0.50	3	Moderate

Based on site observation, which included assessment for indicators of erodibility, such as sheet or gully erosion, it can be concluded that there is an erosion and sedimentation risk associated with the subsoils currently present at the Project Area with evidence of severe gully erosion. The dispersion risk status of the tested soils indicates there is moderate to high potential risk for dispersion for the subsoils of both soil units within the Project Area.

The representative laboratory tested soils also indicate high levels of sodicity primarily in the clay subsoils associated with Soil Unit 2. Based on these results, there is a high potential risk for dispersion where the subsoils of soil unit 2 are disturbed within the Project Area. Higher impact activities such as where earthworks are necessary for construction of sub-station pads or site facilities are very likely to result in increased dispersive behaviour when soil is remoulded, compacted or pulverised.

While sodic soils are generally dispersive, it is important to acknowledge that not all sodic soils disperse, and that not all dispersive soils are sodic. However, given the non-saline nature of the soils tested, all sodic soils should be considered dispersive.

Caution must be taken over the entire Project Area including Soil Unit 1 despite the range in chemical and physical properties or landscape location of specific soil test sites (including sodicity status and EAT class). Controls should be consistent and applied across the entire Project Area where any disturbance occurs (including changes to vegetation cover). Channelised drainage patterns should be minimised, and the Project should avoid hard engineering solutions for erosion control and preference soft, vegetated structures.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Project Area
Disturbance Area
Water Features
Soil Assessment Locations
Soil Mapping Units
Soil Unit 1 - Chromosols
Soil Unit 2 - Sodosols
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MINESOILS
LAND & REHABILITATION SPECIALISTS
Soil Mapping Units
FIGURE 10
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Acid Sulphate Soils

Acid sulfate soils (ASS) have been classified into 5 different classes based on the likelihood of the acid sulfate soils being present in particular areas and at certain depths (NSW Department of Planning and Environment, 2018):

- Class 1: ASS in a class 1 area are likely to be found on and below the natural ground surface.
- Class 2: ASS in a class 2 area are likely to be found below the natural ground surface.
- Class 3: ASS in a class 3 area are likely to be found beyond 1 metre below the natural ground surface.
- Class 4: ASS in a class 4 area are likely to be found beyond 2 metres below the natural ground surface.
- Class 5: ASS are not typically found in Class 5 areas. Areas classified as Class 5 are located within 500 metres on adjacent class 1,2,3 or 4 land.

The Project Area does not contain any of the above classes on the NSW Acid Sulfate Soil Planning Map.

Assessing land elevation and distance from the coast, in conjunction with existing ASS mapping for NSW, the potential for ASS is considered a very low risk.

Further, there was no evidence of ASS indicators such as soil gleying, odour, marine sediments and organic materials recorded as part of the soils survey.

Salinity

The regional mapping for salinity risk within the project area is very low (EC between 0.050 to 0.200 dS/m) based on e-spade (2022). During the fieldwork there was no evidence of areas to be affected by salt scalds or saline seepages. The laboratory data indicated all samples tested were non-saline with EC ranging from 0.007 to 0.056 dS/m, and all ECe <0.7 dS/m. Therefore, the risk of salinity within the project area is considered negligible.

3.2.4 SITE VERIFICATION OF LSC

The 25 soil test sites within the Project Area have been subject to the site verification assessment of LSC, in accordance with the LSC Guideline and outlined in Section 3.2.1.

The Project Area contains three LSC classes:

- LSC class 4: moderate capability land – covering 112.5 ha.
- LSC class 5: moderate - low capability land – covering 82.4 ha.
- LSC class 6: low capability land – covering 412.0 ha.

The spatial extent of each LSC class is shown in **Figure 11**. The LSC verification assessment outcomes for the eight hazards group for the soil profiles assessed is presented in **Table 12**.

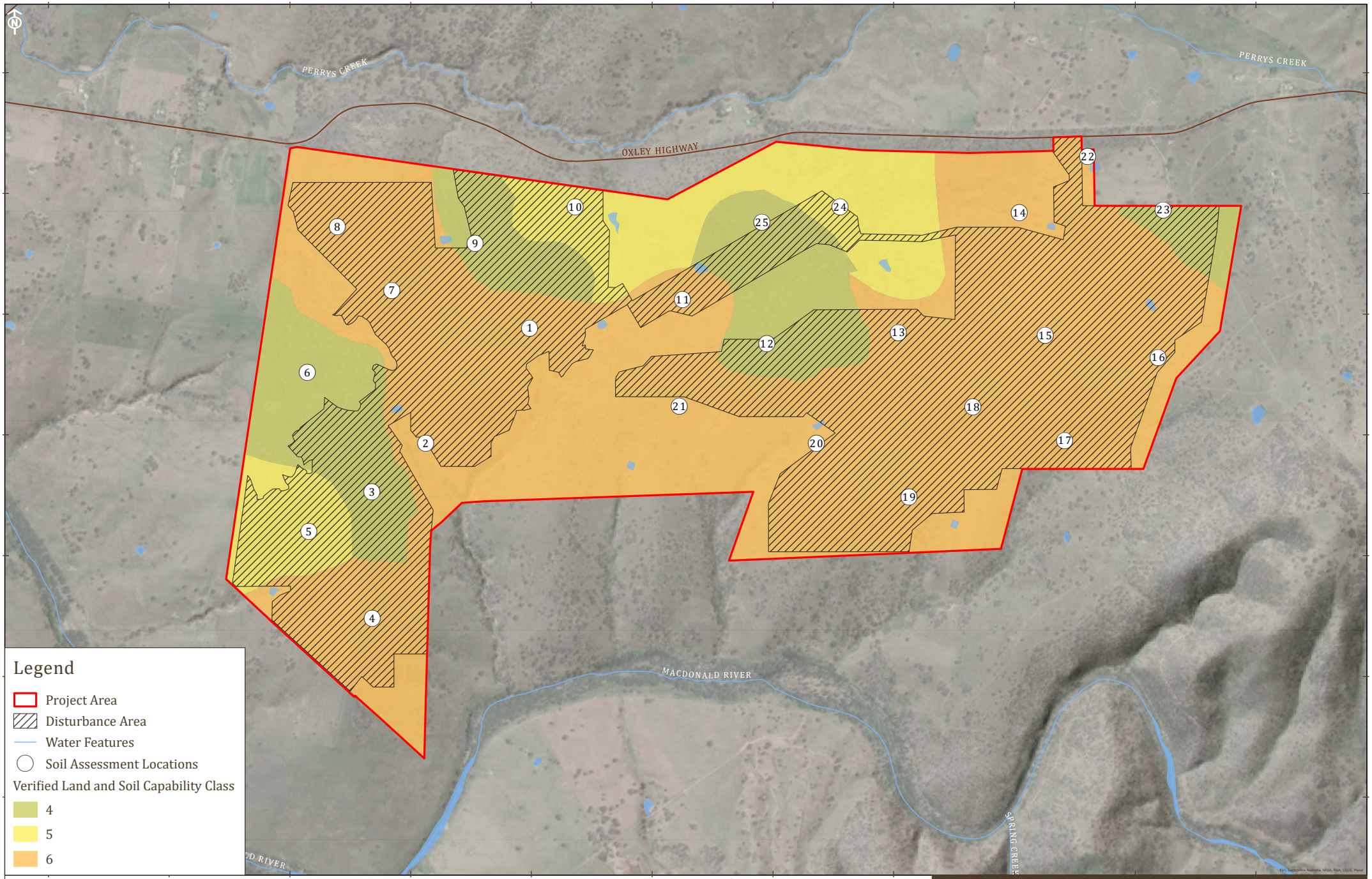
Class 4 land has moderate to high limitations for high-impact land uses that will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology. The key limitations of this class within the Project Area include water-logging and wind erosion.

Class 5 land has high limitations for high-impact land uses and will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation. The key limitations of this class within the Project Area include soil acidity and wind erosion.

Class 6 land is associated with Soil Unit 1 and 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. The key limitations of this class within the Project Area include water-logging, and soil depth.

Table 12: LSC Parameters and Overall Class

		Hazard Criteria								
		1	2	3	4	5	6	7	8	Overall
Site #	Soil Type	Water erosion	Wind erosion	Structure	Acidity	Salinity	Water-logging	Soil depth	Movement	Class
1	Bleached-Mottled Eutrophic Brown Chromosol	3	4	3	5	3	6	4	1	6
2	Brown Chromosol	3	5	3	-	3	6	4	1	6
3	Brown Chromosol	3	5	3	-	3	2	4	1	5
4	Mottled Eutrophic Gray Chromosol	3	5	3	5	3	6	4	1	6
5	Brown Chromosol	3	4	3	-	3	2	1	1	4
6	Mottled Eutrophic Brown Chromosol	3	4	3	5	3	4	4	1	5
7	Eutrophic Mottled-Subnatric Grey Sodosol	3	4	3	5	3	6	4	1	6
8	Grey Chromosol	3	4	3	-	3	6	1	1	6
9	Bleached-Mottled Brown Chromosol	3	5	1	5	3	4	4	1	5
10	Brown Chromosol	3	4	3	-	3	4	1	1	4
11	Brown Chromosol	2	3	3	-	3	6	1	1	6
12	Eutrophic Mottled-Subnatric Brown Sodosol	2	5	1	5	3	4	4	1	5
13	Brown Sodosol	3	4	3	-	3	6	4	1	6
14	Brown Sodosol	2	3	3	-	3	2	6	1	6
15	Bleached-Mottled Eutrophic Gray Chromosol	3	5	1	5	3	6	4	1	6
16	Eutrophic Mottled-Subnatric Gray Sodosol	3	3	3	5	3	6	4	1	6
17	Gray Chromosol	3	4	3	-	3	6	4	1	6
18	Bleached-Mottled Eutrophic Yellow Chromosol	3	5	1	5	3	6	4	1	6
19	Brown Chromosol	3	5	1	-	3	6	4	1	6
20	Brown Sodosol	3	3	3	-	3	6	1	1	6
21	Eutrophic Mottled-Subnatric Gray Sodosol	3	5	1	5	3	6	4	1	6
22	Eutrophic Mottled-Subnatric Gray Sodosol	3	5	1	5	3	6	1	1	6
23	Red Sodosol	3	5	1	-	3	4	1	1	5
24	Red Chromosol	3	3	3	-	3	4	1	1	4
25	Mottled Eutrophic Brown Chromosol	3	5	3	5	3	2	1	1	5



MINESOILS
LAND & REHABILITATION SPECIALISTS

GDA2020 MGA Zone 56

0 500 1000 1500 Meters

Scale 1:20,000 at A4

Verified Land and Soil Capability

FIGURE 11

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4 LAND USE CONFLICT RISK ASSESSMENT

4.1 OVERVIEW

The Land Use Conflict Risk Assessment (LUCRA) (NSW Department of Primary Industries, 2011) is required as part of a Level 2 – Reduced Agricultural Impact Assessment as per the LSSE Guideline. LUCRA is a system to identify and assess the potential for land use conflict to occur between neighbouring land uses. It helps land managers and consent authorities assess the possibility for and potential level of future land use conflict. LUCRA aims 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.

Land use conflicts occur when one land user is perceived to infringe upon the rights or impact the values or amenity of another. In rural areas land use conflicts commonly occur between agricultural and residential uses. However, land use conflicts can also occur between different agricultural enterprises and other primary industries.

Rural amenity issues are the most common land use conflict issues, followed by environmental protection issues. Rural amenity issues include impacts to air quality due to agricultural and rural industry (odour, pesticides, dust, smoke and particulates); use and enjoyment of neighbouring land e.g., noise from machinery; and visual amenity associated with rural industry e.g., the use of netting, planting of monocultures and impacts on views.

Environmental protection issues include soil erosion leading to land and water pollution, clearing of native vegetation, and stock access to waterways.

Direct impacts from neighbouring land uses on farming operations can also cause conflict, such as: harassment of livestock from straying domestic animals; trespass; changes to storm water flows or water availability; and poor management of pest animals and weeds.

4.2 APPROACH

The LUCRA as presented in **Appendix 1** compares and contrasts the Project against adjoining/surrounding land uses and activities for incompatibility and conflict issues based on the risks and impacts identified in Section 5, and the mitigation measures and controls presented in Section 6. Each potential conflict between the operation of the solar farm and adjacent land has been assessed and given a risk ranking based on probability and consequence as outlined in **Appendix 1**. Performance targets will be determined via management plans specified by the EIS (and specialist impact assessments) and development consent conditions (if approved). Monitoring will be undertaken in accordance with those management plans. Indicative performance targets are presents in **Appendix 1**.

Given the significant overlap between the agricultural impact assessment and land use conflict considerations, many agriculture-related risk items listed in the LUCRA are detailed in Section 5.

4.3 FINDINGS

There are 39 risk items that were considered as part of the LUCRA. The mitigation and measures and controls outlined in this assessment and the wider EIS reduce the level of risk for the majority of considered potential risks with complaints or conflict being managed within normal operations. There are no high-risk potential conflicts, however a number of items of potential conflict remain a moderate risk and may require further consultation and management in addition to standard operations. These are summarised in **Table 13**. The LUCRA methodology including risk ranking matrix and full LUCRA assessment are included as **Appendix 1**.

Table 13: LUCRA Moderate Risk Items and Risk Controls Summary

Risk Item	Risk Reduction Controls
Land users in the locality may be concerned about changes to water quality, quantity and surface water flows that may affect the site and locality, including local waterways, from surface disturbances during construction activities	Consideration of impacts to surrounding water courses and water quality has been undertaken within the water impact assessment for the EIS. Appropriate mitigation measures are specified within the EIS, including soil erosion and sedimentation controls within this report, to minimise impacts to watercourse health and quality. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to watercourse health and quality. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved), such as a soil management plan and an erosion and sediment control plan.
Land users in the locality may be concerned about the possibility of increased vehicles during construction or operation may result in an accident with livestock, farm machinery or wildlife on roads.	The assessment of potential traffic impacts has been undertaken via a Traffic Impact Assessment (TIA). Appropriate mitigation measures are specified within the TIA to minimise impacts to the traffic environment. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to traffic for surrounding land users. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).
Stakeholders in the locality who wish to maintain views of the existing agricultural landscape may be concerned about the change in visual amenity resulting from the solar farm	The assessment of visual impacts to surrounding amenity has been undertaken via a Landscape and Visual Impact Assessment (LVIA). Appropriate mitigation measures are specified within the LVIA to minimise the risk of altered amenity for surrounding residents and public within the locality. Compliance with mitigation measures specified within the LVIA is anticipated to further limit visual impact from the Project. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).
Land users in the locality may be concerned about weed, plant pest, plant disease or pest animal introduction and/or spread	The assessment of impacts to biodiversity has been undertaken via a BDAR. Consideration of the potential for pest species to impact agriculture has been included in this assessment. Appropriate mitigation measures are specified within the BDAR and this assessment to minimise the risk for weeds and pests to spread throughout the site and onto neighbouring land. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).
Land users in the locality may be concerned about the risk of fires occurring at the site and their potential to spread to surrounding land, infrastructure or livestock	Consideration of potential bushfire impacts has been undertaken as part of a Preliminary Hazard Analysis (PHA) informing the EIS. Further, a Bushfire Assessment Report (BFAR) was prepared to identify and evaluate the potential hazards and risks associated with bushfires to and from the Project and the use of bushfire prone land. Appropriate mitigation measures are specified within the PHA and BFAR within the EIS to minimise the risk of fire to and from the Project incidents including their risk to people and potential to damage surrounding land. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).

Risk Item	Risk Reduction Controls
Landowners in the locality may be concerned about potential devaluation of properties due to proximity to solar farm infrastructure.	As outlined in the EIS, there are many factors that may influence land value, being amenities impact of the Project to the locality the key factor to devaluation. Given construction impacts will be temporary, it is unlikely to have a permanent impact on the amenity of the locality. The Project has been refined and where impacts could not be avoided, management and mitigation measures will be adopted to further reduce potential impacts that may cause devaluation of properties. This includes the introduction of vegetation screening and landscaping, and noise barriers to reduce potential views and noise disturbance of Project infrastructures. Therefore, the residual impacts of the Project during operational phase, after implementation of management and mitigation measures are predicted to be minimal. Ongoing consultation with stakeholders will identify and address concerns if they arise.
Stakeholders may be concern about potential impacts to biodiversity within the site and locality	The assessment of impacts to biodiversity has been undertaken via a BDAR. Appropriate mitigation measures are specified within the BDAR and this assessment to minimise the risk for impacts on biodiversity within the site and locality. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved). Ongoing consultation with stakeholders will identify and address concerns if they arise.
Public Authorities may have concerns regarding the potential for cumulative impacts arising from the proximity of state significant developments.	An assessment of potential cumulative impacts has been undertaken as part of the EIS. Appropriate mitigation measures (where required) are specified in the EIS to minimise the potential for cumulative impacts to occur at or near the Project Area. Anticipated impacts are determined to be minor and presented in the EIS for Public Authority consideration.
Stakeholders may be concerned about the potential for poor rehabilitation outcomes and the resulting long term environmental and agricultural consequence.	A Decommissioning and Rehabilitation Plan will ensure the land can be successfully returned to pre-disturbance land and soil capability and final land use commitments following decommissioning.

5 IMPACTS ON AGRICULTURAL LAND

Where Section 4 and **Appendix 1** provide an overview of the potential or perceived conflict between the Project and surrounding land uses, this section provides an assessment on the actual impacts on agriculture that are anticipated to occur as a result of the Project.

The potential impacts solar farming activities can have on land resources and agricultural productivity range from short term temporary impacts to long term and permanent impacts. Temporary impacts can include the removal of some agriculture from service over a partial or full period of the life of the Project. Permanent impacts may include changes to land and soil capability and agricultural resources of the Project Area. Permanent impacts are irreversible and compromise the reinstatement of agricultural lands and land productivity.

This section identifies and describes the nature, duration and consequence of the potential impacts on agricultural land as a result of the Project, for the Project Area and in the wider region, across five risk areas:

- Changes in the amount of land used for agriculture.
- Changes to agricultural productivity and agricultural enterprises.
- Changes to agricultural resources.
- Other potential impacts to agriculture considered for the Project.
- Cumulative impacts of the potential for multiple solar farms within the region.

5.1 LAND USED FOR AGRICULTURE

The Project will be undertaken on an area of approximately 606.9 ha of land that is current subject to agriculture land use. During the peak construction phase of approximately 12 months, the entire Project Area will cease to be used for agriculture. It is anticipated there will be agriculture reintroduced after the peak construction phase and within the 18 month overall construction phase.

The Applicant is committed to using as much of the Project Area as possible for agricultural purposes for the duration of the operational phase of the Project. Land being used simultaneously for agriculture and the solar farm is known as agrisolar and is further described in Section 6.4.

Infrastructure areas such as the BESS, switchyard, substation, site facilities (control building) and internal roads will not be suitable for agricultural use. For this assessment, it is assumed that these areas will total 18.5 ha.

(Note, disturbance area provided to Minesoils for earlier iterations of report did not include internal roads.)

It is anticipated that agricultural land use will be re-established over the entire Project Area following decommissioning. Therefore, there will be a temporary decrease of approximately 18.5 ha of land used for agriculture for the duration of the Project.

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

5.2 PRODUCTIVITY AND ENTERPRISES

5.2.1 PRIMARY PRODUCTIVITY

During the peak construction phase of approximately 12 months, the entire Project Area will cease to be used for agriculture, resulting in a reduction of primary productivity, based on Project Area gross margin, of $242,608 to $250,067 per annum, as estimated in Section 3.1.3. Agriculture is planned to be reintroduced within the 18 month overall construction and commissioning phase.

For this assessment, during the operational phase, the impact of the Project on productivity of agricultural land is estimated to be $54,438 per year based on the following assumptions:

- A change in land use within the Project Area of 18.5 ha resulting in a reduction of $7,395 per year as outlined in **Table 14** (DPI, 2022).
- An estimated overall stocking reduction of 20 % for the remaining Project Area subject to agriculture, resulting in reduction of $47,043 per year.
- Sheep grazing enterprise only.

Note: as local experience of agrisolar practices is still developing, a 20 % reduction was considered conservative and suitable for the purposes of this assessment. Some studies show a reduction of <20%, whilst others note up to 25% reduction over summer or less rainfall periods, therefore a 20% reduction has been used.

Table 14: Estimated Productivity Reduction from Land Removed From Agricultural Use

Enterprise (DPI, 2022)	Estimated Gross Margin ($/ha/year)	Land Removed From Agricultural Use (ha)	Gross Margin ($/year)
Merino Ewes (20 micron) – Merino Rams	399.75	18.5	7,395

Due to the minimal disturbance to the landform, following the life of the Project, all land removed from agriculture will be returned to agricultural use, with no reductions in land and soil capability. Agricultural enterprises can then re-commence at an equivalent agricultural productivity.

5.2.2 SECONDARY PRODUCTIVITY

By applying economic multipliers to the estimated productivity reduction of the Project Area, it is possible to estimate the value that would be removed from the NSW economy as a result of the Project. The Economic Impact Assessment (Gillespie 2023) details the methodology applied and the resultant economic productivity reduction based on the proposed construction phase of 18 months and during the operational phase.

5.2.3 PRODUCTIVITY OF LAND WITHIN LOCALITY

Agricultural productivity of land outside of the Project Area will not be affected by the Project as the associated agricultural resources will not be affected. Therefore, the Project will not negatively impact any existing agricultural enterprise outside of the Project Area.

5.2.4 AGRICULTURE SUPPORT SERVICES

The Project will have a negligible impact on local, regional and state agricultural services. Changes to the supply and viability of agricultural support services in the main service centres of Tamworth and Armidale are driven by social and market trends far exceeding the scale of the minor reduction in agricultural land use and productivity as a result of the Project.

The temporary reduction in livestock being sold during project construction and the 20% reduction for 30 years will be a negligible impact on the Tamworth Regional Livestock Exchange, as this reduction is estimated to represents <0.01% of all livestock sold. Tamworth Regional Livestock Exchange sells approximately 10.9% of the States cattle and 2.57% of the States Sheep (MLA 2022), therefore the impact of the Project on NSW would be <0.001% for cattle and <0.00025% for sheep.

5.2.5 CRITICAL MASS THRESHOLDS

Due to the limited reduction in agricultural activity as a result of the Project, there will be no impact to critical mass thresholds of agricultural enterprises needed to attract and maintain investment in agricultural service industries and infrastructure.

5.3 AGRICULTURAL RESOURCES

5.3.1 SOILS

Over most of the Project Area, soils will be subject to minor disturbance as part of the construction or maintenance of solar arrays and electrical cabling trenches. In areas where earthworks are necessary for construction of the BESS, substation and switching station, site facilities or access tracks, soils will be subject to higher impact disturbance.

All soil that is proposed to be disturbed during the Project will be stripped and stored for re-use in rehabilitation efforts in order to mitigate long term effects on soil resources. Given the limited surface disturbance anticipated, all soil stripping and re-use will be localised; that is, soil will be stripped and stored adjacent to disturbance and respread from where it was stripped. This localised approach will promote reinstatement of the soil profile to its original condition.

Additionally, soils will be stripped only in areas where soil disturbance occurs. The depth of soil salvaged will be as deep as excavations or surface disturbance is required, or to a depth where parent material is encountered.

Impacts on soil biological balance and nutrient availability are linked to the status of vegetation beneath the solar panels. Grazing of grass and pastures will continue with required inputs to maintain vegetation cover, therefore with grass cover maintained across the site both between and under the panel rows to provide groundcover, there will be negligible soil composition and productivity impacts as a result of the panels.

A study undertaken in the USA found over a two year period, pastures produced under solar panels produced 38% less forage than open pastures (Andrew et al, 2021). If vegetation beneath the panels is significantly reduced over long periods during operations, the soil may be temporarily sterilised and will require additional efforts and costs at the time of site decommissioning to restore the soil to a level of productivity equivalent to pre-disturbance conditions.

Overall, the impacts to the soils of the Project Area are expected to be minimal and temporary. There will be no direct or indirect impacts to the soil resources of the Project locality outside the Project Area.

Further soil impact mitigation measures are outlined in Section 6.2.

5.3.2 LAND AND SOIL CAPABILITY

Due to the nature of the Project which will require only localised and sporadic landform modification including soil stripping (for excavation works and/or minor leveling), impacts on LSC are expected to be minor. The preliminary surface disturbance footprint for large site infrastructure is shown on **Figure 2**.

Following the end of life for the Project, disturbance footprints will be re-graded (where required) and stockpiled topsoil and subsoil be respread over disturbed areas and rehabilitated with either native vegetation or improved pastures depending on the intended final land use. This strategy, along with good soil management practices as outlined in Section 6.2 will facilitate the rehabilitation in returning the land to an equivalent LSC class.

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

5.3.3 WATER

The risk of groundwater impacts during construction is also expected to be low as site levelling for the solar farm is expected to require excavation of no more than 0.40 – 0.60 m, and trenches for underground cables and foundations for the Substation and BESS are expected to be up to 1.0 to 1.2 m deep.

Water volumes that will be required during construction and operation have been estimated based on an understanding of the construction requirements and schedule, as well as the operational water requirements.

Approximately 110 megalitres (ML) per annum of water will be required during the construction phase. Water required for construction will be supplied from existing or new on-site dams, surface water pumps or groundwater bores (subject to seasonal availability and water licence permissions) or alternatively from an offsite local source from an approved facility.

Water demand during the operation of the Project is expected to be minimal, with the largest requirement likely to be used for solar module cleaning. Water will also be made available for other general maintenance activities and emergency water supply (in the event of a fire). A small amount of potable (drinking) water (estimated at 0.4 ML per annum in an average year) will be collected in rainwater tanks from temporary site compound buildings or imported during the construction period on an as-needs basis to top up the water tanks.

No water network upgrade will be required for the Project construction and operation. Water supply agreements would be secured in consultation with Tamworth Regional Council and/or local water suppliers to ensure adequate water supply is secured for construction and operation.

No impacts are anticipated on the availability of current surface or groundwater resources used by local landholders.

Further, a hydrologic and hydraulic assessment determined the Project will not create any significant adverse impacts to flood behaviour on the subject site, downstream properties and floodplain (Northrop Consulting, 2023).

5.3.4 EROSION AND SEDIMENTATION

Erosion risks are primarily associated with the anticipated impacts to sodic subsoils in the vicinity of the proposed BESS location and switchyard/ switching station; however, EAT classes throughout the entire Project Area indicate the widespread presence of potentially dispersive soils with the potential for increased dispersion upon disturbance. Suitable erosion and sedimentation controls, as outlined in Section 6.2, will be implemented that target these specific erosion hazards to reduce impacts to surface soils and waterways.

5.3.5 AGRICULTURAL INFRASTRUCTURE

The Project will have a no material impact on the functionality of local and regional agricultural infrastructure. There will be no impacts on the road network that connects the agricultural industry to markets, services and suppliers.

Stock fences, dams and access tracks will be retained to accommodate agrisolar. Upgrades to access tracks throughout the Project will benefit post-Project agricultural land uses and is considered a positive impact.

5.4 OTHER POTENTIAL IMPACTS ON AGRICULTURE

5.4.1 PEST SPECIES

Pest species could be inadvertently brought into the Project Area with imported materials, machinery, or allowed to invade naturally through removal or damage of current vegetation. The presence of weed species has the potential to be a major hindrance to rehabilitation, regeneration activities, and agricultural endeavours.

Weeds in general will be managed across the site through a series of control measures, including:

- Prior to re-spreading stockpiled topsoil onto the disturbance area, an assessment of weed infestation on stockpiles will be undertaken to determine if individual stockpiles require herbicide application and / or “scalping” of weed species prior to topsoil spreading.
- Rehabilitation monitoring programs and routine inspections will be undertaken to identify potential weed infestations; and
- There will be an ongoing effort to identify and eliminate (spray) existing weed populations on-site over the life of the Project.

The spread of declared noxious weeds will be prevented by using the measures above. The monitoring and control of weed populations within the site will significantly reduce weed infestations. Weed control, if required, will be undertaken in a manner that will minimise soil disturbance. Any use of herbicides will be carried out in accordance with the regulatory requirements. Records will be maintained of weed infestations and control programs will be implemented according to best management practice for the weed species concerned.

Pest animal control will be undertaken in consultation with neighbouring landholders. Programs to control pest animal species will include the determination of appropriate control practices, consultation with appropriate authorities, obtaining appropriate approvals, implementing control practices, and undertaking follow-up monitoring and control as required. If a substantial increase in the numbers of any known pest animal species, or the occurrence of a previously unrecorded pest animal species, is discovered, advice will be sought from a suitably qualified and experienced person on the management and control options for that species and appropriate measures for mitigating any impacts caused by its management on native species.

Pest animal species may include goats, foxes, cats, rabbits, pigs, and dogs and will be controlled in accordance with Livestock Health and Pest Authority procedures.

5.4.2 BIOSECURITY

Biosecurity is defined in the 'Draft NSW Biosecurity Strategy' (DPI, 2021) as 'the protection of the economy, environment and community from pests, diseases and weeds. It includes measures to prevent new pests, diseases and weeds from entering our country and becoming established. At the local level, as per Section 5.4.1 above, appropriate weed management will reduce biosecurity risks. On a regional level, any import of equipment or machinery from overseas will follow the standard procurement safeguards and quarantine procedures as per Australian requirements, including but not limited to product and packaging declarations, cargo compliance verification, inspections and clearance of goods, and reportable biosecurity activities/incidents. Given the processes above, it is considered that the Project will not have any potential impact on the biosecurity of agricultural resources and enterprises within the region.

5.4.3 AIR QUALITY AND DUST

Construction has the potential to increase dust through movement of traffic on unsealed roads on dry days, vegetation removal, and localised dust emissions generated by land disturbance (such as excavation activities required for infrastructure).

During operations, ongoing maintenance of infrastructures and land will result in very minor, localised vehicle emissions and generation of dust from vehicles travelling along unsealed internal access tracks. These impacts are unlikely to affect agriculture and standard dust suppression measures can be readily implemented where required.

5.4.4 TRAFFIC

Agricultural enterprises can be impacted by increased traffic movements through an increase in noise and dust, and also through the cumulative impact of road transport being utilised by solar farm operations, leaving fewer transport options for agricultural enterprises.

The roads in proximity to the Project Area are anticipated to experience an increase in traffic volumes during the peak construction period. However, the Traffic Impact Assessment (Amber, 2023) determined that the current road network has adequate capacity for construction traffic and free flow conditions would continue. Further, no increases in levels of noise and dust that could impact agriculture will result from increased traffic.

Therefore, the traffic impacts of the Project are not likely to have consequences on agricultural enterprises within the Project locality.

5.4.5 NOISE

ERM has conducted a Noise Impact Assessment assessing potential construction and operational noise impacts associated with Bendemeer Solar Farm. In the assessment, the existing noise environment was quantified, and noise sensitive receivers were identified. Construction and operational noise assessment criteria were developed in accordance with the relevant NSW standards and guidelines, namely the Noise Policy for Industry (NPI) (NSW EPA, 2017), Interim Construction Noise Guideline (ICNG) (NSW DECC, 2009) and the Road Noise Policy (RNP) (NSW DECCW, 2011).

Generally, agriculture is only impacted by noise when constantly high noise levels or sudden loud noise leads to a decrease in animal production through increased livestock stress. Cattle may tolerate moderate levels of noise and may easily adapt to an intensity level of 60-90 dB. Continuous exposure to noise above 90 dB has been known to severely affect animals (Dairy Global, 2017).

The assessment of potential noise impacts has been undertaken via a Noise Impact Assessment (NIA). Appropriate mitigation measures are specified within the NIA to minimise noise impacts. As a result, the NIA does not predict greater than 90dBA where cattle will be located on a non-associated property adjacent to the Project Area. As such, livestock and other agricultural resources are unlikely to be impacted by traffic noise due to the Project.

5.5 CUMULATIVE IMPACTS

The Project has the potential to generate cumulative impacts with other existing, approved or proposed developments in the region. There are several developed, approved or proposed energy-related SSDs listed on the Major Projects website for the region, in addition to the Project, as further detailed in the EIS for the Project.

The applicability of agrisolar to solar farm projects is especially relevant to the New England Renewable Energy Zone given the suitable conditions for sheep grazing and the established wool, sheep and lambing industries. The cumulative impact on agricultural production for the region is considered to be low given changes to agricultural land use and agricultural productivity are anticipated to be minor for each respective project, assuming other renewable projects in the region implement agrisolar or a combination of renewable and agriculture land uses, and assuming other developments such as mining, industrial development, urban development and re-zoning of large lots into smaller rural residential has minimal land disturbance.

Increased cumulative impacts including changes to land used for agricultural, localised productivity, secondary productivity and some agricultural support services are likely to be experienced where renewable projects in the New England Renewable Energy Zone do not implement agriculture as a coexisting landuse. However, given the nature and scale of the established agricultural industries within the region, significant impacts to critical mass thresholds and regional agricultural infrastructure are unlikely to occur in the foreseeable future.

6 MITIGATION MEASURES

The Project will include several measures to prevent, minimise and manage adverse impacts on agricultural resources. This incorporates procedural mitigation measures along with a land management process that ensures the Project has negligible impact on agricultural resources and enterprise.

In addition to the specific measures described in this assessment, all activities associated with the Project will be conducted in consideration of approval obligations and environmental management measures in development consent stipulated environmental management plans.

6.1 PROJECT ALTERNATIVES AND DESIGN

The Applicant has undertaken a constraints and opportunities analysis process to identify potential development sites for its projects. For the Bendemeer Solar Farm, this process included consideration of factors such as:

- Access to existing transmission assets to accept energy from the solar farm.
- Access to, and capacity of, existing energy grids.
- Proximity to coal generators that are planned for closure and need replacement.
- Generation/storage capacity.
- Potential for land acquisition.
- Land suitability (e.g., topography, existing land use, flood risk, zoning).
- Need to minimise environmental and social impacts (e.g., avoiding sensitive environments, areas of cultural heritage value, population centres).

The site selection process undertaken included consideration of factors such as the availability and extent of land for housing solar arrays, the consequent potential capacity for generation, the capacity of the grid to receive the generated electricity, the capital and operational costs of the project, and anticipated market conditions.

The final design and configuration of the Project will reflect the findings of EIS studies and investigations and will follow the hierarchy of impact avoidance, minimisation and mitigation. This will include consideration of environmental and social factors such as the need to:

- Identify and operate within environmental constraints (such as avoiding areas within the Project Area that may be of conservation or cultural significance).
- Minimise disruption to local landholders.
- Minimise amenity issues.
- Consider the expectations and concerns of the local community and Council.

These considerations will be balanced against the need to achieve design, construction and operational efficiencies to reduce projects costs and maximise solar farm efficiency.

The Applicant has made several decisions regarding the layout of the site in response to agricultural and land use considerations. This solar array type was chosen for its simplicity, proven technology and cost-effectiveness, and because it allows retention of existing grassland vegetation in situ with minimal ground disturbance and 6 m spacing of rows in order to facilitate agrisolar and minimise soil impacts. This design approach is a critical mitigation measure employed to reduce the impacts to agriculture as a result of the Project. No further design amendments are recommended.

6.2 LAND AND SOIL DISTURBANCE MITIGATION

6.2.1 SOIL EROSION MANAGEMENT

Based on site observations, there are no significant erosion and sedimentation issues present at the Project Area. However, as the dispersion risk status of the tested soils indicate, there is a potential risk for dispersion for the soils within the Project Area which would result in long term agricultural impacts.

The Project will prepare an erosion and sediment control plan (ESCP) that addressed specific soil dispersion risks based on disturbance activity and phase of the Project, and may include the following:

Construction Phase

- Construction should proceed in sections, and within each section the construction activities will be sequenced, such that the construction zones at any one time will only be a proportion of the overall Project Area.
- Where practical and feasible, the Project should utilise the existing landform and not endeavour to undertake broad-scale re-contouring of the existing ground levels without referring to this soil and land resource assessment and implementing erosion and sediment control accordingly. As a result, the existing vegetative cover and soil structure will be maintained intact across much of the Project Area.
- Construction areas should be progressively revegetated with grass and pasture species as installation of solar panels proceeds across the site, or rehabilitation of the surface post-civil works and prior to panel installation.
- At locations where earthworks are necessary, such as for construction of substation pads, or site facilities, localised erosion and sediment controls will be placed in accordance with the Landcom (2004) guidelines.
- Where practical and feasible, preservation and stabilisation of drainageways and minimisation of the extent and duration of any surface disturbance will be prioritised during construction.
- If sodic subsoils of Soil Unit 2: Sodosols are inadvertently exposed, it is recommended to apply gypsum as an ameliorant to displace the sodium and provide the soil with a stronger aggregate and hold structure when wet.
- All areas disturbed during construction that are not in active use for over 3 months, should be sown with grass and pasture species with starter fertiliser to provide stabilising ground cover and a healthy topsoil to provide long term protection against erosion.

Operation Phase

- Soil disturbance during operation of the Project should be minimal and limited to maintenance activities, involving very small, localised disturbance areas on an infrequent basis.
- Standard erosion and sediment control measures should be implemented to minimise the potential for sediment export within areas to be disturbed during operations. These measures would be developed on a case-by-case basis referring to this soil assessment and are likely to include measures such as sediment fencing, localised sediment traps, and progressive stabilisation with vegetation.
- Measures to manage any bare areas and erosion that develop beneath the solar arrays over time should be included in a land or groundcover management plan for implementation during ongoing operation of the proposal.

Decommissioning and Rehabilitation Phase

- A detailed Decommissioning and Rehabilitation Plan should be prepared within 1 year of the planned closure of the Project. This plan will detail all aspects of decommissioning and removal of all infrastructure unwanted for post Project land use (some infrastructure may remain for post Project land use purposes i.e., constructed internal roads may be kept as part of the agricultural infrastructure), which may require temporary erosion and sediment control measures.

- During decommissioning, where potential erosive impacts have been identified due to the disturbance of sodic subsoils associated with the Chromosol/ Sodosol Complex, primarily in the proposed BESS location, soil amelioration should be undertaken as part of remediation earthworks. Standard temporary erosion and sediment control measures are to be put in place for high disturbance areas.

6.2.2 SOIL STRIPPING FOR REHABILITATION

Soil that is proposed to be disturbed during the Project will be stripped and either directly re-applied over disturbed areas or stored for re-use in rehabilitation efforts to mitigate long term effects on the land and soil capability of the Project Area. Some stockpiled soils may be utilised as noise or visual bunds or for erosion and sedimentation control structures.

The entirety of the Project Area has been assessed to determine suitability for stripping and re-use. This will allow site managers to make decisions on soil stripping for re-use when the locations of soil disturbance for surface infrastructure have been finalised. This localised, fluid approach is an integral process for successful rehabilitation of the Project. This section provides information on the following key areas related to the management of the topsoil resources for the area within the Project Area.

Soil Stripping Strategy

Laboratory soil analytical results (refer **Appendix 2**) were used in conjunction with the field assessment to determine the potential risk associated with soil material for recovery and re-use in rehabilitation, following the life of the Project. Structural and textural properties of soils, along with stones, dispersion potential, sodicity and high acidity are the most common and significant limiting factors in determining depth of soil suitability for re-use; however, given the limited surface disturbance, it is anticipated that all soil stripping and re-use will be localised; that is, soil will be respread from where it is stripped, reinstating the soil profile to its original condition.

Additionally, soils will be stripped only in areas where soil disturbance occurs. The depth of soil salvaged should be as deep as excavations or surface disturbance is required, or to a depth where parent material is encountered.

Due to the sodic nature of the soils, controls must be implemented to manage the high risk of surface water erosion likely to occur once excavated, exposed and stored. Upon respreading, clay subsoils that have been stripped should be used exclusively as a subsoil and encapsulated by the loamy topsoils with which they are currently capped.

Higher Impact Areas

It is recommended that proposed long term stockpiles in areas associated with the higher impact activities where larger amounts of soil will be displaced should be stripped of topsoil. Then the excavated subsoil (if requiring disturbance) should be placed on the exposed subsoil of the stockpile area to create a low-profile landform of subsoil. A thin layer of topsoil material from the stripped areas should be placed as a 'cap' over the subsoil stockpiles to promote vegetation growth. Topsoil materials should otherwise be stockpiled separately to subsoils.

Topsoil and subsoil depths for these areas should be recorded in GIS and rehabilitated with target species to build up the seedbank over the years of stockpiling.

Stripped Soil Management

The following soil handling techniques are recommended to prevent excessive soil deterioration and dispersion.

- Strip soil material to maximum required excavation depths only.
- Soil should ideally be stripped in a slightly moist condition. Material should not be stripped in either an excessively dry or wet condition (where practicable).
- Push soil into windrows or small stockpiles with graders. This technique is an example of preferential less aggressive soil handling. This minimises compression effects of the heavy equipment that is often necessary for economical transport of soil material.

- Stockpile topsoils and subsoils materials separately.
- The surface of soil stockpiles should be left in as coarsely structured a condition as possible in order to promote infiltration and minimise erosion until vegetation is established, and to prevent anaerobic zones forming.
- Where necessary, a flow diversion bank or catch drain should be placed up-slope of a stockpile to direct surface water flows away. All stockpiles shall remain in a free-draining location to avoid long term soil saturation.
- Where necessary, silt fences or cleared vegetation should be installed around topsoil stockpiles or stripped areas as a form of erosion and sediment control. Mulch or wood chip from cleared vegetation can also be applied as a veneer over topsoil stockpiles to slow erosion, weed establishment and to maintain moisture content.
- Maintain a maximum stockpile height of 3 m. Clayey soils should be stored in lower stockpiles for shorter periods of time compared to coarser textured sandy soils. Soils may also be utilised in noise/visual bunds or in erosion and sediment control structures.
- Seed and fertilise stockpiles as soon as possible. An annual cover crop species that produce sterile florets or seeds may be sown. A rapid growing and healthy annual pasture sward will provide sufficient competition to minimise the emergence of undesirable weed species. The annual pasture species will not persist in the rehabilitation areas but will provide sufficient competition for emerging weed species and enhance the desirable micro-organism activity in the soil. Final rehabilitation target species should be established on stockpiles to build up a desirable species seed bank in the topsoil.
- An inventory of available soil should be maintained to ensure adequate materials are available for planned rehabilitation activities when the time comes.
- Prior to re-spreading stockpiled topsoil onto the disturbance area, an assessment of weed infestation on stockpiles should be undertaken to determine if individual stockpiles require herbicide application and / or “scalping” of weed species prior to topsoil spreading.

Soil Re-spreading and Seedbed Preparation

The following re-spreading and seedbank preparation techniques are recommended to prevent excessive soil deterioration and dispersion.

- Topsoil should be spread to a depth that reflects pre-disturbance soil horizons.
- Topsoil should be spread, treated with fertiliser and seeded in one consecutive operation, to reduce the potential for topsoil loss to wind and water erosion. Thorough seedbed preparation should be undertaken to ensure optimum establishment and growth of vegetation.
- All topsoiled areas should be lightly contour ripped (after topsoil spreading) to create a “key” between the soil and material below. Ripping should be undertaken on the contour. Best results will be obtained by ripping when soil is moist and when undertaken immediately prior to sowing.
- The respread soil surface should be scarified prior to, or during seeding, to reduce run-off and increase infiltration. This can be undertaken by contour tilling with a fine-tyned plough or disc harrow.

6.2.3 SOIL BIOLOGY MANAGEMENT

During the 30 year life of the Project, it is unlikely that there will be impacts on soil biology given pasture maintenance and grazing activities will continue, however soil changes may leave legacy effects that could persist long after the installation is removed, if effective rehabilitation is not undertaken post decommissioning.

Based on the intensity of the panel array layout and potential for stock to graze under the panels, the soil will be able to retain and store nutrients. Upon decommissioning the areas under the panels may be seen to have a short term decrease in productivity compared to adjacent areas, however commitments to achieve a groundcover level during the post operative period will be sufficient to increase soil productivity to match adjacent analogue areas.

Several mitigation measures are available for the operational phase to mitigate the long-term impacts of the Projects on soil biological balance and nutrient availability. These include:

- Routine vegetation monitoring and maintenance.
- Erosion and sediment controls to preserve topsoil material.
- Routine monitoring and management of visible surface erosion, such as rilling caused by concentrated flows from infrastructure.
- Promotion of grass cover in spacing between each of the solar panel array rows.
- Weed management strategies to promote continued presence of pasture species and seedbank within topsoil.

These should be incorporated into the Land Management Plan, which will guide operational environmental management following the final design of the Project and would be approved by the relevant statutory authority.

Soil sterilisation, localised or widespread, remains a minor risk throughout the Project. However, soil rehabilitation measures at the decommissioning stage can be employed to restore soil biological balance and nutrient availability. Measures include the application of mulch and organic materials, fertilisers, soil ameliorants and regenerative farming practices. Further, the spacing between each of the solar panel rows are anticipated to remain biologically active and act as an established source of bioactivity for spreading into potentially sterilised islands following the removal of panels.

6.3 MONITORING PROGRAMS

Monitoring programs outlined in the Soil and Water Management Plan will be instituted to assess predicted verses actual impacts as the Project progresses to implement controls where required. All operations associated with the Project will be undertaken in accordance with approved environmental management plans and strategies. The management plans will include environmental monitoring programs, where required. Key management plans, or chapters housed within approved environmental management plans will include land management practices, that will assist in managing impacts on agricultural land.

These management plans, which will include mitigation measures to control impacts to soils and agriculture, will be reviewed and revised where necessary to incorporate the requirements associated with the Project prior to commencement.

6.4 AGRISOLAR

Agrisolar refers to co-developing the same area of land for both use as a solar farm as well as for agriculture activities (Clean Energy Council, 2021). By implementing complementary solar energy and agricultural production, impacts to existing agricultural land use and enterprises, including primary and secondary productivity, can be reduced.

With the development of solar farms commencing in Australia from around 2015 onwards, the local experience of agrisolar practices is still developing and currently dominated by the practice of sheep grazing on solar farms (Clean Energy Council, 2021). By 2020, there were at least 13 large-scale solar farms grazing sheep in Australia.

The Applicant is committed to integrating solar panel installation with the existing agricultural use at the Project Area as a means of mitigating the impacts to agriculture.

Solar Farms typically require access to relatively flat or gently sloping land in sunny areas within proximity to electricity transmission networks, where biodiversity impacts can be avoided or minimised. This often means that land which has been previously cleared or zoned for agricultural use is well-situated to host solar farm developments.

Where solar farms are proposed and developed, there is increasing interest in exploring the opportunities for complementary agricultural activities which can benefit from several the valuable characteristics of solar arrays, including:

- The provision of partial shading and weather protection (including sun, rain, hail and wind).
- Improved soil moisture retention, which can lead to improved vegetation growth beneath the panels.
- Protection from predators for sheep.

Sheep grazing delivers benefits for the operation of solar farms, as the vegetation is maintained in a cost-effective and safe manner by reducing the need for mowing or spraying. This maintenance reduces the risk of fire hazard, protecting the solar assets and neighbouring properties. Further, agrisolar can strengthens relationships, communication and interaction with local landholders and farming communities and mitigate land use conflicts.

The Project Area will be designed to be able to move sheep efficiently between the solar farm areas and other paddocks. This will accommodate flexibility for construction/ maintained works and fluctuations in vegetation growth.

6.5 MITIGATION SUMMARY

The mitigation measures pertaining to soils and agriculture that have been referenced in this assessment will form part of the Project approval commitments. A summary of these is presented in **Table 15**.

Table 15: Summary of Mitigation Measures

Risk Category	Mitigation Measure
Agricultural Land Use	Implement Agrisolar to reduce area of land removed from agricultural service. Agriculture land use will be re-established over the entire 606.9 ha Project Area at the time of decommissioning (unless otherwise agreed with the landowner and/or regulatory authorities).
Agricultural Productivity	Implement Agrisolar at a suitable stocking rate. Project Area will be returned to an equivalent agricultural productivity following the Project.
Soils	All soil that is proposed to be disturbed during the Project will be stripped and stored for re-use in rehabilitation. Channelised drainage patterns should be minimised and the Project should avoid hard engineering solutions for erosion control and preference soft, vegetated structures. All soil resources are to be managed throughout construction, operation and decommissioning phases of the Project in accordance with recommendations outlined in Section 6.2
LSC	Return disturbed land to an equivalent LSC class following the end of life for the Project, through site rehabilitation and good soil management practices as outlined in Section 6.2, will facilitate the rehabilitation in.
Erosion and Sedimentation	Suitable erosion and sedimentation controls, as outlined in Section 6.2, will be implemented
Infrastructure	Stock fences, dams and access tracks to be retained and maintained to accommodate Agrisolar.
Pest Species	Pest species will be managed in accordance with measures outlined in Section 5.4.1
Biosecurity	Biosecurity will be managed in accordance with measures outlined in Section 5.4.2

7 CONSULTATION

Extensive consultation was undertaken with a range of stakeholder groups and individual stakeholders during the scoping and EIS phases of the Project. These include regulators who have a decision-making role in project approvals, and groups or individuals who may be directly or indirectly affected by the project.

Consultation has included formal and informal engagement with the following as indicated in the main EIS volume:

- NSW Department of Primary Industries;
- NSW EPA;
- Tamworth State MP;
- Tamworth Regional Council;
- NSW Rural Fire Service;
- Fire and Rescue NSW;
- Biodiversity Conservation and Science Directorate – North West Planning Team;
- Mining, Exploration and Geoscience;
- Crown Lands;
- Transport for NSW;
- Tamworth Business Chamber;
- Macdonald River Landcare Group;
- TransGrid;
- neighbouring landowners; and
- the local community.

Direct consultation to inform this assessment was undertaken with land managers and landowners regarding current and historical management of land and agricultural practices on the Project Area and its surrounds, and the potential effects on local industries, support services and agribusinesses as a result to changes to agricultural enterprises in the Project Area.

8 CONCLUSION

There is a high level of certainty about the status of agricultural resources and enterprises in the Project Area, locality and broader region, based on the site verification assessment undertaken, consultation and desktop studies carried out. Further, there is a high level of confidence regarding the Project activities, surface disturbance requirements and commitments to returning land to pre-disturbance agricultural status following the life of the Project.

Based on these factors, the impacts on agriculture because of the Project are determined to be minimal, temporary, and limited to the Project Area. These impacts can be summarised as the following:

- Temporary removal of 606.9 ha from agricultural land use within the Project Area during the one year peak construction phase of the Project, assuming grazing will be re-introduced before the 18 month construction program is complete.
- Temporary removal of 18.5 ha from agricultural land use within the Project Area during the operational phase of the Project.
- Temporary removal of potential agricultural primary productivity to the estimated value of up to $250,067 during the construction phase of one year and $54,438 per year of the operational phase.
- Temporary impacts on soil resources within the Project Area where surface disturbance occurs.

Table 16 presents these revised impacts for comparison against previous iterations of this report which were included in the EIS. These changes are based on new data made available to Minesoils, and are considered negligible in context of assessment of impacts to soils and agriculture for the Project Area and wider region.

Table 16: Impacts as presented in the EIS against revised impacts of this report

Risk Category	EIS (previous report)	Post-EIS (this report)
Temporary removal of agricultural land use during construction	606.4 ha	606.9 ha
Temporary removal of agricultural land use during operation	14.8 ha	18.5 ha
Removal of potential agricultural primary productivity during construction	$249,861	$250,067
Removal of potential agricultural primary productivity during operation	$53,214	$54,438

It is anticipated that by adopting the principles of impact avoidance and minimisation during Project construction and operation and implementing effective decommissioning and rehabilitation at the end of Project life, the Project will have no permanent negative impacts on agricultural resources or enterprises.

A description of mitigation measures and management recommendations have been provided in Section 6 to eliminate the permanent and control the temporary risks of the Project on land and soil resources. The salvage of topsoil material for re-use purposes to stripping depths detailed in this report, combined with sound erosion and sedimentation management practices during construction, operational and decommissioning phases of the Project, will ensure rehabilitation requirements are met and land is returned to a pre-disturbance agricultural status.

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Appendix 1

Land Use Conflict Risk Assessment

Overview

LUCRA is a system to identify and assess the potential for land use conflict to occur between neighbouring land uses. It helps land managers and consent authorities assess the possibility for and potential level of future land use conflict.

The LUCRA compares and contrasts the Project against adjoining/surrounding land uses and activities for incompatibility and conflict issues based on the risks and impacts identified in Section 5, and the mitigation measures and controls presented in Section 6. Each potential conflict between the operation of the solar farm and adjacent land has been assessed and given a risk ranking based on probability and consequence as outlined in the following section.

Assumption

The status of rural land use in the area is not considered likely to change significantly during the life of the Project. For example, due to the location of the Project Area relative to major regional towns, it is considered unlikely that surrounding properties will undergo subdivision to accommodate residential or small-block rural developments. Accordingly, it is not expected that future changes to land use will occur that will generate new land use conflicts in addition to those identified.

Methodology

A risk ranking matrix (**Table A1**) provided by the DPI (2011) is used to rank the identified potential land use conflicts. The risk ranking matrix assesses the economic, social and environmental impacts according to the probability of occurrence and consequence of the impact.

Table A1: Risk Ranking Matrix

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

(Source: DPI, 2011)

The risk ranking 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 A2**) and 5 levels of 'consequence', (a number 1 to 5 as defined in **Table A3**) 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. A rank of 25 is the highest magnitude of risk; a highly likely, very serious event. A rank of 1 represents the lowest magnitude of risk; an almost impossible, very low consequence event. Low risk is a ranking score of 10 or below.

Table A2: Probability Definitions

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 or 'I've never heard of it happening.'

(Source: DPI, 2011)

Table A3: Consequence Definitions

	Description	Example of Implications
Level 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	• Harm or death to animals, fish, birds or plants • Long term damage to soil or water • Odours so offensive some people are evacuated or leave voluntarily • Many public complaints and serious damage to Council's reputation • Contravenes Protection of the Environment & Operations Act and the conditions of Council's licences and permits. Almost certain prosecution under the POEO Act
Level 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	• Water, soil or air impacted, possibly in the long term • Harm to animals, fish or birds or plants • Public complaints. Neighbour disputes occur. Impacts pass quickly • Contravenes the conditions of Council's licences, permits and the POEO Act • Likely prosecution
Level 3		
Moderate	• Moderate and/or medium-term impact to the environment and community • Some ongoing management implications • Neighbour disputes occur	• Water or soil known to be affected, probably in the short to medium-term (e.g. 1-5 years) • Management could include significant change of management needed for agricultural enterprises to continue
Level 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	• Theoretically could affect the environment or people but no impacts noticed • No complaints to Council • Does not affect the legal compliance status of Council
Level 5		
Negligible	• Very minor impact to the environment and community • Can be effectively managed as part of normal operations • Neighbour disputes unlikely	• No measurable or identifiable impact on the environment • No measurable impact on the community or impact is generally acceptable

(Source: DPI, 2011)

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
Construction	Land users in the locality may be concerned construction activity disturbances may affect livestock behaviour and/or breeding.	D	3	9	The assessment of potential noise impacts has been undertaken via a Noise Impact Assessment (NIA). Appropriate mitigation measures are specified within the NIA to minimise noise impacts. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to noise impacts on agricultural land users. Ongoing consultation with stakeholders will identify and address concerns if they arise.	D	4	5	Any complaints from neighbours regarding effects to livestock can be managed within normal operations.
Construction	Land users in the locality may be concerned that dust generated by construction activities may have adverse health implications for residential land users within the locality.	D	3	9	The assessment of potential dust impacts has been undertaken as part of the EIS. With the implementation of mitigation measures, the Project can be constructed without any significant impact to local and regional air quality. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to air quality impacts. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).	E	4	3	Effectiveness of mitigation measures will be measured as part of the Environmental Management System (EMS), which will include a Construction Environmental Management Plan (CEMP) that outlines dust suppression strategies.

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
Construction	Increased noise generated by construction activities and heavy vehicle movements may be perceived as nuisance to surrounding residential properties.	C	4	8	The assessment of potential noise impacts has been undertaken via a Noise Impact Assessment (NIA). Appropriate mitigation measures are specified within the NIA to minimise noise impacts. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to noise impacts on agricultural land users. Ongoing consultation with stakeholders will identify and address concerns if they arise.	D	4	5	Effectiveness of mitigation measures will be measured as part of the EMS, which will include reference to relevant noise criteria.
Construction	Land users in the locality may be concerned about changes to water quality, quantity and surface water flows that may affect the site and locality, including local waterways, from surface disturbances during construction activities	C	3	13	Consideration of impacts to surrounding water courses and water quality has been undertaken within the water impact assessment for the EIS. Appropriate mitigation measures are specified within the EIS, including soil erosion and sedimentation controls within this report, to minimise impacts to watercourse health and quality. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to watercourse health and quality. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved), such as a soil management plan and an erosion and sediment control plan.	D	3	9	Effectiveness of mitigation measures will be measured as part of the EMS, specifically the Soil and Water Management Plan (SWMP).

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
Construction	Use of surrounding roadways during construction of the solar farm may cause conflict by interacting with agricultural and/or local transport activities, and/or resulting in additional travel time for road users	C	4	8	The assessment of potential traffic impacts has been undertaken via a Traffic Impact Assessment (TIA), which found the road network can accommodate the traffic generated by the Project during the construction, operation and decommissioning stages. Appropriate mitigation measures are specified within the TIA to minimise impacts to the traffic environment. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to traffic for surrounding land users. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved)	D	4	5	The EMS, specifically the Traffic Management Plan (TMP), will include a complaint resolution and disciplinary procedure as a mechanism to address any issues identified by neighbouring land users.
Construction	Land users in the locality may be concerned about the possibility of increased vehicles during construction or operation may result in an accident with livestock, farm machinery or wildlife on roads.	D	1	19	The assessment of potential traffic impacts has been undertaken via a Traffic Impact Assessment (TIA). Appropriate mitigation measures are specified within the TIA to minimise impacts to the traffic environment. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to traffic for surrounding land users. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).	E	2	10	The EMS, specifically TMP, will include a complaint resolution and disciplinary procedure as a mechanism to address any issues identified by neighbouring land users

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
Construction	Public authorities may be concern about the increased demand for services and infrastructure that may result from the development, especially during the construction stage, including increased accommodation for workers, availability of medical facilities and capacity of surrounding waste facilities	C	5	4	The assessment of impacts related to the increased demand for surrounding services and infrastructure has been undertaken via a Social Impact Assessment (SIA) and as part of the EIS. Levels of anticipated increased demand and appropriate mitigation measures are specified within the SIA to minimise the risk for logistical issues associated with the increased demand for existing infrastructure and services. Ongoing consultation with stakeholders will identify and address concerns if they arise.	D	5	2	Effectiveness of mitigation measures will be measured as part of the EMS.
Construction	Stakeholders may have concerns that construction activities associated with the solar farm may damage existing infrastructure including transmission lines and public infrastructure.	C	4	8	Consideration of potential impacts to surrounding service provider infrastructure has been undertaken as part of the EIS. Appropriate mitigation measures are specified within the EIS and will be detailed in a Construction Environmental Management Plan (CEMP) to minimise the risk of construction activities damaging existing infrastructure. Compliance with construction management measures anticipated to reduce the risk of conflict related to damaging existing infrastructure. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).	D	4	5	No damage to existing infrastructure including transmission lines during the construction phase due to project activities.

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
Construction	Stakeholders may have concerns that the construction and operation of the solar farm may alter and disturb existing soil properties, undermining the suitability of the land for future agricultural production.	C	2	18	The assessment of soil characteristics, erodibility and land and soil capability has been undertaken within this agricultural assessment. Anticipated impacts and appropriate mitigation measures are provided within this report. Compliance with mitigation measures is anticipated to reduce the risk of potential conflicts related to future land capability for agriculture. Implement all measures specified in this report and associated management plans identified in the EIS and/or consent conditions (if approved).	E	3	6	Effectiveness of mitigation measures will be measured as part of the EMS, specifically the Soil and Water Management Plan (SWMP).
Agriculture Cessation	Stakeholders in the locality may be concerned about the reduction of land used for agricultural purposes or the reduction of productivity of the land	A	4	16	The assessment of the reduction of land used for agriculture and the productivity of land has been undertaken within this agricultural assessment. Anticipated impacts and appropriate mitigation measures are provided within the agricultural impact assessment report for stakeholder consideration. A Decommissioning and Rehabilitation Management Plan will ensure the land can be successfully returned to agricultural production following decommissioning.	D	4	5	Rehabilitation objectives and strategies (including performance measures) will be established in the Decommissioning and Rehabilitation
Agriculture Cessation	Land users in the locality may be concerned about impacts to agricultural support infrastructure in the Project locality and wider region	D	4	5	The assessment of the impacts to agricultural support infrastructure in the Project locality and wider region has been undertaken within this agricultural assessment. Anticipated impacts are determined to be negligible and presented in this report for land user consideration. Ongoing consultation with stakeholders will identify and address concerns if they arise.	D	5	2	No complaints from agriculture enterprises regarding impact to agricultural support infrastructure due to project activities.

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
Operation Traffic	Land users in the locality may be concerned about an increase in traffic volume on local roads throughout the operational phase of the Project, which may cause conflict by interacting with agriculture transport activities or increasing travel times over the life of the Project.	D	4	5	The assessment of potential traffic impacts during the operational phase of the Project has been undertaken via a Traffic Impact Assessment (TIA). Anticipated impacts are determined to be negligible and presented in the EIS for land user consideration. Ongoing consultation with stakeholders will identify and address concerns if they arise.	E	5	1	Effectiveness of mitigation measures will be measured as part of the EMS which will include a complaint handling system.
Operation Traffic	Land users in the locality may be concerned that dust generated by increased vehicle movements along access roads during the operational phase of the Project has the potential to impact air quality and may have adverse health implications for residential land users within the locality.	D	3	9	The assessment of potential dust impacts during the operational phase of the Project has been undertaken as part of the EIS. Anticipated impacts are determined to be negligible and presented in the EIS for land user consideration. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).	E	5	1	Effectiveness of mitigation measures will be measured as part of the EMS which will include a complaint handling system.
Operation Noise	Land users in the locality may be concerned about an increase in noise levels generated from power inverters, transformer system, tracker motors and maintenance activities throughout the operational phase of the Project.	C	3	13	The assessment of potential noise impacts has been undertaken via a Noise Impact Assessment (NIA). Anticipated impacts are determined presented in the EIS for land user consideration. Ongoing consultation with stakeholders will identify and address concerns if they arise.	D	4	5	Effectiveness of mitigation measures will be measured as part of the EMS.

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
Operation Visual Amenity	Stakeholders in the locality who wish to maintain views of the existing agricultural landscape may be concerned about the change in visual amenity resulting from the solar farm	B	3	17	The assessment of visual impacts to surrounding amenity has been undertaken via a Landscape and Visual Impact Assessment (LVIA). Appropriate mitigation measures are specified within the LVIA to minimise the risk of altered amenity for surrounding residents and public within the locality. Compliance with mitigation measures specified within the LVIA is anticipated to further limit visual impact from the Project. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).	C	4	8	Effectiveness of mitigation measures will be measured as part of the EMS which will include reference to measures proposed to minimise visual impacts.
Operation Visual Amenity	The solar farm location and potential for glare and reflectivity has the potential to impact the amenity of surrounding residential properties	C	3	13	The assessment of glare and reflectivity impacts to surrounding residential properties has been undertaken via a LVIA. Appropriate mitigation measures are specified within the LVIA to reduce and mitigate glare impact of the Project. Compliance with mitigation measures specified within the LVIA is anticipated to avoid potential glare impact from the Project. Ongoing consultation with stakeholders will identify and address concerns if they arise.	E	3	6	Effectiveness of mitigation measures will be measured as part of the EMS which will include reference to measures proposed to minimise glare impact.
Operation Social	Stakeholders in the locality may be concerned about impacts on agriculture-based tourism	C	3	13	Consideration of potential impacts to agriculture-based tourism has been undertaken as part of the EIS. Anticipated impacts are determined to be negligible and presented in the EIS for stakeholder consideration. Ongoing consultation with stakeholders will identify and address concerns if they arise.	E	4	3	Effectiveness of mitigation measures will be measured as part of the EMS which will include a complaint handling system.

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
Operation Pest Control	Land users in the locality may be concerned about weed, plant pest, plant disease or pest animal introduction and/or spread	B	2	21	The assessment of impacts to biodiversity has been undertaken via a BDAR. Consideration of the potential for pest species to impact agriculture has been included in this assessment. Appropriate mitigation measures are specified within the BDAR and this assessment to minimise the risk for weeds and pests to spread throughout the site and onto neighbouring land. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).	D	3	9	Effectiveness of mitigation measures will be measured as part of the EMS, specifically Vegetation Management Plan (VMP).
Operation Pest Control	Neighbouring property owners may be concerned about sprays from weed control adversely affecting adjacent land	D	4	5	Weed mitigation measures will be undertaken as per methodology specified in the Vegetation Management Plan (VMP) identified in the EIS and/or consent conditions (if approved), including spraying in a manner to prevent spray drift. Ongoing consultation with stakeholders will identify and address concerns if they arise.	E	4	3	Effectiveness of mitigation measures will be measured as part of the EMS, specifically Vegetation Management Plan (VMP).
Operation Pest Control	Land users in the locality may be concerned that waste generated by the development may increase the presence of pest animals and/or vermin which could impact agricultural productivity.	D	4	5	Consideration of waste related impacts has been undertaken as part of the EIS. Appropriate mitigation measures are specified in the Waste Management Plan (WMP) to minimise the risk of attracting pest animals and/or vermin. Compliance with mitigation measures specified in the EIS is anticipated to reduce the risk of conflict related to pest animals and/or vermin. Ongoing consultation with stakeholders will identify and address concerns if they arise.	E	4	3	Effectiveness of mitigation measures will be measured as part of the EMS, specifically WMP.

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
General Operation	Land users in the locality may be concerned about changes to site run-off water quality during operational phases of the Project	C	3	13	Consideration of impacts to surrounding water courses and water quality has been undertaken within the water impact assessment of the EIS. Appropriate mitigation measures are specified within the EIS, including soil erosion and sedimentation controls within this report, to minimise impacts to watercourse health and quality. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to watercourse health and quality. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved), such as an erosion and sediment control plan.	D	4	5	Effectiveness of mitigation measures will be measured as part of the EMS.
General Operation	Land users in the locality may be concerned about the risk of fires occurring at the site and their potential to spread to surrounding land, infrastructure or livestock	C	2	18	Consideration of potential bushfire impacts has been undertaken as part of a Preliminary Hazard Analysis (PHA) informing the EIS. Further, a Bushfire Assessment Report (BFAR) was prepared to identify and evaluate the potential hazards and risks associated with bushfires to and from the Project and the use of bushfire prone land. Appropriate mitigation measures are specified within the PHA and BFAR within the EIS to minimise the risk of fire to and from the Project incidents including their risk to people and potential to damage surrounding land. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).	E	2	10	Effectiveness of mitigation measures will be measured as part of the EMS.

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
General Operation	Stakeholders in the locality may be concerned about the effects on local and regional employment	C	1	4	Consideration of employment impacts has been undertaken as part of the SIA and Economic Assessment. Anticipated impacts are determined to be negligible and outweighed by the employment opportunities of the Project. This finding is presented in the SIA and Economic Assessment. for stakeholder consideration.	E	5	1	No unreasonable additional pressure to local employment due to project activities
General Operation	Neighbouring landowners may be concerned about livestock used for vegetation control on Project Area entering adjacent properties	D	4	5	Operational management plans will include a provision to 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. Ongoing consultation with stakeholders will identify and address concerns if they arise.	E	4	3	Effectiveness of mitigation measures will be measured as part of the EMS.
General Operation	Neighbouring landowners may be concerned about their livestock entering the Project Area and becoming injured or causing damage	D	4	5	Operational management plans will include a provision to 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. If livestock enter the site, the surrounding landowners should be contacted. Efforts will be made to ensure the animal is not distressed and kept away from public roads. Ongoing consultation with stakeholders will identify and address concerns if they arise.	E	4	3	Effectiveness of mitigation measures will be measured as part of the EMS.
General Operation	Land users in the locality may be concerned about electro-magnetic fields (EMF) resulting from electrical infrastructure associated with the Project.	D	2	14	Consideration of EMF impacts resulting from the development has been undertaken as part of the PHA. The PHA finds that the potential for the EMF to exceed the accepted levels is considered negligible. This finding is presented in the EIS for stakeholder consideration.	E	5	1	Nil.

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
General Operation	The placement of the solar farm on agriculturally viable land may cause conflict with surrounding agricultural operators interested in expanding their operations onto the Project Area.	C	3	13	Existing consultation and engagement for the Project has not identified any intent for surrounding agricultural industries to expand operations onto the Project Area in the short term. The reversibility of the Project would allow the site to be returned to its existing agricultural land use, therefore minimising potential for long term conflict.	E	3	6	Effectiveness of engagement will be measured as part of the EMS.
General Operation	The placement of the solar farm on land that may be viable for sub-division may cause conflict with surrounding business operators interested in expanding production onto the site.	D	3	9	Existing consultation and engagement for the Project has not identified any intent for nearby enterprises to expand operations onto the Project Area in the short term. The reversibility of the project would allow the site to be returned to its existing land use, therefore minimising potential for long term conflict.	E	3	6	Effectiveness of engagement will be measured as part of the EMS.
General Operation	The placement of the solar farm in proximity to agricultural business operators may affect insurance premiums for surrounding private property owners.	C	3	13	The Project will implement measures such as Asset Protection Zone (APZ) which ensures that fire cannot spread either from Project's infrastructures to surrounding properties or from adjoining properties. Therefore, avoiding the implications of costs and loss and difficulty in obtaining appropriate insurance for a reasonable premium. Ongoing consultation with stakeholders will identify and address concerns if they arise.	D	4	5	Effectiveness of engagement will be measured as part of the EMS.

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
General Operation	Landowners in the locality may be concerned about potential devaluation of properties due to proximity to solar farm infrastructure.	B	3	17	As outlined in the EIS, there are many factors that may influence land value, being amenities impact of the Project to the locality the key factor to devaluation. Given construction impacts will be temporary, it is unlikely to have a permanent impact on the amenity of the locality. The Project has been refined and where impacts could not be avoided, management and mitigation measures will be adopted to further reduce potential impacts that may cause devaluation of properties. This includes the introduction of vegetation screening and landscaping, and noise barriers to reduce potential views and noise disturbance of Project infrastructures. Therefore, the residual impacts of the Project during operational phase, after implementation of management and mitigation measures are predicted to be minimal. Ongoing consultation with stakeholders will identify and address concerns if they arise.	D	3	9	Effectiveness of engagement will be measured as part of the EMS.
General Operation	Landowners in the locality may be concerned about potential increase in council rates as a result of the change in land use of the Project Area.	C	3	13	Under the *Local Government Act 1993* solar farms or renewable energy developments are not identified as a sub category and as such they are required to be identified as a business category or agriculture or may be grouped with other locational activity. This could result in some increase in land value and subsequent increases in rates. However, it is not anticipated that this will impact land value or council rates on neighbouring agricultural properties. Ongoing consultation with stakeholders will identify and address concerns if they arise.	D	4	5	Effectiveness of engagement will be measured as part of the EMS.

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
General Operation	Land users in the locality may be concerned that waste generated by the development has the potential to enter surrounding residential land.	D	4	5	Consideration of waste related impacts has been undertaken as part of the EIS. Risk will be mitigated by implementing standard operation measures specified in the WMP identified in the EIS and/or consent conditions (if approved). Ongoing consultation with stakeholders will identify and address concerns if they arise.	E	5	1	Effectiveness of mitigation measures will be measured as part of the EMS, specifically WMP
General Operation	Land users in the locality may be concerned that the change in land use may attract people to the area who may not otherwise visit the area, including workers. This may be perceived to adversely affect a resident's security.	D	3	9	Workforce behaviour will be managed through the implementation of the EMS, which will encourage positive workforce behaviour. Ongoing consultation with stakeholders will identify and address concerns if they arise. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).	E	4	3	Effectiveness of engagement will be measured as part of the EMS.
General Operation	Stakeholders may have concerns regarding the ownership of the site i.e., whether it is a foreign-owned company	D	4	5	Engagement for the Project has introduced the Project and the Applicant (Athena Energy Australia (Holdings)) to surrounding stakeholders. Notification to stakeholders outlined the Applicant's ownership and consultation has provided an opportunity for stakeholders to provide feedback. No feedback has been provided regarding the ownership of the site.	E	4	3	Effectiveness of engagement will be measured as part of the EMS.
General Operation	Stakeholders may be concerned about impacts to heritage items or values at the site and locality.	B	4	12	An assessment of impacts to heritage has been undertaken with the preparation of an Aboriginal Cultural Heritage Assessment Report (ACHAR) and Statement of Heritage Impact (SOHI). Appropriate mitigation measures are specified within the ACHAR and SOHI to minimise impacts to heritage. Compliance with mitigation measures specified within the ACHAR and SOHI is anticipated to reduce the risk of conflict related to environmental features, culturally sensitive land and heritage. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved).	D	4	5	Effectiveness of mitigation measures will be measured as part of the EMS, specifically through an Aboriginal Cultural Heritage Management Plan (ACHMP) and Unanticipated Finds Protocol (UFP).

Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
General Operation	Stakeholders may be concern about potential impacts to biodiversity within the site and locality	B	3	17	The assessment of impacts to biodiversity has been undertaken via a BDAR. Appropriate mitigation measures are specified within the BDAR and this assessment to minimise the risk for impacts on biodiversity within the site and locality. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved). Ongoing consultation with stakeholders will identify and address concerns if they arise.	D	3	9	Effectiveness of engagement will be measured as part of the EMS.
General Operation	Public Authorities may have concerns regarding the potential for cumulative impacts arising from the proximity of state significant developments.	B	3	17	An assessment of potential cumulative impacts has been undertaken as part of the EIS. Appropriate mitigation measures (where required) are specified in the EIS to minimise the potential for cumulative impacts to occur at or near the Project Area. Anticipated impacts are determined to be minor and presented in the EIS for Public Authority consideration.	D	3	9	Effectiveness of engagement will be measured as part of the EMS.
General Operation	Dispersion of dust and/or agricultural/ rural products from surrounding land uses may impact the productivity of the solar farm panels, potentially causing conflict between agricultural land users and the solar farmland use.	C	4	8	Compliance with mitigation measures specified within the EIS together within the ongoing maintenance of solar panels and site infrastructure, is anticipated to reduce the risk of conflict related to the functioning of the solar farm panels.	D	5	2	No impact to solar farm operations or infrastructure.
Decommissioning	Stakeholders may be concerned about the potential for poor rehabilitation outcomes and the resulting long term environmental and agricultural consequence.	C	1	22	A Decommissioning and Rehabilitation Plan will ensure the land can be successfully returned to pre-disturbance land and soil capability and final land use commitments following decommissioning.	E	2	10	Rehabilitation objectives and strategies (including performance measures) will be established in the Decommissioning and Rehabilitation Management Plan.

Appendix 2

Soil Profile Descriptions

Site Description – Site 1				
Site Reference	1	**ASC Name**	Bleached-Mottled Eutrophic Brown Chromosol (BELOVNR)	
Average Slope	5%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper slope	**E.R.D.**	0.6m	X: 326492
Surface Condition	Soft	**Drainage**	Poor	Y: 6581441

Plate 1 – Soil Profile (1)

Plate 2 – Landscape (1)

Plate 3 – Surface (1)

Horizon	Depth (m)	Description
A1	0.00 – 0.12	Dark Reddish Brown (Munsell 5YR 3/2) Sandy Loam with weak pedality. Strongly acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.12 – 0.35	Dark Grayish Brown (Munsell 10YR 4/2) Sandy Loam with weak pedality. Moderately acidic pH, non-saline. Non-sodic. 20% coarse fragments 5 – 10mm. Few fine roots and moderately well drained. Clear boundary.
B2	0.35 – 0.60	Brown (Munsell 10YR 5/3) Light Medium Clay with strong pedality. Slightly acidic pH, non-saline and non-sodic. No coarse fragments. Nil roots. Poorly drained. 40% distinct orange mottling. Abrupt boundary.
C	0.60+	Weathered parent material

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 - 0.10	0.6	Non-saline	5.3	Strongly Acidic	0.4	Non sodic
0.20 - 0.30	0.3	Non-saline	5.7	Moderately Acidic	2.3	Non sodic
0.40 - 0.50	0.4	Non-saline	6.2	Slightly Acidic	5.2	Non sodic

Site Description – Site 2				
Site Reference	2	**ASC Name**	Brown Chromosol	
Average Slope	7%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper slope	**E.R.D.**	0.6m	X: 326062
Surface Condition	Soft	**Drainage**	Poor	Y: 6580964

Plate 1 – Soil Profile (2)

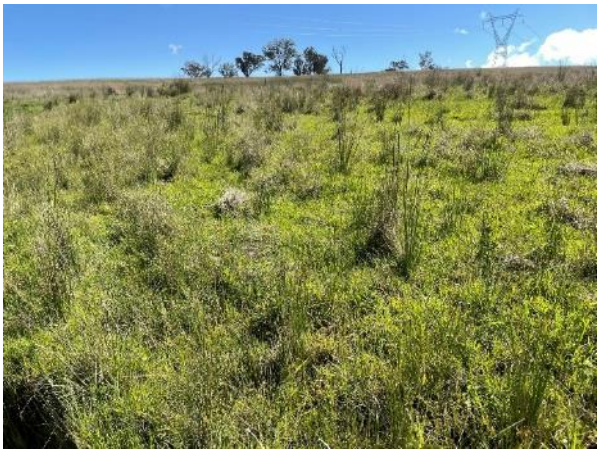

Plate 2 – Landscape (2)

Plate 3 – Surface (2)

Horizon	Depth (m)	Description
A	0.00 – 0.15	Very dark brown (Munsell 10YR 2/2) Sandy Loam field texture with weak pedality. No coarse fragments. Many fine roots and well drained. Gradual boundary.
B	0.15 – 0.50	Yellowish brown (Munsell 10YR 5/6) Sandy Clay field texture with strong pedality. No coarse fragments. Very few fine roots and poorly drained. 40% distinct grey mottling. Clear boundary.
C	0.50 +	Weathered parent material.

Site Description – Site 3				
Site Reference	3	**ASC Name**	Brown Chromosol	
Average Slope	3%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper slope	**E.R.D.**	0.8m	X: 325839
Surface Condition	Soft	**Drainage**	Moderately drained	Y: 6580763

Plate 1 – Soil Profile (3)

Plate 2 – Landscape (3)

Plate 3 – Surface (3)

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Black (Munsell 10YR 2/1) Sandy Loam field texture with weak pedality. No coarse fragments. Many fine roots and moderately well drained. Gradual boundary.
A2	0.15 – 0.40	Bleached light brown (Munsell 10YR 7/2) Sandy Clay Loam field texture with weak pedality. No coarse fragments. Very few fine roots and moderately drained. Clear boundary.
B2	0.40 – 0.60	Yellowish brown (Munsell 10YR 5/6) Heavy Clay field texture with strong pedality. No coarse fragments. Very few fine roots in upper section of layer. Moderately drained. Clear boundary.
C	0.60+	Weathered parent material.

Site Description – Site 4				
Site Reference	4	**ASC Name**	Mottled Eutrophic Gray Chromosol (BELOVNR)	
Average Slope	4%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper slope	**E.R.D.**	0.6m	X: 325840
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6580239

Plate 1 – Soil Profile (4)

Plate 2 – Landscape (4)

Plate 3 – Surface (4)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Dark Brown (Munsell 7.5YR 3/2) Sandy Loam with moderate pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.20 – 0.45	Dark Grayish Brown (Munsell 10YR 4/2) Sandy Loam with weak pedality. Neutral pH, non-saline. Non-sodic. No coarse fragments. Common fine roots and moderately drained. Clear boundary.
B2	0.45– 0.60	Brown (Munsell 7.5YR 4/2) Light Medium Clay with moderate pedality. Neutral pH, non-saline and non-sodic. 10% coarse fragments 20 mm at base of horizon. Few fine roots. Poorly drained. 10% distinct grey mottles. Gradual boundary.
BC	0.60 +	Weathered parent material.

Sample Depth	ECe		pH(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 - 0.10	0.7	Non-saline	5.7	Moderately Acidic	0.3	Non sodic
0.25 - 0.35	0.4	Non-saline	6.5	Neutral	0.3	Non sodic
0.50 - 0.60	0.5	Non-saline	7.3	Neutral	0.5	Non sodic

Site Description – Site 5				
Site Reference	5	**ASC Name**	Brown Chromosol	
Average Slope	8%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper slope	**E.R.D.**	0.6m	X: 325578
Surface Condition	Soft	**Drainage**	Moderately well drained	Y: 6580599

Plate 1 – Soil Profile (5)

Plate 2 – Landscape (5)

Plate 3 – Surface (5)

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Brown (Munsell 7.5YR 4/2) Sandy Loam field texture with moderate pedality. 5% coarse fragments 20 – 100mm. Many fine roots and well drained. Gradual boundary.
A2	0.15 – 0.40	Brown (Munsell 7.5YR 5/2) Sand field texture with weak pedality. No coarse fragments. Common fine roots and moderately well drained. Clear boundary.
B2	0.40 +	Strong Brown (Munsell 7.5YR 4/6) Sandy Clay field texture with strong pedality. No coarse fragments. Very few roots. Moderately well drained.

Site Description – Site 6				
Site Reference	6	**ASC Name**	Mottled Eutrophic Brown Chromosol (BELOVNR)	
Average Slope	5%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper slope	**E.R.D.**	0.6m	X: 325571
Surface Condition	Soft	**Drainage**	Imperfectly drained	Y: 6581257

Plate 1 – Soil Profile (6)

Plate 2 – Landscape (6)

Plate 3 – Surface (6)

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Black (Munsell 5YR 2.5/1) Sandy Loam with moderate pedality. Moderately acidic pH, non-saline. Non-sodic. 10% coarse fragments 10mm. Many fine roots and well drained. Gradual boundary.
A2	0.15 – 0.40	Dark Grayish Brown (Munsell 10YR 4/2) Sandy Loam with weak pedality. Slightly acidic pH, non-saline. Non-sodic. 10% coarse fragments 10mm. Common fine roots and imperfectly drained. Abrupt boundary.
B2	0.40 – 0.60	Light Olive Brown (Munsell 2.5Y 5/3) Medium Clay with moderate pedality. Neutral pH, non-saline and non-sodic. 10% coarse fragments 10mm. Very few fine roots. Imperfectly drained. 50% distinct orange mottles. Gradual boundary.
C	0.60+	Weathered parent material.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 - 0.10	0.3	Non-saline	5.8	Moderately Acidic	0.5	Non sodic
0.20 - 0.30	0.1	Non-saline	6.3	Slightly Acidic	1.5	Non sodic
0.40 - 0.50	0.2	Non-saline	6.9	Neutral	5.0	Non sodic

Site Description – Site 7				
Site Reference	7	**ASC Name**	Eutrophic Mottled-Subnatric Grey Sodosol (BEKOVNR)	
Average Slope	6%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Mid slope	**E.R.D.**	0.6m	X: 325921
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6581597

Plate 1 – Soil Profile (7)

Plate 2 – Landscape (7)

Plate 3 – Surface (7)

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark Reddish Brown (Munsell 5YR 2.5/2) Sandy Loam with moderate pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.15 – 0.30	Bleached Light Gray (Munsell 5YR 7/1) Sand with weak pedality. Slightly acidic pH, non-saline. Sodic. No coarse fragments. Common fine roots and imperfectly drained. Clear boundary.
B2	0.30 – 0.80	Light Brownish Gray to Pale Brown (Munsell 10YR 6/2 to 10YR 6/3) Heavy Clay with moderate pedality. Slightly acidic trending to neutral pH, non-saline and sodic. No coarse fragments. Very few fine roots. Imperfectly drained. 50% distinct grey mottles. Gradual boundary.
C	0.80+	Weathered parent material.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 - 0.10	0.3	Non-saline	5.5	Moderately Acidic	1.3	Non sodic
0.20 - 0.30	0.2	Non-saline	6.0	Slightly Acidic	2.5	Non sodic
0.40 - 0.50	0.1	Non-saline	6.4	Slightly Acidic	10.4	Sodic
0.70 - 0.80	0.4	Non-saline	6.7	Neutral	14.6	Sodic

Site Description – Site 8				
Site Reference	8	**ASC Name**	Grey Chromosol	
Average Slope	6%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Mid slope	**E.R.D.**	0.6m	X: 326267
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6581792

Plate 1 – Soil Profile (8)

Plate 2 – Landscape (8)

Plate 3 – Surface (8)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Brown (Munsell 7.5YR 4/2) Sandy Loam with moderate pedality. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.20 – 0.35	Bleached Light Gray (Munsell 5YR 7/1) Loamy Sand with weak pedality. No coarse fragments. Common fine roots and imperfectly drained. Clear boundary.
B2	0.35+	Dark Yellowish Brown (Munsell 10YR4/4) Medium Clay with moderate pedality. No coarse fragments. Very few fine roots. Poorly drained. 50% distinct grey mottles.

Site Description – Site 9				
Site Reference	9	**ASC Name**	Bleached-Mottled Brown Chromosol (BEKOVNR)	
Average Slope	6%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Mid slope	**E.R.D.**	0.8m	X: 326267
Surface Condition	Soft	**Drainage**	Imperfectly drained	Y: 6581792

Plate 1 – Soil Profile (9)

Plate 2 – Landscape (9)

Plate 3 – Surface (9)

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Very Dark Grayish Brown (Munsell 10YR 3/2) Loamy Sand with moderate pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.15 – 0.40	Bleached Light Gray (Munsell 5YR 7/1) Sand with weak pedality. Slightly acidic pH, non-saline. Non-sodic. No coarse fragments. Common fine roots and imperfectly drained. Abrupt boundary.
B22	0.40 – 0.80	Pale Brown (Munsell 10YR 6/3) Sandy Clay with moderate pedality. Neutral pH, non-saline and non-sodic. No coarse fragments. Very few fine roots. Imperfectly drained. 20% faint grey mottles. Gradual boundary.
C	0.80+	Weathered parent material.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.0 - 0.10	0.5	Non-saline	5.6	Moderately Acidic	2.4	Non sodic
0.20 - 0.30	0.2	Non-saline	6.3	Slightly Acidic	1.6	Non sodic
0.45 - 0.55	0.6	Non-saline	6.6	Neutral	4.3	Non sodic

Site Description – Site 10				
Site Reference	10	**ASC Name**	Brown Chromosol	
Average Slope	6%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Mid slope	**E.R.D.**	0.8m	X: 326680
Surface Condition	Soft	**Drainage**	Imperfectly drained	Y: 6581941

Plate 1 – Soil Profile (10)

Plate 2 – Landscape (10)

Plate 3 – Surface (10)

Horizon	Depth (m)	Description
A1	0.00 – 0.25	Brown (Munsell 7.5YR 4/2) Sandy Loam with moderate pedality. No coarse fragments. Many fine roots and well drained. Gradual boundary.
B21	0.25 – 0.55	Bleached Light Gray (Munsell 5YR 7/1) Loamy Sand with weak pedality. No coarse fragments. Common fine roots and imperfectly drained. Abrupt boundary.
B22	0.55+	Yellowish Brown (Munsell 10YR 5/8) Medium Clay with moderate pedality. No coarse fragments. Very few fine roots. Imperfectly drained. 20% faint grey mottles.

Site Description – Site 11				
Site Reference	11	**ASC Name**	Brown Chromosol	
Average Slope	1%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Drainage flat	**Land Use**	Grazing	MGA 56
Landform Element	Flat	**E.R.D.**	0.6m	X: 327125
Surface Condition	Soft	**Drainage**	Poor drainage	Y: 6581559

Plate 1 – Soil Profile (11)

Plate 2 – Landscape (11)

Plate 3 – Surface (11)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Brown (Munsell 7.5YR 4/2) Sandy Loam with moderate pedality. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.20 – 0.35	Bleached Light Gray (Munsell 5YR 7/1) Loamy Sand with weak pedality. No coarse fragments. Common fine roots and imperfectly drained. Clear boundary.
B2	0.35+	Dark Yellowish Brown (Munsell 10YR4/4) Medium Clay with moderate pedality. No coarse fragments. Very few fine roots. Poorly drained. 40% distinct grey mottles.

Site Description – Site 12				
Site Reference	12	**ASC Name**	Eutrophic Mottled-Subnatric Brown Sodosol (BEKOVNR)	
Average Slope	2%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Crest	**E.R.D.**	0.8m	X: 327474
Surface Condition	Soft	**Drainage**	Imperfect drainage	Y: 6581376

Plate 1 – Soil Profile (12)

Plate 2 – Landscape (12)

Plate 3 – Surface (12)

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Very Dark Grayish Brown (Munsell 10YR 3/2) Loamy Sand with moderate pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.15 – 0.35	Bleached Light Gray (Munsell 5YR 7/1) Loamy Sand with weak pedality. Slightly acidic pH, non-saline. Non-sodic. No coarse fragments. Common fine roots and imperfectly drained. Abrupt boundary.
B2	0.35 – 0.60	Brown (Munsell 10YR 5/3) Heavy Clay with moderate pedality. Neutral pH, non-saline and sodic. No coarse fragments. Very few fine roots. Poorly drained. 20% faint grey mottles. Gradual boundary.
C	0.60+	Weathered parent material.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.0 - 0.10	0.4	Non-saline	5.7	Moderately Acidic	1.5	Non sodic
0.20 - 0.30	0.3	Non-saline	6.2	Slightly Acidic	1.5	Non sodic
0.40 - 0.50	0.2	Non-saline	6.8	Neutral	7.6	Sodic

Site Description – Site 13				
Site Reference	13	**ASC Name**	Brown Sodosol	
Average Slope	3%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper Slope	**E.R.D.**	0.6m	X: 328019
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6581422

Plate 1 – Soil Profile (13)

Plate 2 – Landscape (13)

Plate 3 – Surface (13)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very dark brown (Munsell 7.5YR 2.5/3) Sandy Loam with moderate pedality. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.10 – 0.35	Bleached White (Munsell 10YR 8/1) apedal Sand. No coarse fragments. Common fine roots and imperfectly drained. Abrupt boundary.
B2	0.35 – 0.70	Reddish Yellow (Munsell 5YR 6/6) Sandy Clay with moderate pedality. No coarse fragments. Very few fine roots. Poorly drained. 20% faint grey mottles. Gradual boundary.
C	0.70+	Weathered parent material.

Site Description – Site 14				
Site Reference	14	**ASC Name**	Brown Sodosol	
Average Slope	1%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Drainage Bench	**Land Use**	Grazing	MGA 56
Landform Element	Flat	**E.R.D.**	0.6m	X: 328520
Surface Condition	Soft	**Drainage**	Moderately well drained	Y: 6581918

Plate 1 – Soil Profile (14)

Plate 2 – Landscape (14)

Plate 3 – Surface (14)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Brown (Munsell 7.5YR 4/2) Sandy Loam with moderate pedality. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.10 – 0.20	Bleached White (Munsell 10YR 8/1) Loamy Sand with weak pedality. No coarse fragments. Common fine roots and imperfectly drained. Abrupt boundary.
B2	0.20 – 0.40	Gray (Munsell 7.5YR 5/1) Sandy Clay with moderate pedality. No coarse fragments. Very few fine roots. Poorly drained. 20% faint orange mottles. Clear boundary.
C	0.40+	Weathered parent material.

Site Description – Site 15				
Site Reference	15	**ASC Name**	Bleached-Mottled Eutrophic Gray Chromosol (BEKOVNR)	
Average Slope	5%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Plateau	**Land Use**	Grazing	MGA 56
Landform Element	Upper Slope	**E.R.D.**	0.6m	X: 328627
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6581411

Plate 1 – Soil Profile (15)

Plate 2 – Landscape (15)

Plate 3 – Surface (15)

Horizon	Depth (m)	Description
A1	0.00 – 0.12	Black (Munsell 10YR 2/1) Loamy Sand with moderate pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.12 – 0.40	Bleached Light Gray (Munsell 5YR 7/1) Loamy Sand with weak pedality. Slightly acidic pH, non-saline. Non-sodic. No coarse fragments. Common fine roots and imperfectly drained. Clear boundary.
B2	0.40 – 0.60	Pale Brown (Munsell 10YR 6/3) Medium Clay with moderate pedality. Neutral pH, non-saline and non-sodic. No coarse fragments. Very few fine roots. Poorly drained. 30% distinct grey mottles. Gradual boundary.
C	0.60+	Weathered parent material.

Sample Depth	ECe		pH(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 - 0.10	0.5	Non-saline	5.9	Moderately Acidic	0.8	Non sodic
0.20 - 0.30	0.3	Non-saline	6.4	Slightly Acidic	1.0	Non sodic
0.40 - 0.50	0.2	Non-saline	6.8	Neutral	1.8	Non sodic

Site Description – Site 16				
Site Reference	16	**ASC Name**	Eutrophic Mottled-Subnatric Gray Sodosol (BELOVNR)	
Average Slope	6%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Mid slope	**E.R.D.**	0.5m	X: 329095
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6581319

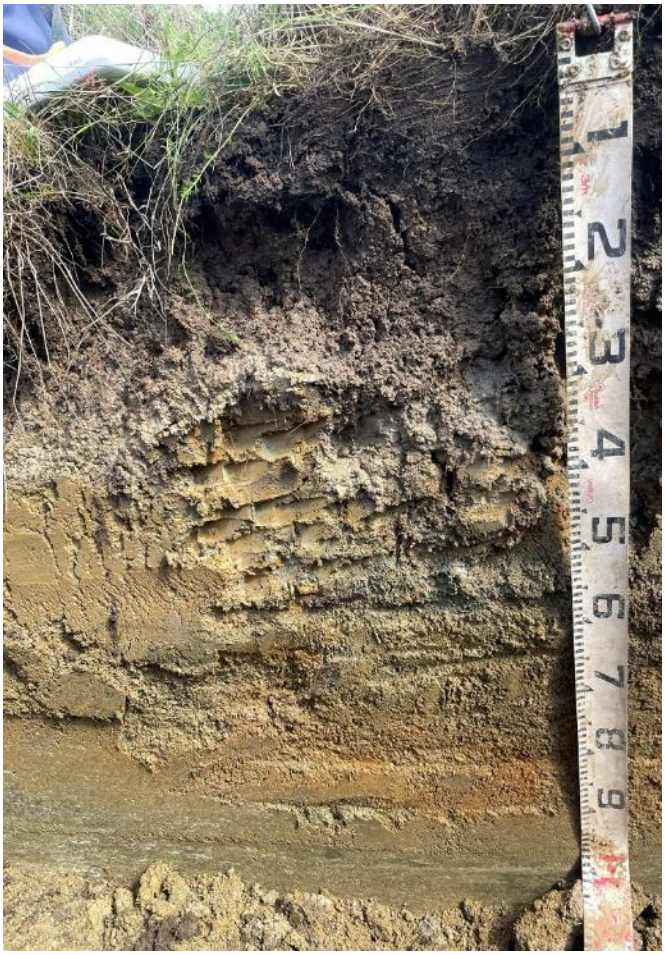

Plate 1 – Soil Profile (16)

Plate 2 – Landscape (16)

Plate 3 – Surface (16)

Horizon	Depth (m)	Description
A1	0.00 – 0.12	Very Dark Brown (Munsell 10YR 2/2) Sandy Loam with moderate pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.12 – 0.30	Bleached Light Gray (Munsell 5YR 7/1) Sandy Loam with weak pedality. Slightly acidic pH, non-saline. Non-sodic. No coarse fragments. Common fine roots and imperfectly drained. Clear boundary.
B2	0.30 – 0.60	Olive Gray (Munsell 5Y 5/2) Medium Clay with moderate pedality. Neutral pH, non-saline and sodic. No coarse fragments. Very few fine roots. Poorly drained. 30% distinct grey mottles. Gradual boundary.
C	0.60+	Weathered parent material.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.0 - 0.10	0.3	Non-saline	5.7	Moderately Acidic	0.8	Non sodic
0.20 - 0.30	0.1	Non-saline	6.3	Slightly Acidic	1.9	Non sodic
0.35 – 0.45	0.4	Non-saline	7.1	Neutral	6.9	Sodic

Site Description – Site 17				
Site Reference	17	**ASC Name**	Gray Chromosol	
Average Slope	6%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Plateau	**Land Use**	Grazing	MGA 56
Landform Element	Upper slope	**E.R.D.**	0.5m	X: 328708
Surface Condition	Cracked	**Drainage**	Poorly drained	Y: 6580976

Plate 1 – Soil Profile (17)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very Dark Brown (Munsell 7.5YR 2.5/3) Sandy Loam with moderate pedality. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.10 – 0.40	Bleached White (Munsell 10YR 8/1) apedal Sand. No coarse fragments. Common fine roots and imperfectly drained. Abrupt boundary. (Collapsing horizon.)
B2	0.40 – 0.80	Gray (Munsell 7.5YR 5/1) Sandy Clay with moderate pedality. No coarse fragments. Very few fine roots. Poorly drained. 20% distinct orange mottles. Gradual boundary.
C	0.80+	Weathered parent material.

Site Description – Site 18				
Site Reference	18	**ASC Name**	Bleached-Mottled Eutrophic Yellow Chromosol (BEKOVNR)	
Average Slope	7%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper Slope	**E.R.D.**	0.7m	X: 328327
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6581114

Plate 1 – Soil Profile (18)

Plate 2 – Landscape (18)

Plate 3 – Surface (18)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very Dark Grayish Brown (Munsell 10YR 3/2) Sand with moderate pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.10 – 0.30	Bleached Light Gray (Munsell 7.5YR7/1) Loamy Sand with weak pedality. Slightly acidic pH, non-saline. Non-sodic. No coarse fragments. Common fine roots and imperfectly drained. Clear boundary.
B2	0.30 – 0.70	Light Yellowish Brown (Munsell 10YR 6/4) Sandy Clay with strong pedality. Neutral pH, non-saline and non-sodic. No coarse fragments. Very few fine roots. Poorly drained. 30% distinct grey mottles. Gradual boundary.
C	0.70+	Weathered parent material.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.0 - 0.10	0.6	Non-saline	5.7	Moderately Acidic	0.9	Non sodic
0.20 - 0.30	0.2	Non-saline	6.2	Slightly Acidic	0.9	Non sodic
0.40 - 0.50	0.6	Non-saline	6.9	Neutral	4.2	Non sodic

Site Description – Site 19				
Site Reference	19	**ASC Name**	Brown Chromosol	
Average Slope	7%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper Slope	**E.R.D.**	0.7m	X: 328063
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6580741

Plate 1 – Soil Profile (19)

Plate 2 – Landscape (19)

Plate 3 – Surface (19)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very Dark Brown (Munsell 7.5YR 2.5/3) Loamy Sand with moderate pedality. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.10 – 0.30	Bleached Light Gray (Munsell 7.5YR7/1) apedal Sand. No coarse fragments. Common fine roots and imperfectly drained. Clear boundary. (Collapsing horizon.)
B2	0.30 – 0.70	Dark Yellowish Brown (Munsell 10YR4/4) Medium Clay with strong pedality. No coarse fragments. Very few fine roots. Poorly drained. 30% distinct grey mottles. Gradual boundary.
C	0.70+	Weathered parent material.

Site Description – Site 20				
Site Reference	20	**ASC Name**	Brown Sodosol	
Average Slope	5%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper Slope	**E.R.D.**	0.5m+	X: 327680
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6580964

Plate 1 – Soil Profile (20)

Plate 2 – Landscape (20)

Plate 3 – Surface (20)

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark Brown (Munsell 10YR 3/3) Sandy Loam with moderate pedality. 10% coarse fragments 10 – 20mm. Many roots and well drained. Gradual boundary.
A2	0.15 – 0.45	Bleached Light Gray (Munsell 5YR 7/1) apedal Loamy Sand. Common fine roots and poorly drained. Gradual boundary.
B2	0.45+	Dark Yellowish Brown (Munsell 10YR4/4) Medium Clay with moderate pedality. No coarse fragments. No roots. Poorly drained.

Site Description – Site 21				
Site Reference	21	**ASC Name**	Eutrophic Mottled-Subnatric Gray Sodosol (BELOVNR)	
Average Slope	2%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Crest	**E.R.D.**	0.6m	X: 327112
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6581118

Plate 1 – Soil Profile (21)

Plate 2 – Landscape (21)

Plate 3 – Surface (21)

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Very Dark Brown (Munsell 7.5YR 2.5/2) Loamy Sand with moderate pedality. Strongly acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.15 – 0.35	Bleached Light Gray (Munsell 7.5YR7/1) Sandy Loam with weak pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Common fine roots and imperfectly drained. Clear boundary.
B2	0.35 – 0.60	Light Brownish Gray (Munsell 10YR 6/2) Heavy Clay with strong pedality. Moderately acidic pH, non-saline and sodic. No coarse fragments. Very few fine roots. Poorly drained. 30% distinct orange mottles. Gradual boundary.
C	0.60+	Weathered parent material.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.0 - 0.10	0.4	Non-saline	5.3	Strongly Acidic	0.9	Non sodic
0.20 - 0.30	0.1	Non-saline	5.6	Moderately Acidic	1.6	Non sodic
0.40 - 0.50	0.1	Non-saline	5.9	Moderately Acidic	6.7	Sodic

Site Description – Site 22				
Site Reference	22	**ASC Name**	Eutrophic Mottled-Subnatric Gray Sodosol (BEKOWNR)	
Average Slope	5%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Mid Slope	**E.R.D.**	0.5m+	X: 328803
Surface Condition	Soft	**Drainage**	Poorly drained	Y: 6582151

Plate 1 – Soil Profile (22)

Plate 2 – Landscape (22)

Plate 3 – Surface (22)

Horizon	Depth (m)	Description
A1	0.00 – 0.12	Brown (Munsell 7.5YR 4/2) Loamy Sand with moderate pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.12 – 0.30	Bleached Light Pinkish Gray (Munsell 5YR 7/2) Loamy Sand with weak pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Common fine roots and imperfectly drained. Clear boundary.
B2	0.30 +	Grayish Brown (Munsell 10YR 5/2) Medium Clay with strong pedality. Moderately acidic pH, non-saline and sodic. No coarse fragments. No roots. Poorly drained. 30% distinct grey mottles. Gradual boundary.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.0 - 0.10	0.3	Non-saline	5.7	Moderately Acidic	2.0	Non sodic
0.15 - 0.25	0.3	Non-saline	5.9	Moderately Acidic	4.0	Non sodic
0.30 - 0.40	0.2	Non-saline	5.9	Moderately Acidic	7.9	Sodic

Site Description – Site 23				
Site Reference	23	**ASC Name**	Red Sodosol	
Average Slope	3%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Crest	**E.R.D.**	0.5m+	X: 329116
Surface Condition	Soft	**Drainage**	Imperfectly drained	Y: 6581930

Plate 1 – Soil Profile (23)

Plate 2 – Landscape (23)

Plate 3 – Surface (23)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark Reddish Brown (Munsell 2.5YR 2.5/3) Loamy Sand with moderate pedality. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.10 – 0.20	Bleached Light Pinkish Gray (Munsell 5YR 7/2) apedal Sand. No coarse fragments. Common fine roots and imperfectly drained. Clear boundary. (Collapsing horizon.)
B2	0.30 +	Red (Munsell 2.5YR 5/6) Medium Clay with strong pedality. No coarse fragments. Very few fine roots. Imperfectly drained. 40% faint grey mottles.

Site Description – Site 24				
Site Reference	24	**ASC Name**	Red Chromosol	
Average Slope	5%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper Slope	**E.R.D.**	0.5m+	X: 327777
Surface Condition	Soft	**Drainage**	Imperfectly drained	Y: 6581943

Plate 1 – Soil Profile (24)

Plate 2 – Landscape (24)

Plate 3 – Surface (24)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark Brown (Munsell 10YR 3/3) Sandy Loam with moderate pedality. No coarse fragments. Many roots and well drained. Gradual boundary.
A2	0.25 – 0.50	Bleached Light Pinkish Gray (Munsell 5YR 7/2) apedal Loamy Sand. Common fine roots and moderately drained. Clear boundary.
B2	0.50+	Yellowish Red (Munsell 5YR 5/6) Medium Clay with moderate pedality. No coarse fragments. Very few roots. Imperfectly drained. 40% faint grey mottles.

Site Description – Site 25				
Site Reference	25	**ASC Name**	Mottled Eutrophic Brown Chromosol (BELOWNR)	
Average Slope	7%	**Land Disturbance**	Extensive clearing	**Coordinates**
Landform Pattern	Hillslope	**Land Use**	Grazing	MGA 56
Landform Element	Upper Slope	**E.R.D.**	0.4m+	X: 327454
Surface Condition	Soft	**Drainage**	Moderately drained	Y: 6581879

Plate 1 – Soil Profile (25)

Plate 2 – Landscape (25)

Plate 3 – Surface (25)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very Dark Grayish Brown (Munsell 10YR 3/2) Sandy Loam with moderate pedality. Strongly acidic pH, non-saline. Non-sodic. No coarse fragments. Many fine roots and well drained. Gradual boundary.
B2	0.10+	Brown (Munsell 10YR 4/3) Heavy Clay with moderate pedality. Moderately acidic pH, non-saline. Non-sodic. No coarse fragments. Common fine roots and moderately drained. 20% distinct orange mottling.

Sample Depth	ECe		pH(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 - 0.10	0.3	Non-saline	5.4	Strongly Acidic	1.3	Non sodic
0.20 - 0.30	0.1	Non-saline	5.7	Moderately Acidic	2.0	Non sodic

Appendix 3

Laboratory Certificates of Analysis

RESULTS OF SOIL ANALYSIS

36 soil samples supplied by Minesoils Pty Ltd on 3rd November, 2022 - Lab Job No. N4289
Analysis requested by Clayton Richards. Job Ref MS-076 Bendemeer.
PO BOX 11034 TAMWORTH NSW 2340

SAMPLE ID	*Job No.*	Emerson Dispersion Class	Wet Munsell Colour		Wet Munsell Mottle Colour		
			Code	Description	Code	Description	Degree of Mottling (%)
	Method	*See sheet EAT Flow Chart - Emerson Aggregate Test (EAT)*	***Inhouse Munsell Soil Colour Classification*		***Inhouse Munsell Soil Colour Classification*		
1 0 - 10	N4289/1	4	5YR 3/2	Dark Reddish Brown	2.5YR 4/4	Reddish Brown	2
1 20-30	N4289/2	..	10YR 4/2	Dark Grayish Brown	..	..	..
1 40 - 50	N4289/3	2	10YR 5/3	Brown	7.5 6/6, 7.5 3/2	Reddish Yellow, Dark Brown	30, 10
4 0 - 10	N4289/4	..	7.5YR 3/2	Dark Brown	..	..	..
4 25 - 35	N4289/5	..	10YR 4/2	Dark Grayish Brown	..	..	..
4 50 - 60	N4289/6	..	7.5YR 4/2	Brown	..	..	..
6 0 - 10	N4289/7	..	5YR 2.5/1	Black	..	..	..
6 20 - 30	N4289/8	..	10YR 4/2	Dark Grayish Brown	..	..	..
6 40 - 50	N4289/9	..	2.5Y 5/3	Light Olive Brown	7.5YR 5/8, 10YR 5/1	Strong Brown, Gray	50, 40
7 0 - 10	N4289/10	..	5YR 2.5/2	Dark Reddish Brown	..	..	..
7 20 - 30	N4289/11	..	10YR 5/3	Brown	7.5YR 6/8	Reddish Yellow	15
7 40 - 50	N4289/12	..	10YR 6/2	Light Brownish Gray	2.5YR 4/8	Red	20
7 70 - 80	N4289/13	..	10YR 6/3	Pale Brown	7.5YR 6/8, 7.5YR 3/1	Reddish Yellow, Very Dark Gray	50, 20
9 0 - 10	N4289/14	4	10YR 3/2	Very Dark Grayish Brown	..	..	..
9 20 - 30	N4289/15	..	10YR 5/2	Grayish Brown	..	..	..
9 45 - 55	N4289/16	4	10YR 6/3	Pale Brown	7.5YR 5/6	Strong Brown	20
12 0 - 10	N4289/17	..	10YR 3/2	Very Dark Grayish Brown	..	..	..
12 20 - 30	N4289/18	..	10YR 4/2	Dark Grayish Brown	..	..	..
12 40 - 50	N4289/19	2	10YR 5/3	Brown	2.5YRV 4/8, 10YR 4/1	Red, Dark Gray	30, 30
15 0 - 10	N4289/20	..	10YR 2/1	Black	..	..	..
15 20 - 30	N4289/21	..	10YR 5/2	Grayish Brown	..	..	..
15 40 - 50	N4289/22	..	10YR 6/3	Pale Brown	7.5YR 6/8, 10YR 3/2	Reddish Yellow, Very Dark Grayish Brown	30, 40
16 0 - 10	N4289/23	..	10YR 2/2	Very Dark Brown	..	..	..
16 15-25	N4289/24	..	10YR 4/2	Dark Grayish Brown	..	..	..
16 35- 45	N4289/25	2	5Y 5/2	Olive Gray	7.5YR 5/8, 2.5YR 4/8	Strong Brown, Red	40, 2
18 0 - 10	N4289/26	..	10YR 3/2	Very Dark Grayish Brown	..	..	..
18 20 - 30	N4289/27	..	2.5Y 4/3	Olive Brown	..	..	..
18 40 - 50	N4289/28	3	10YR 6/4	Light Yellowish Brown	5YR 5/8, 2.5Y 4/2	Yellowish Red, Dark Gray ish Brown	40, 7
21 0 - 10	N4289/29	..	7.5YR 2.5/2	Very Dark Brown	..	..	..
21 20 - 30	N4289/30	..	10YR 5/3	Brown	..	..	..
21 40 - 50	N4289/31	..	10YR 6/2	Light Brownish Gray	7.5YR 6/6	Reddish Yellow	40
22 0 - 10	N4289/32	..	7.5YR 4/2	Brown	..	..	..
22 15 - 25	N4289/33	..	10YR 5/4	Yellowish Brown	5YR 4/6	Yellowish Red	20
22 30 - 40	N4289/34	..	10YR 5/2	Grayish Brown	2.5YR 3/6, 7.5YR 4/2	Dark Red, Brown	50, 15
25 0 - 10	N4289/35	..	10YR 3/2	Very Dark Grayish Brown	..	..	..
25 20 - 30	N4289/36	..	10YR 4/3	Brown	2.5YR 4/8, 5YR 2.5/1	Red, Black	50, 7

Notes:

1. All results as dry weight DW - samples were dried at 40oC for 24-48hrs prior to crushing and analysis.
2. Australian Standard 1289.3.8.1-1997 (see summary attached as sheet 2)
3. Analysis conducted between sample arrival date and reporting date.
4. ** NATA accreditation does not cover the performance of this service.
5. .. Denotes not requested.
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7. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal or on request).
8. This report was issued on 23/11/2022

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

GRAIN SIZE ANALYSIS (hydrometer and sieving techniques)

36 soil samples supplied by Minesoils Pty Ltd on 3rd November, 2022 - Lab Job No. N4289

Analysis requested by Clayton Richards. Job Ref MS-076 Bendemeer.

PO BOX 11034 TAMWORTH NSW 2340

SAMPLE ID	Lab Code	MOISTURE CONTENT (% of water in sample)	TOTAL GRAVEL > 2 mm (% of total oven-dry equivalent)	GRAVEL > 4.75 mm (% of total oven-dry equivalent)	GRAVEL 2.00-4.75 mm (% of total oven-dry equivalent)	COARSE SAND 200-2000 µm (0.2-2.0 mm) (% of total oven-dry equivalent)	FINE SAND 20-200 µm (0.02-0.2 mm) (% of total oven-dry equivalent)	SILT 2-20 µm (% of total oven-dry equivalent)	CLAY < 2 µm (% of total oven-dry equivalent)
1 0 - 10	N4289/1	17.7%	4.9%	0.5%	4.5%	48.8%	27.4%	5.1%	13.8%
1 20-30	N4289/2	11.6%	11.7%	0.7%	11.0%	49.3%	25.3%	0.6%	13.1%
1 40 - 50	N4289/3	18.3%	8.7%	2.1%	6.5%	28.0%	14.7%	9.0%	39.6%
4 0 - 10	N4289/4	15.2%	5.4%	0.0%	5.4%	53.4%	24.3%	4.9%	12.0%
4 25 - 35	N4289/5	12.5%	8.9%	0.0%	8.9%	50.4%	27.5%	2.6%	10.7%
4 50 - 60	N4289/6	21.0%	13.3%	3.9%	9.4%	39.9%	6.6%	4.7%	35.4%
6 0 - 10	N4289/7	19.3%	5.2%	0.0%	5.2%	43.2%	34.6%	6.5%	10.5%
6 20 - 30	N4289/8	12.7%	13.7%	0.0%	13.7%	45.0%	27.3%	4.7%	9.3%
6 40 - 50	N4289/9	20.1%	5.4%	0.0%	5.4%	30.5%	18.6%	2.8%	42.7%
7 0 - 10	N4289/10	15.6%	6.5%	0.0%	6.5%	50.1%	27.7%	3.8%	11.9%
7 20 - 30	N4289/11	14.4%	18.7%	3.1%	15.7%	48.8%	24.2%	3.7%	4.5%
7 40 - 50	N4289/12	17.8%	9.0%	1.8%	7.2%	22.0%	5.3%	3.2%	60.6%
7 70 - 80	N4289/13	14.8%	8.1%	0.0%	8.1%	38.6%	25.2%	6.3%	21.8%
9 0 - 10	N4289/14	14.8%	5.0%	0.0%	5.0%	50.2%	31.0%	8.8%	5.1%
9 20 - 30	N4289/15	12.5%	9.4%	0.0%	9.4%	50.7%	34.0%	4.9%	0.9%
9 45 - 55	N4289/16	16.6%	5.3%	0.0%	5.3%	27.4%	30.9%	3.4%	32.9%
12 0 - 10	N4289/17	18.3%	4.7%	0.0%	4.7%	51.0%	31.2%	6.5%	6.6%
12 20 - 30	N4289/18	14.5%	9.9%	0.5%	9.4%	50.8%	25.2%	7.7%	6.5%
12 40 - 50	N4289/19	20.4%	5.9%	0.0%	5.9%	28.3%	16.1%	0.3%	49.3%
15 0 - 10	N4289/20	20.1%	7.9%	0.0%	7.9%	55.5%	23.9%	5.4%	7.4%
15 20 - 30	N4289/21	13.4%	17.4%	6.3%	11.1%	48.4%	23.9%	4.7%	5.6%
15 40 - 50	N4289/22	18.9%	5.3%	0.0%	5.3%	26.5%	16.4%	5.1%	46.8%
16 0 - 10	N4289/23	19.1%	4.2%	0.0%	4.2%	41.2%	41.9%	3.4%	9.3%
16 15-25	N4289/24	16.6%	7.5%	0.0%	7.5%	53.4%	26.7%	3.5%	8.9%
16 35- 45	N4289/25	23.6%	5.5%	0.0%	5.5%	36.7%	5.4%	7.9%	44.4%
18 0 - 10	N4289/26	22.0%	5.0%	0.0%	5.0%	6.0%	79.8%	3.5%	5.7%
18 20 - 30	N4289/27	12.0%	12.7%	3.5%	9.2%	50.6%	26.6%	5.3%	4.8%
18 40 - 50	N4289/28	18.7%	3.3%	0.0%	3.3%	35.5%	21.8%	2.6%	36.7%
21 0 - 10	N4289/29	15.6%	4.8%	0.0%	4.8%	43.4%	37.6%	9.0%	5.2%
21 20 - 30	N4289/30	11.8%	6.8%	0.0%	6.8%	47.2%	30.9%	6.1%	9.0%
21 40 - 50	N4289/31	21.4%	6.3%	0.0%	6.3%	27.0%	14.3%	4.6%	47.8%
22 0 - 10	N4289/32	16.4%	5.3%	0.0%	5.3%	49.2%	29.8%	7.2%	8.5%
22 15 - 25	N4289/33	12.1%	9.3%	0.0%	9.3%	48.0%	27.8%	6.7%	8.1%
22 30 - 40	N4289/34	20.5%	4.1%	0.0%	4.1%	26.9%	15.4%	7.9%	45.8%
25 0 - 10	N4289/35	17.0%	11.5%	0.0%	11.5%	38.7%	31.1%	6.7%	11.9%
25 20 - 30	N4289/36	20.9%	3.5%	0.4%	3.0%	14.8%	12.5%	5.9%	63.4%

Note:

1: The Hydrometer Analysis method was used to determine the percentage sand, silt and clay,
modified from SOP meth004 (California Dept of Pesticide Regulation), using method of Gee & Bauder (1986),
in *Methods of Soil Analysis. Part 1* Agron. Monogr. 9 (2nd Ed). Klute, A., American Soc. of Agronomy Inc., Soil Sci. Soc. America Inc., Madison WI: 383-411.

2: Australian Standard 1289.3.8.1-1997 (see attached)

3. Analysis conducted between sample arrival date and reporting date.

4. This report is not to be reproduced except in full. Results only relate to the item tested.

5. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal).

6. This report was issued on 23/11/2022

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Graham Lancaster (Nata signatory)
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AGRICULTURAL SOIL ANALYSIS REPORT

36 samples supplied by Minesoils Pty. Ltd. on 03/11/2022. Lab Job No.N4289

Analysis requested by Clayton Richards. Your Job: MS-076 Bendemeer

PO BOX 11034 TAMWORTH NSW 2340

		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
	Sample ID:	1 0 - 10	1 20-30	1 40 - 50	4 0 - 10	4 25 - 35
	Crop:	n/g	n/g	n/g	n/g	n/g
	Client:	ERM	ERM	ERM	ERM	ERM
Parameter	Method reference	N4289/1	N4289/2	N4289/3	N4289/4	N4289/5
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.34	5.74	6.20	5.69	6.51
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.042	0.024	0.041	0.049	0.029
Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	2.3	0.93	2.9	2.0	1.4
Exchangeable Calcium (kg/ha)		1,038	417	1,312	889	639
Exchangeable Calcium (mg/kg)		464	186	586	397	285
Exchangeable Magnesium (cmol$_+$/kg)		0.55	0.31	9.3	0.66	0.74
Exchangeable Magnesium (kg/ha)		149	85	2,536	181	202
Exchangeable Magnesium (mg/kg)		67	38	1,132	81	90
Exchangeable Potassium (cmol$_+$/kg)		<0.12	<0.12	0.29	0.41	0.42
Exchangeable Potassium (kg/ha)		<112	<112	255	363	365
Exchangeable Potassium (mg/kg)		<50	<50	114	162	163
Exchangeable Sodium (cmol$_+$/kg)		<0.065	<0.065	0.73	<0.065	<0.065
Exchangeable Sodium (kg/ha)		<33	<33	374	<33	<33
Exchangeable Sodium (mg/kg)		<15	<15	167	<15	<15
Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	0.07	0.07	0.29	0.02	<0.01
Exchangeable Aluminium (kg/ha)		14	14	58	3.1	1.6
Exchangeable Aluminium (mg/kg)		6.4	6.4	26	1.4	<1
Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	2.9	0.15	0.38	0.11	<0.01
Exchangeable Hydrogen (kg/ha)		66	3.4	8.4	2.5	<1
Exchangeable Hydrogen (mg/kg)		29	1.5	3.8	1.1	<1
Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	6.0	1.5	14	3.2	2.6
Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	39	60	21	62	55
Magnesium (%)		9.2	20	67	21	29
Potassium (%)		1.7	2.6	2.1	13	16
Sodium - ESP (%)		0.36	2.3	5.2	0.29	0.29
Aluminium (%)		1.2	4.7	2.1	0.49	0.30
Hydrogen (%)		49	9.8	2.7	3.5	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol$_+$/kg)	4.2	3.0	0.31	3.0	1.9

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 cmol$_+$/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
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17. This report was issued on 15/11/2022.

Quality Checked: Kris Saville
Agricultural Co-Ordinator KS

Accreditation No. 14960
Accredited for compliance with ISO/IEC 17025 - Testing

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AGRICULTURAL SOIL ANALYSIS REPORT

36 samples supplied by Minesoils Pty. Ltd. on 03/11/2022. Lab Job No.N4289

Analysis requested by Clayton Richards. Your Job: MS-076 Bendemeer

PO BOX 11034 TAMWORTH NSW 2340

			Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
		Sample ID:	4 50 - 60	6 0 - 10	6 20 - 30	6 40 - 50	7 0 - 10
		Crop:	n/g	n/g	n/g	n/g	n/g
		Client:	ERM	ERM	ERM	ERM	ERM
	Parameter	Method reference	N4289/6	N4289/7	N4289/8	N4289/9	N4289/10
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.25	5.79	6.26	6.87	5.54
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.056	0.020	0.010	0.024	0.022
	Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	10	2.3	1.6	4.7	1.2
	Exchangeable Calcium (kg/ha)		4,500	1,044	708	2,099	561
	Exchangeable Calcium (mg/kg)		2,009	466	316	937	250
	Exchangeable Magnesium (cmol$_+$/kg)		7.7	0.76	0.89	7.0	0.67
	Exchangeable Magnesium (kg/ha)		2,098	208	243	1,897	182
	Exchangeable Magnesium (mg/kg)		937	93	108	847	81
	Exchangeable Potassium (cmol$_+$/kg)		1.1	<0.12	<0.12	0.24	<0.12
	Exchangeable Potassium (kg/ha)		947	<112	<112	214	<112
	Exchangeable Potassium (mg/kg)		423	<50	<50	96	<50
	Exchangeable Sodium (cmol$_+$/kg)		0.09	<0.065	<0.065	0.64	<0.065
	Exchangeable Sodium (kg/ha)		44	<33	<33	328	<33
	Exchangeable Sodium (mg/kg)		20	<15	<15	146	<15
	Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	<0.01	0.02	0.03	0.08	0.10
	Exchangeable Aluminium (kg/ha)		<1	4.9	6.0	16	21
	Exchangeable Aluminium (mg/kg)		<1	2.2	2.7	7.0	9.4
	Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	0.13	0.10	<0.01	0.21
	Exchangeable Hydrogen (kg/ha)		<1	2.8	2.2	<1	4.7
	Exchangeable Hydrogen (mg/kg)		<1	1.3	1.0	<1	2.1
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	19	3.4	2.7	13	2.4
	Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	53	69	59	37	53
	Magnesium (%)		41	23	33	55	28
	Potassium (%)		5.7	3.1	1.4	1.9	3.8
	Sodium - ESP (%)		0.46	0.46	1.5	5.0	1.3
	Aluminium (%)		0.02	0.72	1.1	0.61	4.4
	Hydrogen (%)		0.00	3.7	3.7	0.00	8.9
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol$_+$/kg)	1.3	3.0	1.8	0.67	1.9

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwoo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
10. Conversions for 1 cmol$_+$/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimat
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
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17. This report was issued on 15/11/2022.

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AGRICULTURAL SOIL ANALYSIS REPORT

36 samples supplied by Minesoils Pty. Ltd. on 03/11/2022. Lab Job No.N4289

Analysis requested by Clayton Richards. Your Job: MS-076 Bendemeer

PO BOX 11034 TAMWORTH NSW 2340

			Sample 11	Sample 12	Sample 13	Sample 14	Sample 15
		Sample ID:	7 20 - 30	7 40 - 50	7 70 - 80	9 0 - 10	9 20 - 30
		Crop:	n/g	n/g	n/g	n/g	n/g
		Client:	ERM	ERM	ERM	ERM	ERM
	Parameter	Method reference	N4289/11	N4289/12	N4289/13	N4289/14	N4289/15
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.03	6.43	6.72	5.63	6.31
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.008	0.025	0.045	0.021	0.007
	Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.70	0.90	0.54	1.6	1.00
	Exchangeable Calcium (kg/ha)		312	404	244	739	448
	Exchangeable Calcium (mg/kg)		139	180	109	330	200
	Exchangeable Magnesium (cmol$_+$/kg)		0.35	7.5	7.7	0.42	0.53
	Exchangeable Magnesium (kg/ha)		95	2,030	2,092	114	143
	Exchangeable Magnesium (mg/kg)		43	906	934	51	64
	Exchangeable Potassium (cmol$_+$/kg)		<0.12	0.17	0.14	<0.12	<0.12
	Exchangeable Potassium (kg/ha)		<112	148	123	<112	<112
	Exchangeable Potassium (mg/kg)		<50	66	55	<50	<50
	Exchangeable Sodium (cmol$_+$/kg)		<0.065	1.1	1.5	<0.065	<0.065
	Exchangeable Sodium (kg/ha)		<33	561	747	<33	<33
	Exchangeable Sodium (mg/kg)		<15	250	333	<15	<15
	Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	0.04	0.41	0.12	0.07	<0.01
	Exchangeable Aluminium (kg/ha)		8.1	84	25	14	1.7
	Exchangeable Aluminium (mg/kg)		3.6	37	11	6.2	<1
	Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.13	0.47	<0.01	0.15	0.06
	Exchangeable Hydrogen (kg/ha)		3.0	11	<1	3.4	1.4
	Exchangeable Hydrogen (mg/kg)		1.3	4.7	<1	1.5	<1
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	1.3	11	9.9	2.4	1.6
	Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	54	8.6	5.5	69	61
	Magnesium (%)		27	71	77	18	32
	Potassium (%)		2.6	1.6	1.4	1.7	1.6
	Sodium - ESP (%)		2.5	10	15	2.4	1.6
	Aluminium (%)		3.1	3.9	1.2	2.9	0.53
	Hydrogen (%)		10	4.5	0.00	6.3	3.8
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol$_+$/kg)	2.0	0.12	0.07	3.9	1.9

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwoo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
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7. Total Acid Extractable Nutrients indicate a store of nutrients.
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Quality Checked: Kris Saville
Agricultural Co-Ordinator KS

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AGRICULTURAL SOIL ANALYSIS REPORT

36 samples supplied by Minesoils Pty. Ltd. on 03/11/2022. Lab Job No.N4289

Analysis requested by Clayton Richards. Your Job: MS-076 Bendemeer

PO BOX 11034 TAMWORTH NSW 2340

			Sample 16	Sample 17	Sample 18	Sample 19	Sample 20
		Sample ID:	9 45 - 55	12 0 - 10	12 20 - 30	12 40 - 50	15 0 - 10
		Crop:	n/g	n/g	n/g	n/g	n/g
		Client:	ERM	ERM	ERM	ERM	ERM
	Parameter	Method reference	N4289/16	N4289/17	N4289/18	N4289/19	N4289/20
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.60	5.73	6.23	6.77	5.88
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.025	0.018	0.012	0.029	0.024
	Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	4.2	1.7	2.6	2.7	2.9
	Exchangeable Calcium (kg/ha)		1,906	757	1,169	1,191	1,292
	Exchangeable Calcium (mg/kg)		851	338	522	532	577
	Exchangeable Magnesium (cmol$_+$/kg)		9.0	0.56	0.79	6.9	0.84
	Exchangeable Magnesium (kg/ha)		2,440	153	214	1,868	228
	Exchangeable Magnesium (mg/kg)		1,089	68	96	834	102
	Exchangeable Potassium (cmol$_+$/kg)		0.25	<0.12	<0.12	0.18	0.12
	Exchangeable Potassium (kg/ha)		221	<112	<112	160	<112
	Exchangeable Potassium (mg/kg)		99	<50	<50	71	<50
	Exchangeable Sodium (cmol$_+$/kg)		0.61	<0.065	<0.065	0.81	<0.065
	Exchangeable Sodium (kg/ha)		316	<33	<33	417	<33
	Exchangeable Sodium (mg/kg)		141	<15	<15	186	<15
	Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	0.13	0.08	0.02	0.07	0.02
	Exchangeable Aluminium (kg/ha)		26	16	3.7	14	4.7
	Exchangeable Aluminium (mg/kg)		11	7.2	1.7	6.2	2.1
	Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	0.16	0.08	<0.01	0.12
	Exchangeable Hydrogen (kg/ha)		<1	3.7	1.8	<1	2.7
	Exchangeable Hydrogen (mg/kg)		<1	1.6	<1	<1	1.2
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	14	2.6	3.6	11	4.0
	Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	30	64	72	25	72
	Magnesium (%)		63	21	22	65	21
	Potassium (%)		1.8	3.8	2.1	1.7	3.1
	Sodium - ESP (%)		4.3	1.5	1.5	7.6	0.83
	Aluminium (%)		0.89	3.1	0.51	0.65	0.58
	Hydrogen (%)		0.00	6.2	2.3	0.00	3.0
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol$_+$/kg)	0.47	3.0	3.3	0.39	3.4

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwoo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
10. Conversions for 1 cmol$_+$/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimat
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			Sample 21	Sample 22	Sample 23	Sample 24	Sample 25
		Sample ID:	15 20 - 30	15 40 - 50	16 0 - 10	16 15-25	16 35- 45
		Crop:	n/g	n/g	n/g	n/g	n/g
		Client:	ERM	ERM	ERM	ERM	ERM
	Parameter	Method reference	N4289/21	N4289/22	N4289/23	N4289/24	N4289/25
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.40	6.77	5.72	6.27	7.11
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.012	0.032	0.018	0.011	0.049
	Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	1.8	7.2	2.0	0.98	2.8
	Exchangeable Calcium (kg/ha)		791	3,233	914	441	1,239
	Exchangeable Calcium (mg/kg)		353	1,443	408	197	553
	Exchangeable Magnesium (cmol$_+$/kg)		0.59	9.5	0.77	0.34	15
	Exchangeable Magnesium (kg/ha)		162	2,578	210	92	4,027
	Exchangeable Magnesium (mg/kg)		72	1,151	94	41	1,798
	Exchangeable Potassium (cmol$_+$/kg)		<0.12	0.31	0.13	<0.12	0.28
	Exchangeable Potassium (kg/ha)		<112	276	117	<112	245
	Exchangeable Potassium (mg/kg)		<50	123	52	<50	109
	Exchangeable Sodium (cmol$_+$/kg)		<0.065	0.32	<0.065	<0.065	1.3
	Exchangeable Sodium (kg/ha)		<33	163	<33	<33	686
	Exchangeable Sodium (mg/kg)		<15	73	<15	<15	306
	Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	<0.01	0.02	0.07	0.01	0.02
	Exchangeable Aluminium (kg/ha)		2.0	4.8	15	2.3	3.5
	Exchangeable Aluminium (mg/kg)		<1	2.2	6.7	1.0	1.6
	Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.06	<0.01	0.14	0.06	<0.01
	Exchangeable Hydrogen (kg/ha)		1.3	<1	3.1	1.3	<1
	Exchangeable Hydrogen (mg/kg)		<1	<1	1.4	<1	<1
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	2.5	17	3.2	1.4	19
	Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	71	42	64	68	14
	Magnesium (%)		24	55	24	23	77
	Potassium (%)		1.6	1.8	4.2	1.4	1.5
	Sodium - ESP (%)		1.0	1.8	0.78	1.9	6.9
	Aluminium (%)		0.39	0.14	2.3	0.80	0.09
	Hydrogen (%)		2.3	0.00	4.4	4.1	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol$_+$/kg)	3.0	0.76	2.6	2.9	0.19

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwoo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
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7. Total Acid Extractable Nutrients indicate a store of nutrients.
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			Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
		Sample ID:	18 0 - 10	18 20 - 30	18 40 - 50	21 0 - 10	21 20 - 30
		Crop:	n/g	n/g	n/g	n/g	n/g
		Client:	ERM	ERM	ERM	ERM	ERM
	Parameter	Method reference	N4289/26	N4289/27	N4289/28	N4289/29	N4289/30
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.69	6.16	6.87	5.30	5.61
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.026	0.009	0.025	0.017	0.009
	Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	1.9	1.5	5.0	0.90	0.46
	Exchangeable Calcium (kg/ha)		870	661	2,258	402	208
	Exchangeable Calcium (mg/kg)		388	295	1,008	180	93
	Exchangeable Magnesium (cmol$_+$/kg)		0.91	0.75	8.4	0.35	0.18
	Exchangeable Magnesium (kg/ha)		247	203	2,289	94	50
	Exchangeable Magnesium (mg/kg)		110	91	1,022	42	22
	Exchangeable Potassium (cmol$_+$/kg)		<0.12	<0.12	0.27	<0.12	<0.12
	Exchangeable Potassium (kg/ha)		<112	<112	240	<112	<112
	Exchangeable Potassium (mg/kg)		<50	<50	107	<50	<50
	Exchangeable Sodium (cmol$_+$/kg)		<0.065	<0.065	0.60	<0.065	<0.065
	Exchangeable Sodium (kg/ha)		<33	<33	310	<33	<33
	Exchangeable Sodium (mg/kg)		<15	<15	138	<15	<15
	Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	0.04	0.04	0.10	0.25	0.22
	Exchangeable Aluminium (kg/ha)		8.0	7.5	20	50	44
	Exchangeable Aluminium (mg/kg)		3.6	3.3	8.9	23	20
	Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.13	0.10	<0.01	0.32	0.31
	Exchangeable Hydrogen (kg/ha)		2.8	2.3	<1	7.1	6.9
	Exchangeable Hydrogen (mg/kg)		1.3	1.0	<1	3.2	3.1
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	3.1	2.4	14	1.9	1.2
	Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	62	61	35	47	38
	Magnesium (%)		29	31	58	18	15
	Potassium (%)		3.5	0.91	1.9	3.9	2.3
	Sodium - ESP (%)		0.92	0.86	4.2	0.94	1.6
	Aluminium (%)		1.3	1.5	0.69	13	18
	Hydrogen (%)		4.0	4.3	0.00	17	25
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol$_+$/kg)	2.1	2.0	0.60	2.6	2.5

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwoo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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			Sample 31	Sample 32	Sample 33	Sample 34	Sample 35
		Sample ID:	21 40 - 50	22 0 - 10	22 15 - 25	22 30 - 40	25 0 - 10
		Crop:	n/g	n/g	n/g	n/g	n/g
		Client:	ERM	ERM	ERM	ERM	ERM
Parameter		Method reference	N4289/31	N4289/32	N4289/33	N4289/34	N4289/35
pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.89	5.70	5.86	5.88	5.36
Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.018	0.014	0.014	0.030	0.025
Exchangeable Calcium	(cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.18	1.5	0.94	1.2	2.7
	(kg/ha)		79	695	420	528	1,195
	(mg/kg)		35	310	188	236	533
Exchangeable Magnesium	(cmol$_+$/kg)		6.0	0.51	0.40	7.0	0.99
	(kg/ha)		1,643	138	110	1,915	269
	(mg/kg)		733	62	49	855	120
Exchangeable Potassium	(cmol$_+$/kg)		0.14	<0.12	<0.12	0.21	<0.12
	(kg/ha)		127	<112	<112	181	<112
	(mg/kg)		57	<50	<50	81	<50
Exchangeable Sodium	(cmol$_+$/kg)		0.87	<0.065	0.07	0.96	<0.065
	(kg/ha)		447	<33	38	492	<33
	(mg/kg)		200	<15	17	220	<15
Exchangeable Aluminium	(cmol$_+$/kg)	**Inhouse S37 (KCl)	3.1	0.21	0.17	1.5	0.38
	(kg/ha)		628	42	34	293	76
	(mg/kg)		280	19	15	131	34
Exchangeable Hydrogen	(cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	2.5	0.22	0.25	1.2	0.31
	(kg/ha)		57	4.8	5.7	28	6.9
	(mg/kg)		25	2.2	2.5	12	3.1
Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	13	2.6	1.9	12	4.5
Calcium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	1.4	60	50	9.8	59
Magnesium (%)			47	20	22	58	22
Potassium (%)			1.1	1.3	0.97	1.7	2.0
Sodium - ESP (%)			6.7	2.0	4.0	7.9	1.3
Aluminium (%)			24	8.2	9.1	12	8.4
Hydrogen (%)			20	8.4	14	10	6.9
Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol$_+$/kg)	0.03	3.0	2.3	0.17	2.7

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
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3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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			Sample 36	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	**25 20 - 30**				
		Crop:	**n/g**				
		Client:	**ERM**	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter		**Method reference**	**N4289/36**	**Indicative guidelines - refer to Notes 6 and 8**		
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.72	*6.5*	*6.5*	*6.3*	*6.3*
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.020	*0.200*	*0.150*	*0.120*	*0.100*
	Exchangeable Calcium	**(cmol$_+$/kg)**	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	4.3	*15.6*	*10.8*	*5.0*	*1.9*
		(kg/ha)		1,926	*7000*	*4816*	*2240*	*840*
		(mg/kg)		860	*3125*	*2150*	*1000*	*375*
	Exchangeable Magnesium	**(cmol$_+$/kg)**		5.3	*2.4*	*1.7*	*1.2*	*0.60*
		(kg/ha)		1,442	*650*	*448*	*325*	*168*
		(mg/kg)		644	*290*	*200*	*145*	*75*
	Exchangeable Potassium	**(cmol$_+$/kg)**		0.16	*0.60*	*0.50*	*0.40*	*0.30*
		(kg/ha)		144	*526*	*426*	*336*	*224*
		(mg/kg)		64	*235*	*190*	*150*	*100*
	Exchangeable Sodium	**(cmol$_+$/kg)**		0.23	*0.3*	*0.26*	*0.22*	*0.11*
		(kg/ha)		116	*155*	*134*	*113*	*57*
		(mg/kg)		52	*69*	*60*	*51*	*25*
	Exchangeable Aluminium	**(cmol$_+$/kg)**	**Inhouse S37 (KCl)	0.72	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		144	*121*	*101*	*73*	*30*
		(mg/kg)		64	*54*	*45*	*32*	*14*
	Exchangeable Hydrogen	**(cmol$_+$/kg)**	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.54	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		12	*13*	*11*	*8*	*3*
		(mg/kg)		5.4	*6*	*5*	*4*	*2*
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	11	*20.1*	*14.3*	*7.8*	*3.3*
	Calcium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	38	*77.6*	*75.7*	*65.6*	*57.4*
	Magnesium (%)			47	*11.9*	*11.9*	*15.7*	*18.1*
	Potassium (%)			1.5	*3.0*	*3.5*	*5.2*	*9.1*
	Sodium - ESP (%)			2.0	*1.5*	*1.8*	*2.9*	*3.3*
	Aluminium (%)			6.4	*6.0*	*7.1*	*10.5*	*12.1*
	Hydrogen (%)			4.8				
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol$_+$/kg)	0.81	*6.5*	*6.4*	*4.2*	*3.2*

Notes:

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3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
10. Conversions for 1 cmol$_+$/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimat
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditic
17. This report was issued on 15/11/2022.

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