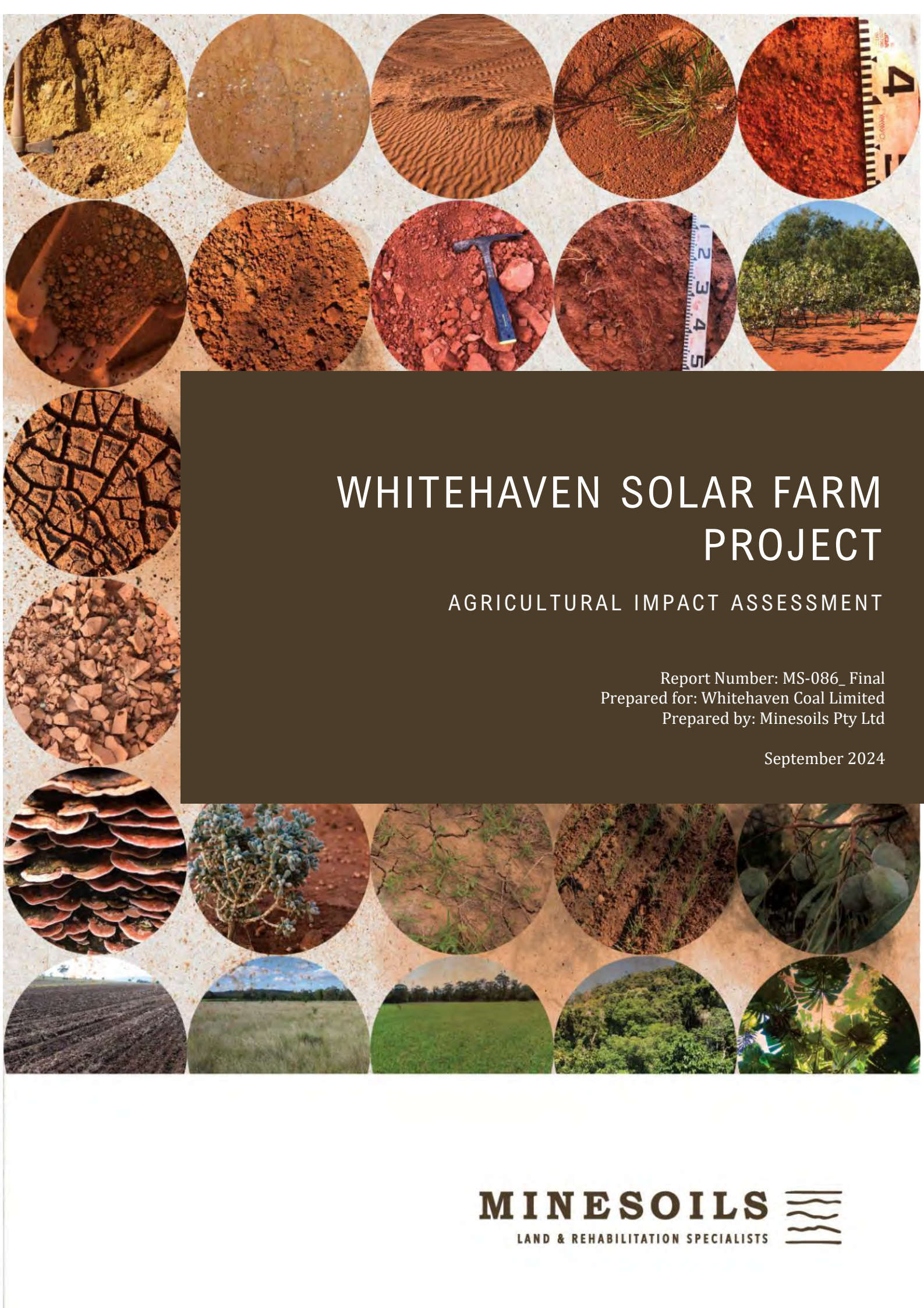


**Whitehaven
Solar Farm Project**

Environmental Impact Statement



WHITEHAVEN SOLAR FARM PROJECT

AGRICULTURAL IMPACT ASSESSMENT

Report Number: MS-086_Final
Prepared for: Whitehaven Coal Limited
Prepared by: Minesoils Pty Ltd

September 2024

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1. INTRODUCTION

1.1 OVERVIEW

The Whitehaven Solar Farm Project (the Project) is located approximately 25 kilometres (km) south-east of Narrabri and approximately 60 km north-west of Gunnedah, within the Narrabri Shire Council Local Government Area (LGA), in the New England North West region of New South Wales (refer **Figure 1**).

The Project would be located adjacent to the existing Narrabri Mine on Narrabri Coal Operations Pty Ltd (NCOPL)-owned land and would include approximately 26 megawatts (MW) direct current (DC) of solar electricity generation and construction of a 10 Megawatt Hour DC Battery Energy Storage System (BESS). The Project would provide behind-the-meter electricity supply to the Narrabri Mine via the existing 66 kilovolt (kV) electricity transmission line (ETL).

Whitehaven Energy Pty Ltd (Whitehaven) is the proponent of the Project and is seeking approval for the Project as a State Significant Development (SSD) under Section 4.36 of the *Environmental Planning and Assessment Act 1979*.

Minesoils Pty Ltd (Minesoils) was engaged by Whitehaven to provide specialised support for a site verification and Agricultural Impact Assessment to inform an Environmental Impact Assessment (EIS) for the Project.

This Agriculture Impact Assessment addresses 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*
- *assessment of the impact on agricultural resources and agricultural productivity.*

1.2 PROJECT DESCRIPTION

The Project would include the following primary components and activities:

- construction and operation of approximately 50,000 solar photovoltaic (PV) panels to provide electricity supply for the Narrabri Mine;
- construction and operation of ancillary infrastructure including access roads, inverter stations, temporary staging areas, perimeter fencing and operations and maintenance buildings;
- construction of a substation that facilitates connection to the existing 66 kV overhead ETL;
- construction of an overhead ETL to connect the proposed substation to the existing 66 kV overhead ETL, north of Kurrajong Creek Rd;
- Construction and operation of a BESS;
- ongoing maintenance activities; and
- decommissioning and rehabilitation of the site.

Table 1 provides a summary of the key attributes of the Project.



Table 1: Summary of Key Project Attributes

Project Component	Summary Description
Size and Purpose	26 MW DC, 20 MW AC for behind-the-meter electricity supply to the Narrabri Mine.
Project Area	Development site footprint of approximately 100 hectares (ha).
Solar Configuration	• Approximately 50,000 PV panels in a north to south alignment. • East to west tracking system (single axis).
Access Route	The proposed access route is via the Kamilaroi Highway and Kurrajong Creek Road.
Power Infrastructure	• Substation. • 66 kV connector to the existing 66 kV ETL.
BESS	• 10 Megawatt Hour DC. • Centralised system. • Lithium battery.
Site Entry	Site entry would be via a constructed access point on Kurrajong Creek Road.
Construction	• Construction period of approximately 6-9 months. • Employment of approximately 30 personnel on average during its construction, with peak construction requiring approximately 65 personnel. • Construction undertaken during daylight hours.
Operational Life	The design operational life is approximately 50 years.
Decommissioning and Rehabilitation	Decommissioning at the end of the of Project life, involving the removal of all infrastructure with a proposed final land use to comprise a combination of native vegetation and agricultural (pasture).
Capital Investment	Approximately \$55M.
Hours of Operation	24 hours per day with scheduled maintenance activities generally undertaken during daytime hours.

1.3 PROJECT AREA

The Project is located approximately 25 km south-east of Narrabri and approximately 60 km north-west of Gunnedah (refer **Figure 1**). The Project would be located adjacent to the Narrabri Mine on Whitehaven-managed land, covering an area of approximately 100 ha (the Project Area) (refer **Figure 2**).

The Project Area has historically been utilised for agricultural practices, with evidence of broad native vegetation modification resulting from extensive clearing and agricultural land use. The Project Area would be removed from agricultural service for the duration of the Project (approximately 50 years).

1.4 ASSESSMENT APPROACH

The assessment has been undertaken in accordance with the NSW Department of Planning and Environment (DPE) *Large-Scale Solar Energy Guidelines* (LSSE Guidelines) (DPE, 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) (NSW Office of Environment and Heritage [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 requirements 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 2**.





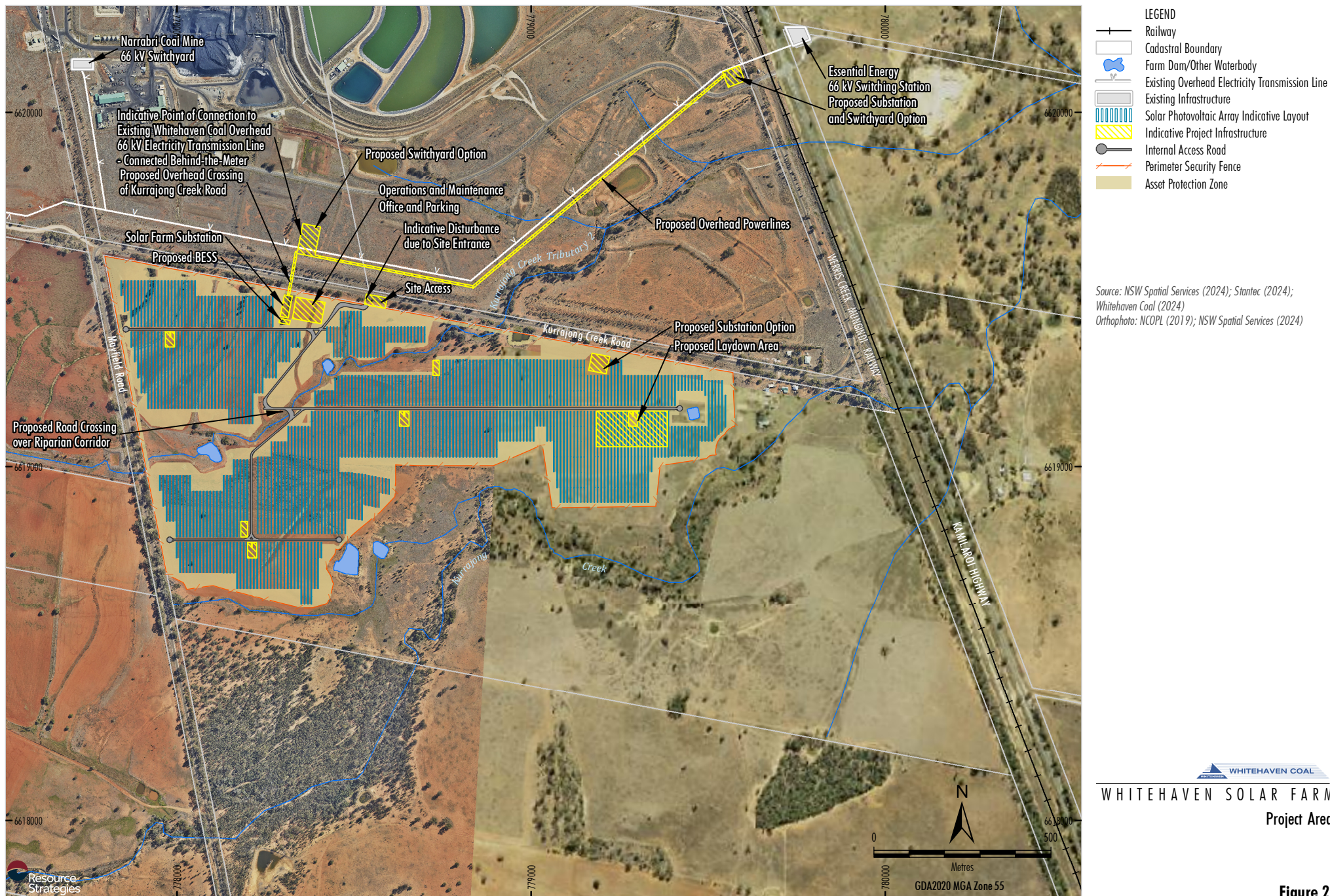
GDA 1994 MGA Zone 55

Regional Context

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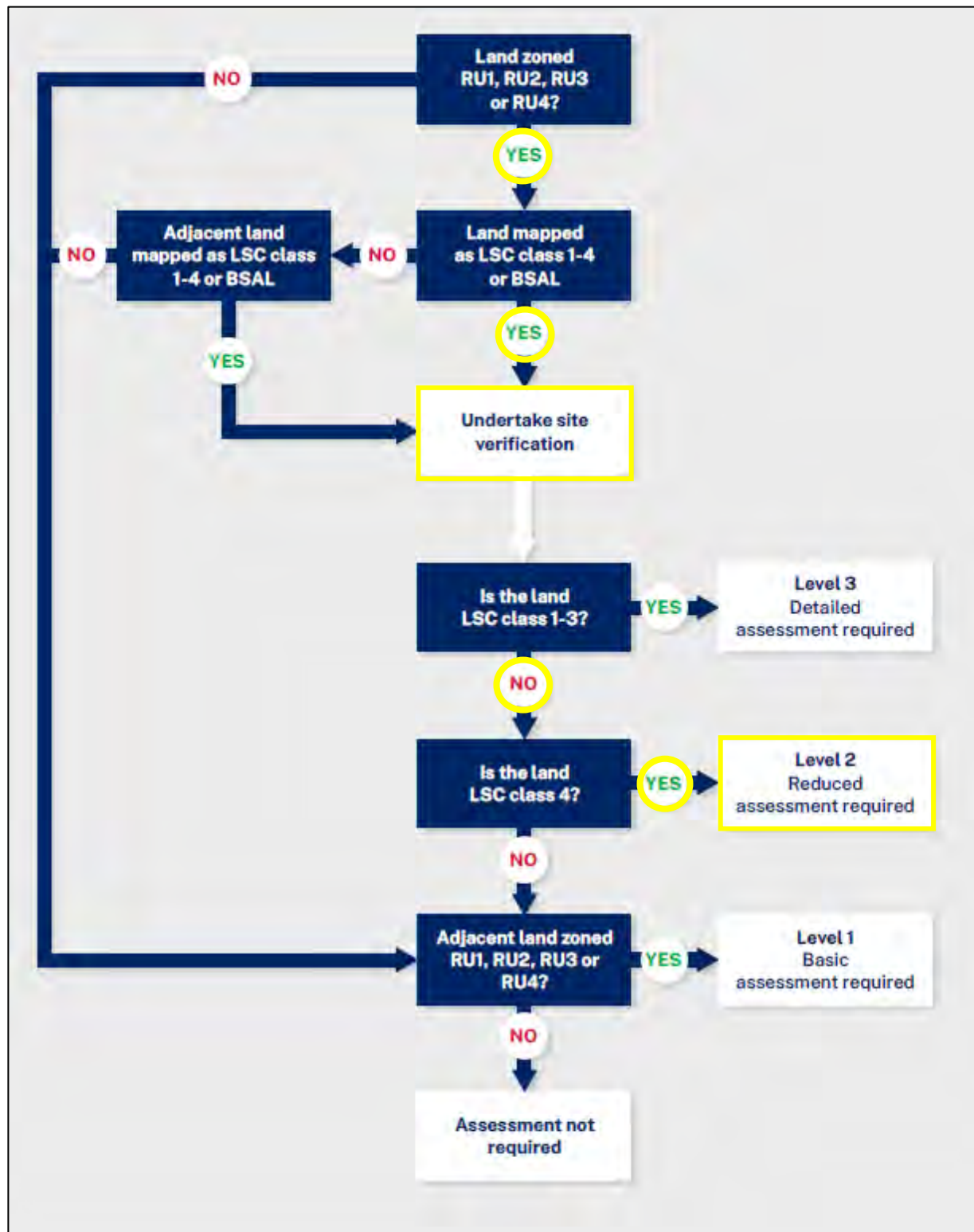
FIGURE 1



WHITEHAVEN COAL
WHITEHAVEN SOLAR FARM
Project Area

Figure 2

Figure 3. Agricultural Assessment Requirement Pathway



Source: DPE, 2022.



Table 2: 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 • location • duration • areas of the site that would be disturbed or temporarily removed from agricultural use	1
Regional context Describe the regional context.	• zoning of the Project Area • 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 site • describe existing agricultural land uses (i.e. orchards, vineyards, breeding paddocks, intensive livestock areas) • describe the history of agricultural practices on the project site • identify soil type, fertility, land and soil capability • provide a map showing the verified LSC class of the project site • provide a map showing topography of the site • describe the agricultural productivity of the site	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 site and in the wider region	• describe project impacts on identified agricultural lands, including but not limited to, potential weeds, pests, dust, bushfire, livestock, crop production • consider impacts to the agricultural 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 energy projects on agriculture in the region	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 • include accommodation of agrisolar practices in the Project design, particularly sheep grazing, which would be subject to an initial trial to confirm suitability and carrying capacity on the Project land	6

Source: DPE, 2022



2 REGIONAL CONTEXT

2.1 LAND ZONING

The Project Area is contained within Lot 9, DP 757104 and is zoned as Rural Use 1 (RU1) – Primary Production under the *Narrabri Local Environmental Plan 2012* (LEP) (Narrabri Shire Council, 2012) (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 allow for non-agricultural land uses that will not restrict the use of other land for agricultural purposes.

Development for the purpose of electricity generation is not specified in item 2 or 3 of the RU1 Primary Production Land Use Table under Part 2 of the LEP, therefore the development is 'Prohibited' according to item 4. However, the provisions of the *NSW State Environmental Planning Policy (Transport and Infrastructure) 2021*, override the LEP, allowing the proposal to be undertaken with consent under section 2.36 (1(b)).

2.2 CLIMATE AND RAINFALL

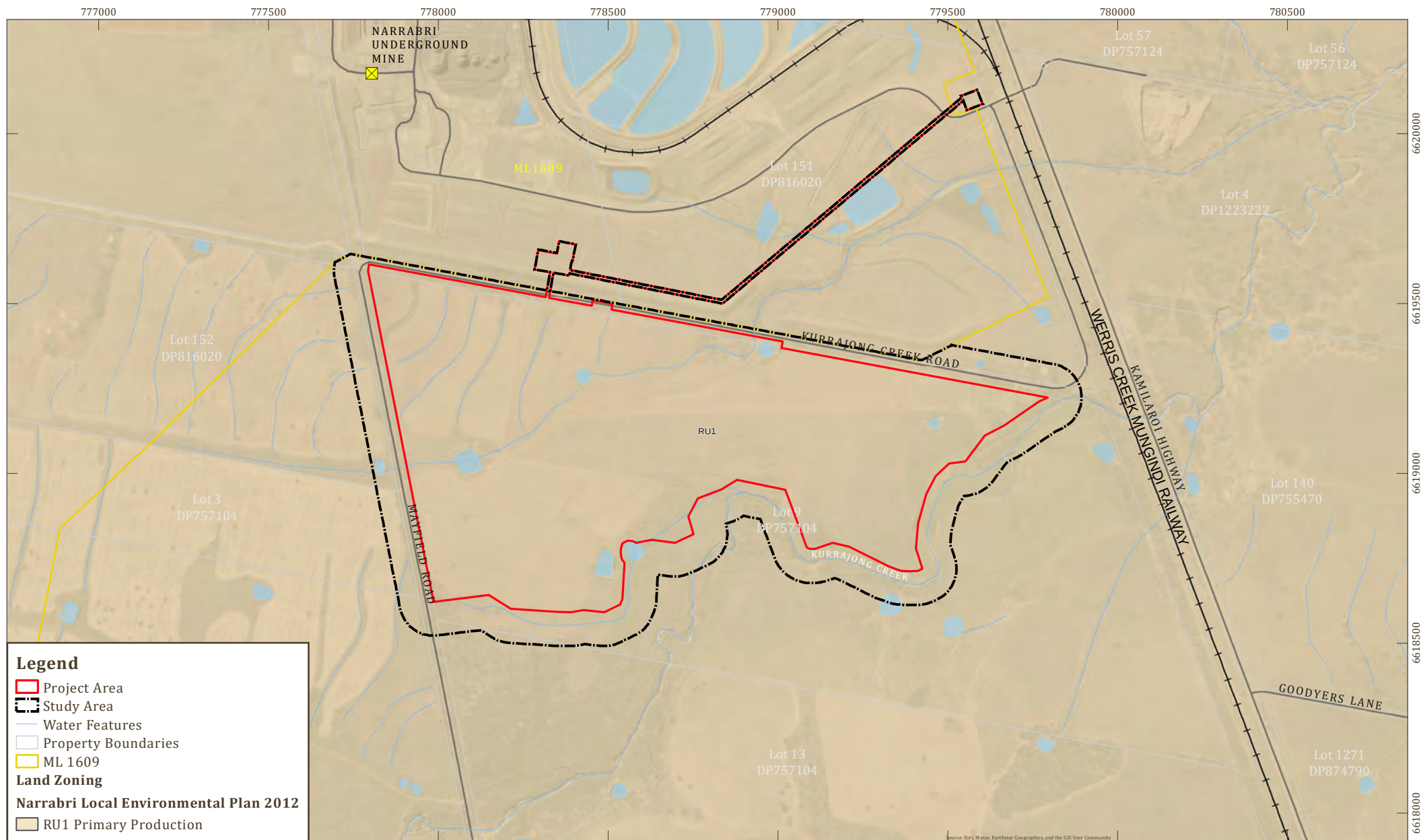
The Project Area lies within the Namoi subregion of the New England North West region, which is characterised by hotter and drier climate in the west and by cooler and wetter climate in the east. Subtropical areas are located to the west of Narrabri with temperate areas to the east and south. A subtropical zone extends south-east along the main Namoi River channel to Gunnedah adjacent to the Project Area (Australian Government, 2019).

Annual average potential evapotranspiration is highest in the north-east of the subregion, and lower in the west and south-west. In contrast, average annual actual evapotranspiration exhibits a strong decreasing gradient from east to west. Annual rainfall varies from about 500 millimetres (mm) to 1100 mm with most rainfall typically occurring in the summer months. Widespread drought has occurred in the past, lasting for several years in the Namoi river basin, and severe water shortage typically occurs in the subregion between May to December each year. Flooding also occurs frequently.

The closest Bureau of Meteorology (the Bureau) Automatic Weather Station (AWS) to the Project is the Narrabri Airport (Station No. 054038), approximately 25 km north (the Bureau, 2022). The annual average rainfall is 569.8 mm, over an average of 53 rain days, with the average lowest rainfall in the month of April and the highest in the month of November.

The annual average maximum temperature recorded at the site is 26.8 degrees Celsius (°C) and the annual average minimum temperature is 12.1°C. The highest average maximum temperature of 34.1°C is recorded in January, while the lowest average minimum temperature of 4.0°C is recorded in July (the Bureau, 2022).





2.3 REGIONAL LANDFORM

2.3.1 REGIONAL LANDFORM CHARACTERISTICS

The New England North West Region comprises an area of 9.9 million ha and includes the Northern Tablelands to the east, and the North West Slopes and Plains to the west. The region includes the LGAs of Armidale Regional, Glen Innes Severn, Gunnedah, Gwydir, Inverell, Liverpool Plains, Narrabri, Tamworth Regional, Tenterfield, Uralla and Walcha. The New England North West Region is split into four agricultural-geographical subregions:

1. Southern Plains (Liverpool Plains and Gunnedah LGAs).
2. Northern Plains (Moree Plains and Narrabri LGAs).
3. Slopes (Tamworth Regional, Gwydir and Inverell LGAs).
4. Tablelands (Armidale Regional, Uralla, Walcha, Glen Innes Severn and Tenterfield LGAs).

The Project is located in the Northern Plains subregion of the New England North West Region. The Northern Plains most significant crop is cotton, with beef cattle and wheat production also being main industries.

At the scale of the LGA, Narrabri Shire covers an area of 1.3 million ha and supports a population of approximately 12,700 people. Narrabri is the largest town in the Narrabri Shire and is the administrative centre. Other towns and villages include Boggabri, Wee Waa, Baan Baa, Bellata, Edgeroi, Gwabegar and Pilliga. The landscape of the Narrabri Shire consists of flat open plains to the west and steep land that is associated with Mount Kaputar and the accompanying ranges to the east.

The Narrabri Shire forms part of the Namoi River catchment, bounded by the Nandewar Range in the north, the New England Plateau in the north-east, the Liverpool Plains in the south-east and the Warrumbungle Range in the south-west. The Namoi River system is subject to extensive flooding and is regulated with several dams, the largest being Lake Keepit, which provides major water storage for the catchment. The associated Namoi alluvium is a key source of water, in addition to the Great Artesian Basin.

2.3.2 REGIONAL GEOLOGY

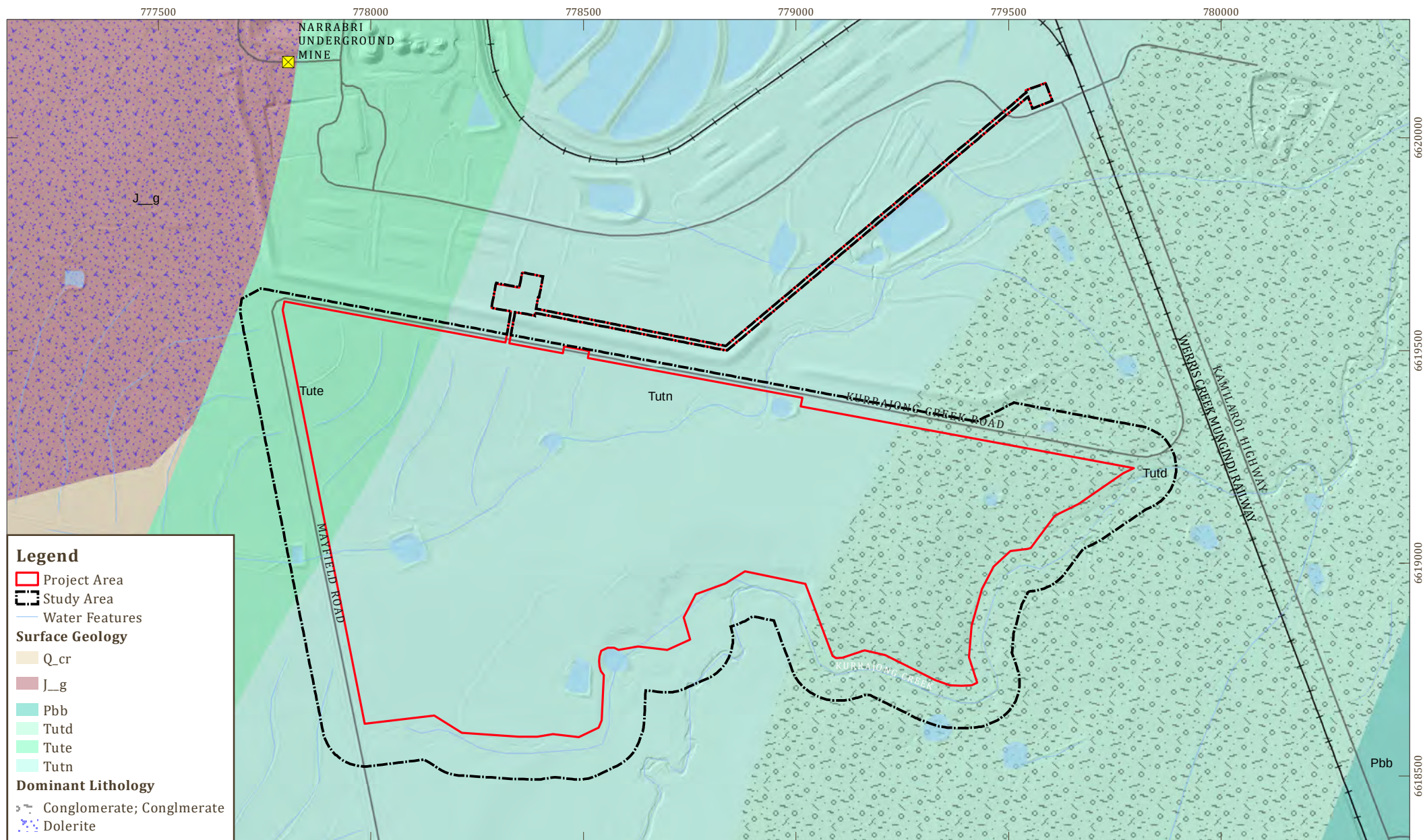
The Project Area is located within the Mullaley Sub-basin, which forms part of the larger Gunnedah Basin (AGE, 2020) (refer **Figure 5**). The main stratigraphic units in the Project Area are:

- Surat Basin Units of Jurassic age, including the Pilliga Sandstone, Purlawaugh Formation and Garrawilla Volcanics; and
- The Gunnedah Basin Units:
 - Napperby and Digby Formations of Triassic age; and
 - Permian coal measures within the Black Jack Group, including the Hoskissons Seam, the Arkarula Formation and the Pamboola Formation.

In addition to the stratigraphic units above, quaternary alluvium comprising unconsolidated clays, silts, sands and gravels associated with the Namoi River is located approximately 5 km to the east of the Project Area.

Geological features identified in the locality include the Digby Formation Conglomerate, a dolerite sill intruding into the Napperby Formation and the Boggabri Ridge.





GDA 1994 MGA Zone 55



Scale 1:12000 at A4

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Surface Geology

FIGURE 5

2.4 REGIONAL LAND USE

2.4.1 AGRICULTURAL LAND USE

The Namoi River catchment has been used extensively for agricultural activities for over 100 years. It is one of Australia's most developed irrigation areas, supporting significant cotton and broad acre cropping (mainly sorghum, sunflower and wheat) as well as other crops, and some sheep and cattle grazing.

Current agricultural uses in the Narrabri Shire LGA include sheep and cattle grazing, grain crops, cotton, piggeries, feedlots, vineyards and forestry. The open flat floodplains located in the west of the LGA provide areas which are used for irrigated agriculture, particularly cotton. These crops rely heavily on water from the Namoi River and groundwater. Grazing of sheep and cattle is the primary form of agriculture to the south-east of the Narrabri Shire where the Project lies.

At the scale of the Narrabri Shire LGA, 539,844 ha is land subject to agricultural activity (Australian Bureau of Statistics [ABS], 2022a). The area of land use for of the agricultural types for the Narrabri Shire LGA is presented in **Table 3**, which shows cropping as the dominant land use, accounting for 62% of this area.

Table 3: Narrabri Shire LGA Agricultural Land Use by Type 2020 - 2021

Agricultural Land Use	Area	
	ha	%
Cropping	332,209	62
Grazing	205,158	38
Forestry	1,814	<1
Other	662	<1
Total	539,844	100.0

Source: ABS, 2022a

2.4.2 AGRICULTURAL ENTERPRISES

In a year with normal rainfall, the Narrabri and Moree Shires are the wealthiest agricultural areas in Australia (Regional Development Australia, 2023). The Moree and Narrabri LGAs produce around 66% of NSW cotton from around 4% of the land area in NSW. These same LGAs also produce 5% of the gross value of NSW beef cattle and the area known as the Golden Triangle (350,000 ha generally considered to be between Croppa Creek, North Star and Yallaro) produces consistently high yields of prime hard (high protein) wheat.

The region's economy is dominated by key industries, with business income concentrated in mining, agriculture and construction. Together, these sectors make up three quarters of Narrabri LGAs business income. The agricultural industries are in turn supported by a host of specialist supply, engineering, chemicals, and consulting businesses within the region and across the state.

For the census year of 2020 – 2021, there were 277 cropping enterprise businesses and 254 livestock grazing businesses in the LGA (ABS 2022a), with agriculture contributing approximately 9% of the economic output of the LGA by industry, second only to mining with a 60% economic output (Remplan, 2022, using ABS 2016 Census Place of Work Employment [Scaled], ABS 2019 / 2020 National Input Output Tables, and ABS June 2021 Gross State Product).



The gross value of agricultural enterprises within the Narrabri Shire LGA for 2020-2021 is approximately \$453 million (ABS, 2022b). As shown in **Table 4**, cropping accounts for 91% of the total gross value of agriculture for the LGA. Other key enterprises are livestock for slaughter and livestock products.

Within the category of cropping, wheat for grain and cotton are the dominant enterprises (refer **Table 5**), contributing more than three quarters of crop value (ABS, 2022b).

For livestock slaughtered, cattle and calves make up 87% of the gross value with sheep and lambs making up 13% (refer **Table 6**). Pigs, poultry and other livestock slaughter enterprises contribute <1% combined (ABS, 2022b).

Despite the dominance of cropping in the region, at a scale of the locality, grazing of sheep and cattle on native and improved pastures is the primary form of agricultural enterprise, with occasional fodder cropping (2rog Consulting 2020). The nearest cropping activities take place approximately 3 km east on the floodplains of the Namoi River.

Table 4: Narrabri Shire LGA Agricultural Commodity Gross Value by Type 2020 - 2021

Agricultural Commodity	Gross Value	
	S	%
Crops	413,964,228	91
Livestock for slaughter	35,971,323	8
Livestock products	3,404,491	<1
Total	453,340,042	100

Source: ABS, 2022a



Table 5: Narrabri Shire LGA Crop Gross Value by Type 2020 - 2021

Crop	Area	
	\$	%
Wheat for grain	168,701,864	41
Cotton lint	146,852,044	35
Chickpeas	38,983,457	9
Barley for grain	15,014,886	4
Sorghum for grain	13,219,634	3
Other pulses	10,189,296	2
Canola	6,811,754	2
Hay	5,420,520	1
Maize for grain	4,146,349	1
Fruit and nuts	1,986,846	<1
Oats for grain	1,221,677	<1
Other	1,415,901	<1
Total	413,964,228	100

Source: ABS, 2022a

Table 6: Narrabri Shire LGA Livestock Slaughtered Gross Value by Type 2020 - 2021

Livestock Slaughtered	Area	
	\$	%
Sheep and lambs	4,760,396	13
Cattle and calves	31,156,186	87
Pigs	39,826	<1
Poultry	59	<1
Other	14,856	<1
Total	35,971,323	100

Source: ABS, 2022a



2.4.3 REGIONAL 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 a given season. The region is traversed by the Kamilaro, Newell and Oxley Highways which links agricultural enterprises to Sydney, Newcastle, and Brisbane, as well as other regional centres. In addition, the Werris Creek Mungindi Railway provides rail access to the area from the Port of Newcastle.

In proximity to the Project Area, the large agricultural service centres of Narrabri (25 km north-west) and Gunnedah (60 km south-east) allow access to businesses providing agricultural equipment and supplies, including animal fencing, animal vaccinations, livestock identification (ID), stock supplements, seed, fertiliser and crop protection. The nearby town of Narrabri contains the Narrabri Livestock Exchange, while there is also the focal centre of the New England North West's beef industry is Tamworth, approximately 130 kms south east of Narrabri. Tamworth Regional Livestock Exchange is largest livestock exchange in the region, drawing livestock from as far south as Dubbo, the Hunter Valley and as far North as Tenterfield and Goondiwindi.

Irrigation infrastructure, utilizing both surface water from the Namoi River (provided via a regulated flow from Keepit Dam) and groundwater, is a very important component of the LGA's agricultural profile. A number of major storages in the Namoi catchment, namely Keepit, Chaffey and Split Rock Dams located on the Namoi, Peel and Manilla Rivers, respectively, to provide water for the licensed water users in the region.

The successes of the agricultural industries have resulted in the development of storage and transport centres. Further, the high volumes of agricultural commodities have led to the establishment of secondary processing industries such as the Cargill Oilseeds plant at Narrabri which processes approximately 250,000 tonnes of cottonseed each year and the Canzac Pulse Processors Pty Ltd which produces high quality pulse seeds for export. Other plants include seed grading, mixing and packaging operations.

Other infrastructure critical to agricultural production include energy needs (gas and electricity), telecommunications services, 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 agricultural use.



3 SITE CHARACTERISTICS AND LAND USE

3.1 SITE CHARACTERISTICS

3.1.1 LANDSCAPE

A site inspection was undertaken by Minesoils in November 2022. The Project Area was determined to be a stable, free draining landform with 50 - 90% surface cover that has been highly disturbed in the past by land clearing for agriculture, which is now dominated by sustainable pasture and cultivation with sporadic presence of native trees (**Plates 1 and 2**).

The Project Area is a very gently undulating open drainage plain with engineered contours to an area in the north west and a series of farm dams. Kurrajong Creek runs along the south eastern boundary of the Study Area, and two additional ephemeral drainage lines run through the Project Area; one a small tributary of Kurrajong Creek in the south of site, the other transecting the site from the west to the northern boundary.

Slopes range from 0% slope on open flats to 2 – 3% on very gently undulating areas in the Study Area. Minor areas of slope >10% are limited (3.6 ha) and associated with farm dams and drainage lines (refer **Figure 6**).

Topography is consistent with slope character and is consistent throughout the central portions of the Study Area, with elevations ranging from approximately 245 metres Australian Height Datum (m AHD) on lower sections of drainage flats associated with Kurrajong Creek to approximately 275 m AHD on the very gently undulating slopes to the north west (refer **Figure 7**).

The Project Area is bounded by Mayfield Road to the west and Kurrajong Creek Road to the north. To the north of Kurrajong Creek Road lies the Narrabri Mine infrastructure area. The Kamilaroi Highway immediately to the east of the Project Area is the major sealed road in the area and extends approximately 25 km from Narrabri in the north-west to approximately 60 km to Gunnedah in the south-east.

3.1.2 AGRICULTURAL LAND USE

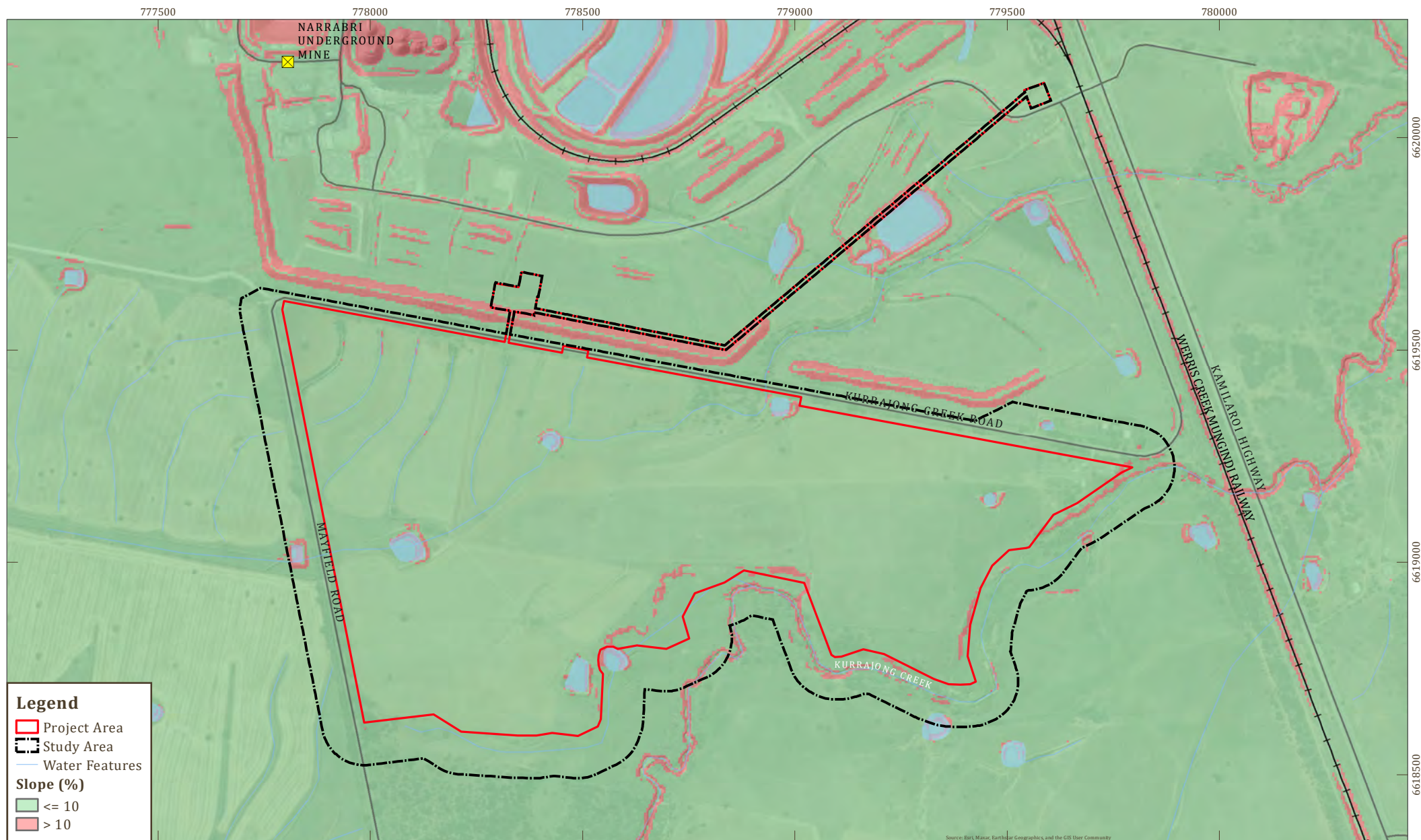
The Project Area is subject to grazing of cattle on pastures and occasional fodder crops as the primary land-use. Cattle are managed on a rotational basis, and are watered through surface dams or pumped water from elsewhere. No additional feeding is currently carried out. Currently, the Project Area is not fertilised, and there is no ongoing use of herbicides. General agricultural improvements are present, including dams, stock fences (**Plates 3**), shedding, gates and unsealed access tracks. As of November 2022, the Project Area was stocked with approximately 50 cows and calves (refer **Plate 4**).

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

Based on aerial photography, site observation, soil and land capability, and anecdotal evidence, it is determined that cleared areas of land within the Project Area has historically been used for livestock grazing and fodder cropping (i.e. consistent with existing land use).

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 similar agriculture use.





Legend

- Project Area
- Study Area
- Water Features

Slope (%)

- <= 10
- > 10

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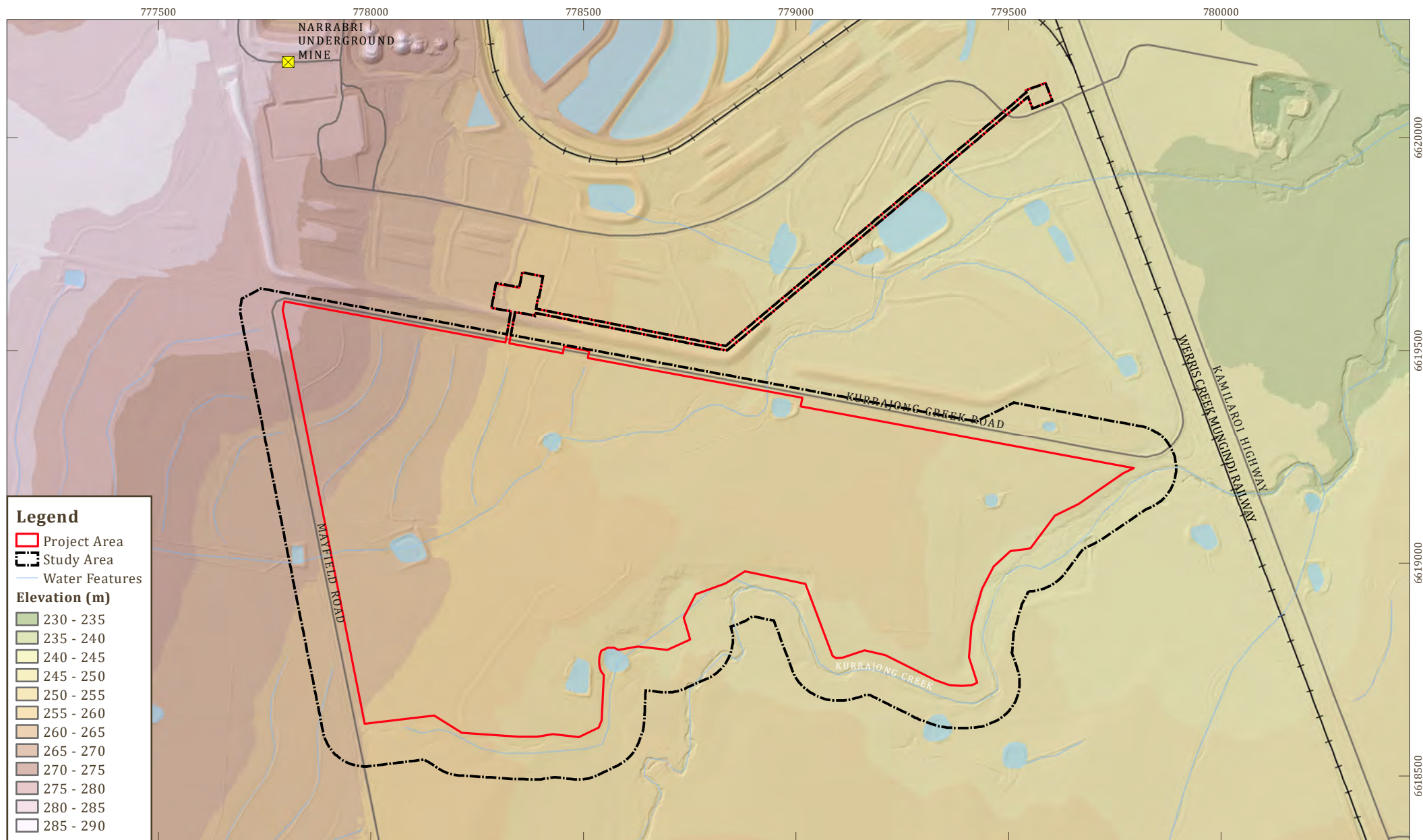
GDA 1994 MGA Zone 55

Meters

Scale 1:12000 at A4

Slope

FIGURE 6



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Topography

FIGURE 7



Plate 1: Lands cleared for grazing on native and improved pastures with remnant native trees



Plate 2: Land used for fodder cropping



Plate 3: Agricultural infrastructure includes farm dams and stock fencing.



Plate 4: Cattle and calves observed November 2022

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 (DPI) (2019) *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 enterprises including inland weaners and growing out steers (240 – 460 kilograms [kgs]), the estimated productivity of the Project Area ranges from \$18,978 to \$45,410 per annum as summarised in **Table 7**.

Table 7: Estimated Productivity of Grazing Land within the Project Area

Enterprise	Estimated Gross Margin (\$/ha/year)	Grazing Land (ha)	Project Area Gross Margin (\$/year)
Inland Weaners	161.65	117.4	18,977.71
Growing-out Steers 240 – 460kg	386.80	117.4	45,410.32

Source: DPI, 2023

An alternative method by which to estimate the potential productivity of the Project Area and best reflects current land use, is by analysing the information presented from the last agricultural census of 2020 – 2021 in Section 2.4 (ABS 2022a and 2022b). This information shows that within the Narrabri Shire LGA, 205,158 ha of land was used for grazing activities, of which >99% the gross commodity value of livestock slaughtered and livestock products can be attributed (totalling \$39,375,814 combined). This resulting in an annual \$/ha ratio of \$192/ ha.

By modelling grazing enterprises over the Project Area, based on the ABS LGA data, the potential productivity of the Project Area is estimated to be up to \$22,541 per year, as shown in **Table 8**.

Table 8: Estimated Potential Productivity based on LGA Data

Enterprise	Estimated Gross Value in LGA (\$/ha/year)	Area (ha)	Estimated Productivity (\$/year)
Livestock (Grazing and Products)	192	117.4	22,541

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 landscapes, soil types, inherent soil fertility and LSC as applied to the Project Area (DPE, 2022).

Soil Types

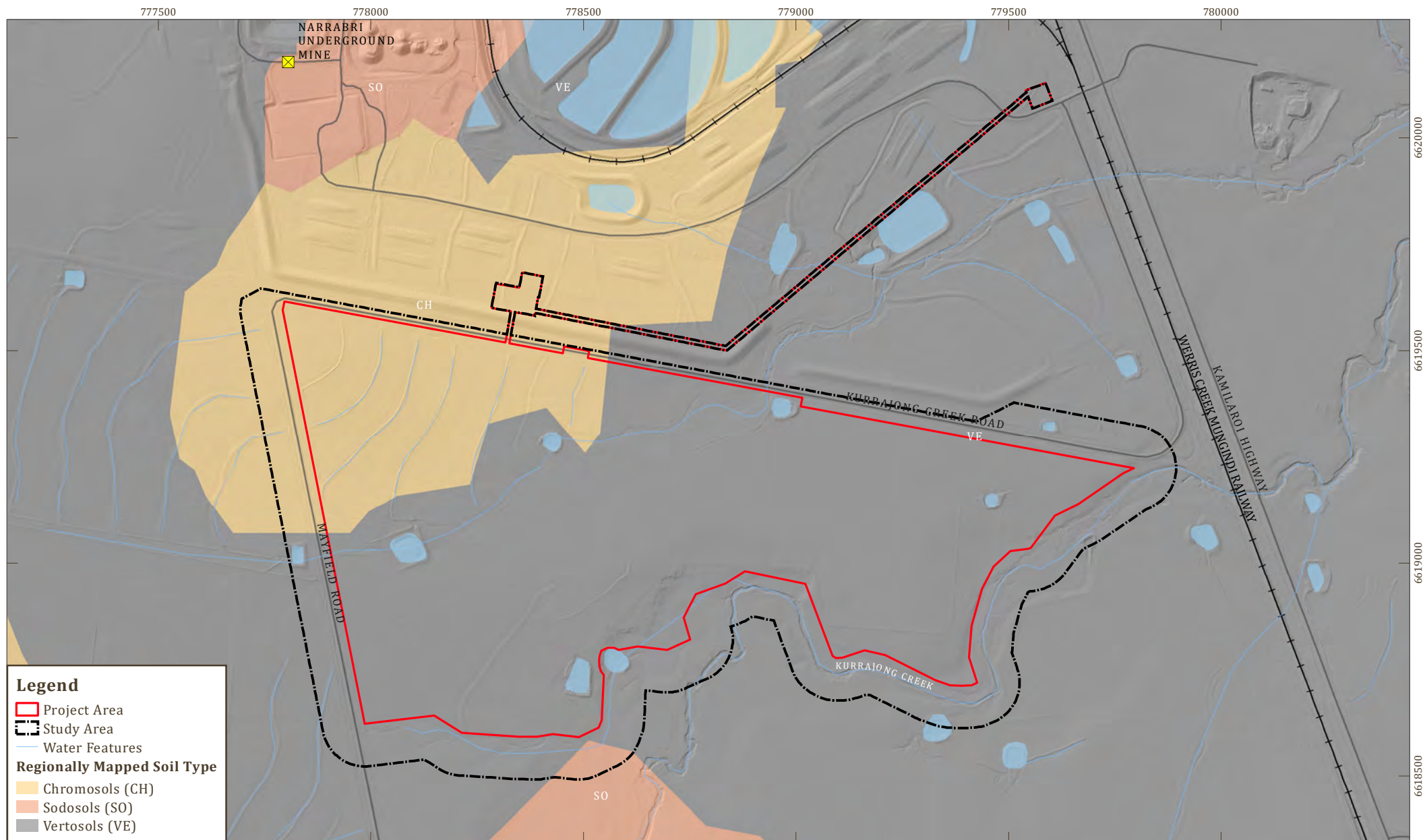
The NSW regional soil mapping indicates the dominant soil types within the Study Area are Chromosols and Sodosols, as per Australian Soil Classification (ASC) (Isbell, R. F., 2021) (refer **Figure 8**).

Vertosols are defined as soils with the following:

- a clay field texture of 35% or more clay throughout the solum except for thin, surface crusty horizons 30 mm or less thick;
- when dry, open cracks occur at some time in most years. These are at least 5 mm wide and extend upward to the surface or to the base of any plough layer, peaty horizon, self-mulching horizon, or thin, surface crusty horizon; and
- slickensides and/or lenticular peds occur at some depth in the solum.

Chromosols 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 metres [m] thick) is not sodic and not strongly acid. Soils with strongly subplastic upper B2 horizons are also included even if they are sodic.





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Regionally Mapped Soil Types

FIGURE 8

Sodosols 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.

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).

Soils with 'Low' fertility, due to their poor physical and/or chemical status, only support limited plant growth. Soils with 'Moderately Low' fertility can generally only support plants suited to grazing; large inputs of fertiliser are required to make the soil suitable for arable purposes. Soils with 'Moderate' fertility usually require fertilisers and/or have some physical restrictions for arable use. Soils with 'Moderately High' fertility have a high level of fertility in their virgin state which is significantly reduced after a few years of cultivation (Murphy *et al.*, 2007).

The Study Area is dominated by soils with Moderate fertility (3), Moderately high fertility (4) and High fertility (5) (refer **Figure 9**).

Land and Soil Capability

Land capability, as detailed in the LSC Guideline, 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 8** and their definition has been based on two considerations:

- the biophysical features of the land to derive the LSC classes associated with various hazards; and
- 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. | 5. Salinity. |
| 2. Wind erosion. | 6. Water logging. |
| 3. Soil structure decline. | 7. Soil depth. |
| 4. Soil acidification. | 8. Mass movement. |

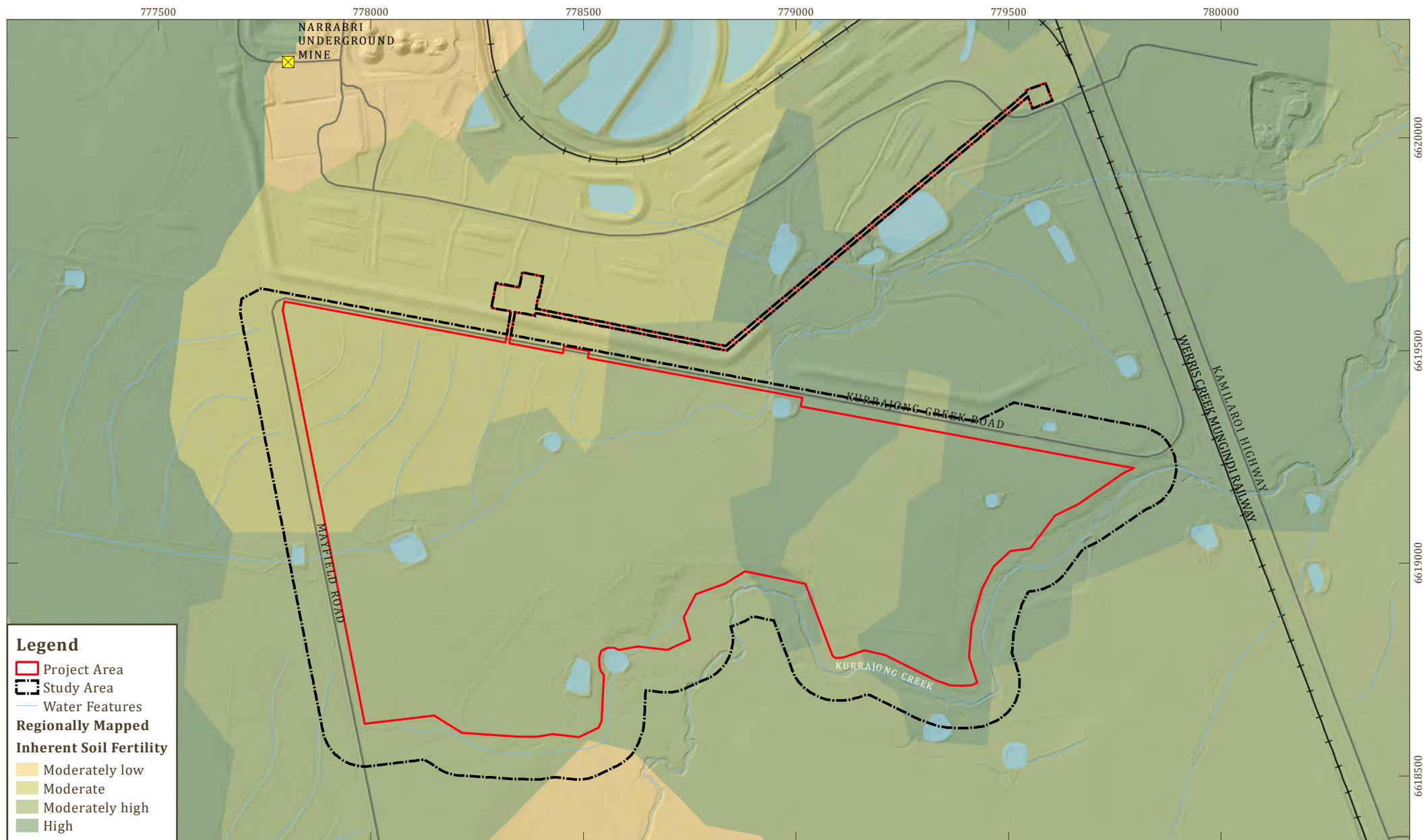
Each hazard is assessed against set criteria tables, as described in the LSC Guideline, with each hazard ranked from 1 through to 8 with the overall ranking of the land determined by its most significant limitation.

The NSW regional based maps of LSC indicate the Project Area is characterised by LSC class 3: high capability land, LSC class 4: moderate capability land, and LSC class 5: moderate-low capability land (refer **Figure 10**).

Biophysical Strategic Agricultural Land

Regionally mapped Biophysical Strategic Agricultural Land (BSAL) extends throughout a large portion of the eastern half of the Study Area. Minesoils was engaged to undertake a BSAL assessment to determine the presence and extent of site verified BSAL. The Study Area was found to have no verified BSAL (Minesoils 2024).





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Scale 1:12000 at A4

Regionally Mapped
Inherent Soil Fertility

FIGURE 9

State Significant Agricultural Land

The NSW Department of Primary Industries is undertaking a mapping program to identify State Significant Agricultural Land (SSAL). A map of SSAL will become a component of agricultural land use planning, enabling clearer local planning with informed prioritisation of future land uses.

SSAL is mapped throughout the Project Area.

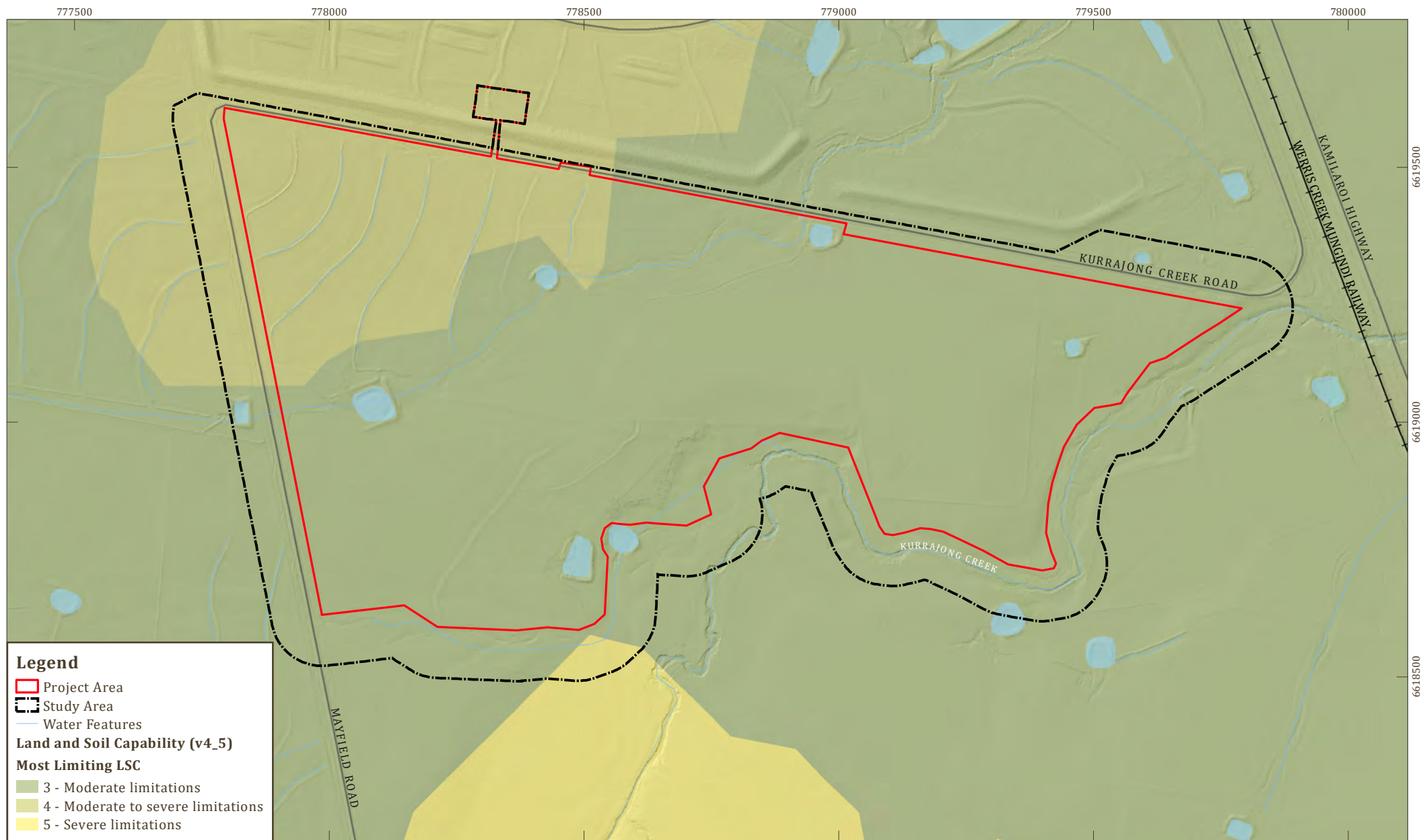
Further consideration of SSAL is not required as per the *LSSE Guidelines*.

Table 8: 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.

Source: OEH, 2013





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Scale 1:10000 at A4

Regionally Mapped
Land and Soil Capability

FIGURE 10

3.2.2 SOIL SURVEY METHODOLOGY

Minesoils undertook a soil and land resource survey in accordance with guidance provided in guidelines in Table 4 of the *Large-Scale Solar Energy Guideline* 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;
- LSC verification; and
- management and mitigation measures for handling soil during construction, operations and decommissioning.

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

- Soil survey and mapping: This was undertaken at a minimum 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 ASC criteria, within the Project site.
- 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 acid sulfate soils (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 a hand auger 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.

The survey covered the full 117.4 ha of the Project Area plus a 100 m buffer (excluding areas covered by a mining lease), resulting in a Study Area of 161.3 ha. A total of 11 sites were assessed, resulting in a survey intensity of 1 site per <15 ha. Soil profiles within the Project Area (refer to **Figure 11**) were assessed in accordance with the *Australian Soil and Land Survey Field Handbook* soil classification procedures (NCST, 2009) and *Guidelines for Surveying Soil and Land Resources* (McKenzie et al (2008)). Detailed soil profile descriptions were recorded covering the major parameters specified in **Table 9**. 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 ASC (Isbell, R. F., 2021).

Soil samples were collected at each of the assessment site's soil horizons to a depth of 1 m, with a total of 44 samples collected subject to laboratory testing. The laboratory testing suite for these sites is detailed in the Table 10 and undertaken in accordance with *Soil chemical methods – Australasia* (Rayment and Lyons, 2011)

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



Table 9: 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 10: 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
Particle Size Analysis (PSA)	ISSS Hydrometer plus 0.2 and 2.0 mm Sieving (CSIRO 'Yellow Book')
Cation Exchange Capacity (CEC) & ESP and Ca:Mg Ratio	Rayment & Lyons 2011-15J1
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 Study Area to contain two dominant soil mapping units, as shown on **Figure 11**, and presented in **Table 11**:

- Soil Unit 1: Sodosols – covering 111.7 ha; and
- Soil Unit 2: Dermosols – covering 51.6 ha.

Soil Unit 1 is characterised by Sodosols, which, as outlined in Section 3.2.1, 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. Representative sites for this unit are Sites 2, 6, 7, 8, 9 and 10. This unit generally features deep soils with coarser textured topsoils (sandy loams) with weak to moderate pedality over clay or clay loam subsoils with stronger pedality. This unit is consistently sodic throughout the profile, non-saline in the topsoil and ranges from non-saline to highly saline in the subsoil. pH generally trends from slightly to moderately acidic or neutral in the topsoil to moderately or very strongly alkaline at depth. Soil profiles within this unit were observed to be moderately drained, with occasional occurrence of imperfect drainage.



Soil Unit 1 contains a sub-dominant Chromosol over a limited area. This soil type variation is expected to be present sporadically over minor areas throughout the unit where the B2 is non-sodic. Site 1 is representative of the Soil Unit 1 sub-dominant soil type.

Soil Unit 2 is characterised by Dermosols, which are defined as soils other than Vertosols, Hydrosols, Calcarosols and Ferrosols which:

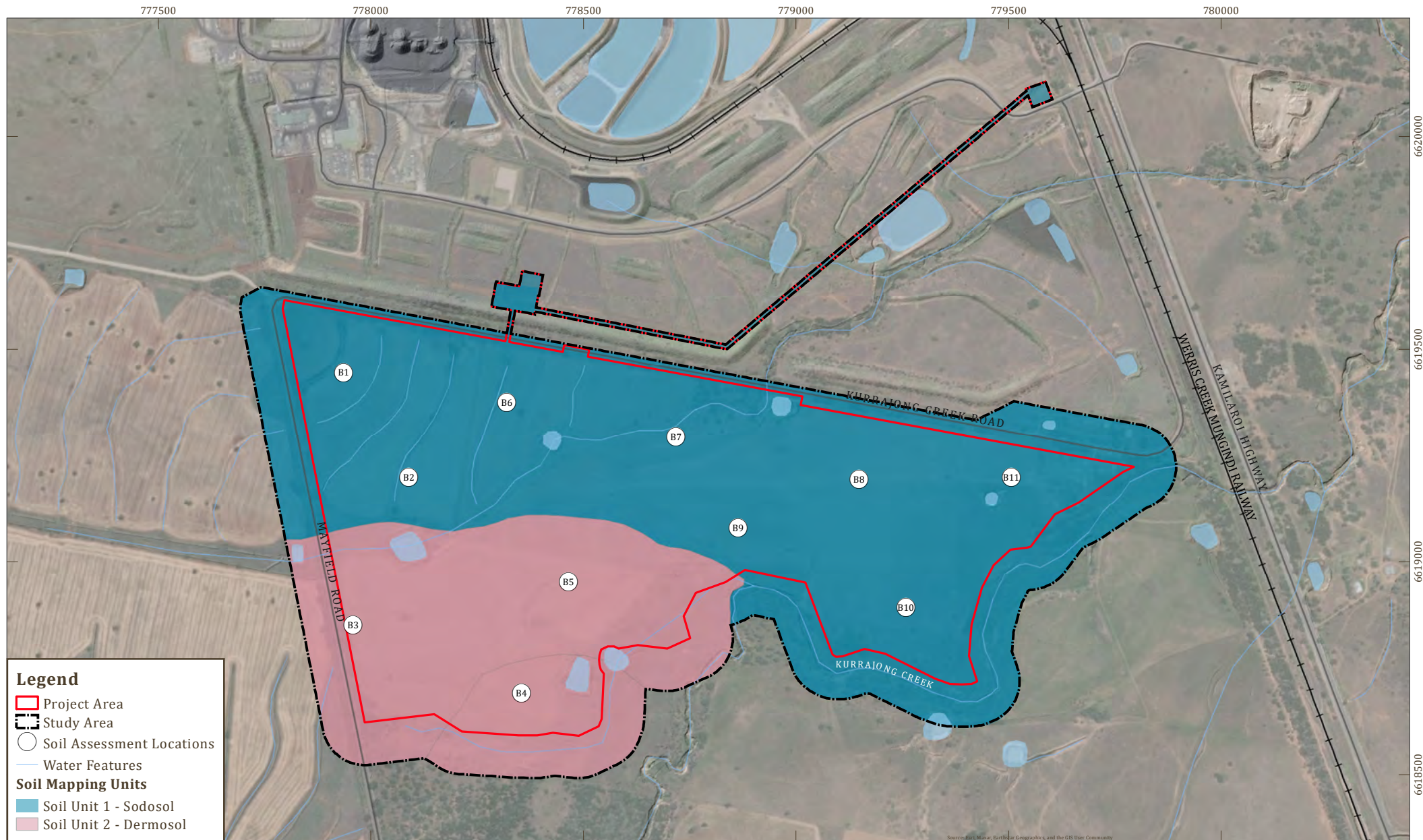
- Have B2 horizons that have grade of pedality greater than weak throughout the major part of the horizon, and
- Do not have clear or abrupt textural B horizon.

This unit features deep soils with a range in coarser textured topsoils (sands, loams and clay loams) with weak pedality over clay or clay loam subsoils with strong pedality. This unit is consistently sodic, non-saline in the topsoil and ranges from non-saline to moderately saline in the subsoil. pH generally trends from slightly acidic to mildly alkaline in the topsoil to strongly or very strongly alkaline at depth. Soil profiles within this unit were observed to be moderately drained. Representative sites for this unit are Sites 3, 4 and 5.

Table 11: Soil Mapping Units and Soil Units Summary

Site #	Soil Mapping Units		Soil Profile - Australian Soil Classification	ASC Family Criteria
	#	Name		
1	1	Sodosol	Haplic Eutrophic Brown Chromosol	AHKOVNR
2	1	Sodosol	Vertic Subnatric Red Sodosol	BFLOWNR
3	2	Dermosol	Sodic Eutrophic Red Dermosol	BEMOWNR
4	2	Dermosol	Sodic Eutrophic Red Dermosol	BEKMWNR
5	2	Dermosol	Sodic Eutrophic Red Dermosol	AELMWNR
6	1	Sodosol	Eutrophic Mesonatric Red Sodosol	AFLMWNR
7	1	Sodosol	Vertic Hypernatric Brown Sodosol	BELMWNR
8	1	Sodosol	Eutrophic Hypernatric Red Sodosol	BFLMWNR
9	1	Sodosol	Eutrophic Mesonatric Brown Sodosol	AEKOWNR
10	1	Sodosol	Eutrophic Hypernatric Brown Sodosol	BEKOWNR
11	1	Sodosol	Eutrophic Mesonatric Brown Sodosol	CEKMWNR





Soil Mapping Units

FIGURE 11

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 12** shows the EAT class and the dispersion degree during testing and resulting risk of dispersion for that soil.

Table 12: 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)

EAT 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.

EAT 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.

EAT 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 13 highlights the lowest EAT Class Number recorded for the detailed laboratory data representative sites of the Project site, as an indicator of highest potential risk during disturbance activities.



Table 13: Highest Recorded Dispersion Risk by Soil Mapping Unit

Site No.	ASC	Soil Depth (cm)	EAT	Potential Risk
1	Haplic Eutrophic Brown Chromosol	20-30	2	High
2	Vertic Subnatric Red Sodosol	20-30	2	High
3	Sodic Eutrophic Red Dermosol	20-30	2	High
4	Sodic Eutrophic Red Dermosol	20-30	2	High
5	Sodic Eutrophic Red Dermosol	20-30	2	High
6	Eutrophic Mesonatric Red Sodosol	20-30	2	High
7	Vertic Hypernatric Brown Sodosol	20-30	2	High
8	Eutrophic Hypernatric Red Sodosol	20-30	2	High
9	Eutrophic Mesonatric Brown Sodosol	20-30	2	High
10	Eutrophic Hypernatric Brown Sodosol	40-50	2	High
11	Eutrophic Mesonatric Brown Sodosol	40-50	2	High
		65-75	2	High

Based on site observations, which included assessment for indicators of erodibility, such as sheet or gully erosion, it can be concluded that there is a minimal erosion and sedimentation risk associated with the topsoils currently present in the Study Area with evidence of minor sheet erosion. However, as the dispersion risk status of the tested soils indicate, there is a consistently high potential risk for dispersion throughout the Study Area.

The representative laboratory tested soils also indicate high levels of sodicity primarily in the clay subsoils. This sodicity is generally consistent throughout the Study Area. 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 ranges in salinity of the soils tested, all sodic soils should be considered dispersive.

Based on these results, there is a high potential risk for dispersion where subsoils are disturbed within the Study 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.

Specific erosion management must be implemented over the entire Study Area where disturbance occurs (including changes to vegetation cover).

Acid Sulphate Soils

ASS have been classified into 5 different classes based on the likelihood of the ASS being present in particular areas and at certain depths (DPE, 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 m on adjacent class 1, 2, 3 or 4 land.

The Study 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.

3.2.4 SITE VERIFICATION OF LSC

The 11 soil test sites within the Study Area have been subject to the site verification assessment of LSC, in accordance with the LSC Guideline and as per Section 3.2.1.

The Study Area contains two LSC classes:

- LSC class 4: moderate capability land – covering 68.2 ha; and
- LSC class 5: moderate-low capability land – covering 95.1 ha.

The spatial extent of each LSC class is shown in **Figure 12**. The LSC verification assessment outcomes for the eight hazards group for the soil profiles assessed is presented in **Table 14**.

Class 4 land has moderate to high limitations for high-impact land uses that would 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.

Class 5 land has high limitations for high-impact land uses and would 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.

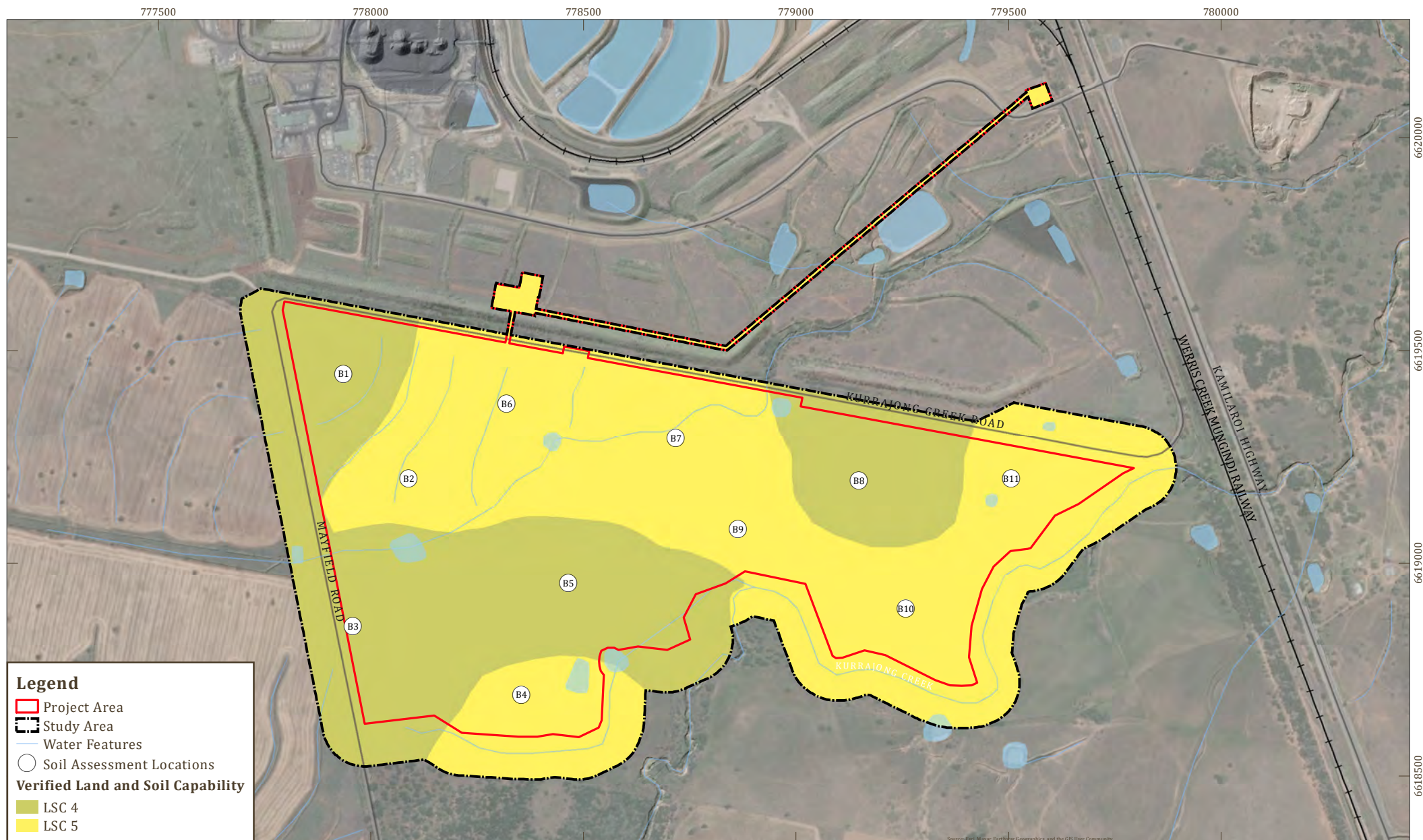
The key limitations of the Project Area, for both class 4 and 5 lands, include salinity, soil acidity and wind erosion.



Table 14: LSC Parameters and Overall Class

		Hazard Criteria								
		1	2	3	4	5	6	7	8	Overall
		Water erosion	Wind erosion	Structure	Acidity	Salinity	Water-logging	Soil depth	Movement	Class
1	Haplic Eutrophic Brown Chromosol	2	4	3	4	4	2	3	1	4
2	Vertic Subnatric Red Sodosol	2	4	3	5	4	2	2	1	5
3	Sodic Eutrophic Red Dermosol	2	2	3	3	4	2	2	1	4
4	Sodic Eutrophic Red Dermosol	1	5	1	4	5	2	2	1	5
5	Sodic Eutrophic Red Dermosol	1	2	3	3	4	2	2	1	4
6	Eutrophic Mesonatric Red Sodosol	1	4	3	4	5	2	2	1	5
7	Vertic Hypernatric Brown Sodosol	1	4	3	4	5	2	2	1	5
8	Eutrophic Hypernatric Red Sodosol	1	4	3	4	4	2	2	1	4
9	Eutrophic Mesonatric Brown Sodosol	1	4	3	5	4	2	2	1	5
10	Eutrophic Hypernatric Brown Sodosol	1	4	3	5	4	4	2	1	5
11	Eutrophic Mesonatric Brown Sodosol	1	5	1	5	4	4	2	1	5





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Scale 1:12000 at A4

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Verified Land and Soil Capability

FIGURE 12

4 LAND USE CONFLICT RISK ASSESSMENT

4.1 OVERVIEW

The Land Use Conflict Risk Assessment (LUCRA) (DPI, 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; and
- 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 Project and adjacent land has been assessed and given a risk ranking based on probability and consequence as outlined in **Appendix 1**. Performance targets would be determined via management plans specified by the EIS (and specialist impact assessments) and development consent conditions (if approved). Monitoring would 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 were 41 risk items 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 the following 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 15**. The LUCRA methodology including risk ranking matrix and full LUCRA assessment are included as **Appendix 1**.

Table 15: 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 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 would 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, mine vehicles or wildlife on roads.	The assessment of potential traffic impacts has been undertaken via a Road Transport Assessment. Appropriate mitigation measures are specified within the Road Transport Assessment to minimise impacts to the traffic environment. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to traffic for local users. Ongoing consultation with stakeholders would 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 reduce the risk of conflict related to visual amenity. Ongoing consultation with stakeholders would 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 Biodiversity Development Assessment Report (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 would 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	The Project incorporates management of bushfire risk (noting that the Project layout [Figure 2] includes asset protection zones which would be maintained for the Project). Ongoing consultation with stakeholders would 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	Given the size of the landholdings in the locality, it is likely that their agricultural production attributes provide a strong foundation for overall property value. The project would not impact the agricultural resources or production value of properties proximate to the Project site. Further, the change in visual amenity is not anticipated to have any noticeable effect on property values. Ongoing consultation with stakeholders would 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 would 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 site. 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 Rehabilitation and Decommissioning Management Plan (or similar) would be prepared to facilitate the land being successfully returned to pre-disturbance land and soil capability and final land use commitments following decommissioning.



5 IMPACTS ON AGRICULTURAL LAND

The impacts that solar farm activities can have on land resources and agricultural productivity range from short term temporary impacts when managed appropriately, to long term and permanent impacts when mismanaged. Temporary impacts can include the removal agriculture from service over a 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; and
- Cumulative impacts of the potential for multiple solar farms within the region.

5.1 LAND USED FOR AGRICULTURE

The Project would disturb an area of approximately 117.4 ha of land that is currently subject to agricultural land use. Whitehaven would include accommodation of agrisolar practices in the Project design, particularly sheep grazing, which would be subject to an initial trial to confirm suitability and carrying capacity on the Project land. However, in order to take a conservative approach, for the purpose of this assessment it is assumed that land would not be subject to agricultural use for the duration of the Project.

It is anticipated that the pre-existing land use would be re-established at the time of decommissioning, unless otherwise agreed with the landowner and/or regulatory authorities. Therefore, 117.4 ha would be temporarily removed from agricultural as a result of the Project.

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

No biodiversity offsets which would remove land from agricultural use are currently proposed by the Project.

5.2 PRODUCTIVITY AND ENTERPRISES

5.2.1 PRIMARY PRODUCTIVITY

The productivity of the Project Area is described in Section 3.1.3. For the purpose of this assessment, the impact of the Project on productivity of agricultural land based on change in land use within the Project Area is estimated to be up to \$45,410 per year.

This is considered negligible impact in the context of the agricultural industry gross value of the Narrabri Shire LGA as outlined in Section 2.4.2.

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

This is considered negligible impact in the context of the agricultural industry gross value of the Narrabri Shire LGA as outlined in Section 2.4.2.



5.2.2 PRODUCTIVITY OF LAND WITHIN LOCALITY

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

5.2.3 AGRICULTURE SUPPORT SERVICES

The Project would have a minimal impact on specific local and regional agricultural services. Changes to the supply and viability of agricultural support services in the main service centres are the towns of Narrabri and Gunnedah are generally driven by social trends exceeding the scale of the Project Area and its locality.

The reduction in cattle being sold would not be a significant impact on the Narrabri Livestock Exchange, as this reduction is estimated to represents <0.01% of all cattle sold.

5.2.4 CRITICAL MASS THRESHOLDS

Due to the limited reduction in agricultural activity as a result of the Project, there would 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 the majority of the Project Area, soils would 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 site facilities or access tracks, soils would be subject to higher impact disturbance.

All soil that is proposed to be disturbed during the Project would 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 would be small scale and localised; that is, soil would be stripped and stored adjacent to disturbance and respread from where it was stripped. This localised approach would promote reinstatement of the soil profile to its original condition.

Additionally, soils would be stripped only in areas where soil disturbance occurs. The depth of soil salvaged would 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 panels. If grass cover is maintained across the Project both between and under the panel rows to provide groundcover, there would be negligible soil composition and productivity impacts as a result of the panels.

However, if vegetation beneath the panels is significantly reduced or eliminated over long periods during operations, the soil may be temporarily sterilised and would require additional efforts and costs at the time of Project 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 would 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 would require only localised and sporadic landform modification including soil stripping (for excavation works and 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 areas would 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 would facilitate the rehabilitation in returning the land to an equivalent LSC class.

Therefore, it is anticipated there would 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 ground levelling for the solar farm and substation foundations is expected to require excavation of no more than 0.40 – 0.60 m, and trenches for underground cables are expected to be 1.0 to 1.2 m deep.

Water use during Project construction and operation would be minimal and water would be brought to site by tanker as required. No impacts are anticipated on the availability of current surface or groundwater resources used by local landholders.

5.3.4 EROSION AND SEDIMENTATION

Erosion risk is high throughout the entire Project Area. Sodicity and EAT results indicate the widespread presence of potentially dispersive soils with the potential for dispersion to be exacerbated by disturbance. Suitable erosion and sedimentation controls, as outlined in Section 6.2, would be implemented that target these specific erosion hazards to reduce impacts to surface soils and waterways.

5.3.5 AGRICULTURAL INFRASTRUCTURE

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

Stock fences, dams and access tracks would be retained to accommodate a post-Project land use of cattle grazing. Upgrades to access tracks throughout the Project would benefit post-Project agricultural land uses and is considered a positive impact.

5.4 OTHER POTENTIAL IMPACTS ON AGRICULTURE

5.4.1 PEST SPECIES

Weeds and 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 long term hindrance to agricultural endeavours within the locality and region, as well as rehabilitation efforts within the Project area.

The impacts of weeds and pest species on agriculture as a result of the project are anticipated to be minor due to the proposed mitigation measures, which are described in Section 6.5.

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.

Given the proposed mitigation measures described in Section 6.6, it is considered that the project will not have any significant impact on the biosecurity of agricultural resources and enterprises within the region.



Based on a review of the likely pest, weed, and disease risks, and a consideration of the available mitigation measures able to be implemented by the Project (As seen for other NSW solar farm projects), the key biosecurity risks are summarised as follows:

- New weeds occur as a result of a change in land use (i.e., cessation of grazing), and go undetected.
- New weeds, pest species or diseases are introduced during construction due to the increased volume of new personnel, vehicles and materials entering the Project site and locality.
- New weeds, pest species or diseases that occur as a result of a change of land use (i.e., cessation of grazing), or which are introduced to the Project site as part of Project activities (i.e., construction), spread to neighbouring properties.
- Project personnel are unable to recognise a new endemic or emergency disease, pest or weed.

Biosecurity mitigation measures would be prepared for the Project and incorporated into the Construction and Operational Environmental Management Plans to address these key risks.

5.4.3 AIR QUALITY AND DUST

Existing sources of air pollution at the Project Area are likely to result from mine sources, vehicle emissions and dust from agriculture and may increase during the colder months from solid fuel heating and during summer periods if bushfires or dust storms occur in the region.

Construction has the potential to increase dust through movement of traffic on unsealed roads on dry days, vegetation removal, and construction activities (such as access road construction). However, dust impacts are unlikely to be significant and standard dust suppression measures can be readily implemented.

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 mining operations, leaving fewer transport options for agricultural enterprises.

Mayfield Road and Kurrajong Creek Road would experience an increase in traffic volumes during the peak construction period which would be accommodated without any significant impacts on the operation of these roads. Therefore, the traffic impacts of the Project are not likely to have consequences on agricultural enterprises within the Project locality. Further, increases in levels of noise and dust that would result from increased traffic would not impact agriculture.

5.4.5 NOISE AND VIBRATION

Background noise sources would include mine sources, traffic, farm equipment (e.g., harvesters, boom sprayers and tractors), wind through trees, and insects.

It is expected that noise would be effectively managed and minimised through the adoption of standard management practices.

Vibration issues are not expected to be significant during either construction or operation due to the distance between the Project and the nearest sensitive receivers (approximately 0.8 km).

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. The predicted noise levels are not anticipated to pose a negligible impact on agricultural activities.



5.5 CUMULATIVE IMPACTS

The Project has the potential to generate cumulative impacts with other existing, approved or proposed developments in the region. Additional to the nearby Narrabri Mine, there are currently multiple approved or proposed mining and energy-related State Significant Developments listed on the Major Projects website in the Narrabri Shire LGA and neighbouring LGAs, in addition to the Project.

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 solar farm projects in the region do not implement agrisolar. 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.

On a broader scale, the cumulative risk to agricultural land and productivity across NSW because of large-scale solar development is estimated to be very low (DPE 2022). The Australian Energy Market Operator estimates that NSW will need approximately 20,000 MW of large-scale solar generation by 2050. This would require approximately 40,000 ha of land or only 0.06% of rural land in NSW. Even in the highly unlikely scenario that all of NSW's solar generation were located on important agricultural land (this land covers around 13.8% of the state and is 6 to 7 times more agriculturally productive than the remaining 86.2% of the state) only 0.4% of this land would be required (DPE 2022).



6 MITIGATION MEASURES

The Project would include a number of 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 would be conducted in consideration of approval obligations and environmental management measures in site specific environmental management plans.

6.1 PROJECT ALTERNATIVES AND DESIGN

Whitehaven has undertaken a constraints and opportunities analysis process to identify potential development sites for the Project. For the Project, this process has included consideration of factors such as:

- access to existing Narrabri Mine transmission assets to accept energy from the solar farm;
- land ownership;
- land suitability (e.g. topography, existing land use, flood risk, zoning); and
- need to minimise environmental and social impacts (e.g. avoiding sensitive environments, areas of cultural heritage value, population centres).

As a result of the above-mentioned process, the location of the Project was selected as the site:

- is on NCOP-owned land;
- is comprised of generally flat topography, predominantly cleared of vegetation for agricultural use;
- is approximately 0.8 km from the nearest private receiver (i.e. the Project would have limited noise and dust emissions impacts during construction);
- is located adjacent to the Narrabri Mine Infrastructure Area and associated electrical infrastructure;
- avoids Kurrajong Creek;
- is located wholly within land zoned RU1 and therefore the Project is permissible with development consent in accordance with the *NSW State Environmental Planning Policy (Transport and Infrastructure) 2021*; and
- is not located in the Namoi River flood plain.

6.2 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.

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 a number of 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



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).

Whitehaven would include accommodation of agrisolar practices in the Project design, particularly sheep grazing, which would be subject to an initial trial to confirm suitability and carrying capacity on the Project land.

Grazing would commence following construction and after a resting period of approximately 1 year, subject to availability of stock feed and site conditions, and would occur generally consistent with the *Australian Guide to Agrisolar for Large-Scale Solar* (the Guideline).

A short trial would be conducted initially in a small, controlled area within the site to assess any potential issues associated with co-us. The trial would confirm the suitability and carrying capacity of agrisolar activities on the Project land, and demonstrate the sheep aren't going to damage equipment.

Based on Merino sheep successfully used in agrisolar operations in other NSW solar farms, and established presence as an agricultural enterprise within the region, Merino sheep would be used. However, other breeds may be used dependent on market conditions.

Existing agricultural improvements, including stock fences and watering infrastructure (e.g. farm dam) and would be retained to accommodate agrisolar practices. The broader Project boundary would be fully fenced.

Grazing would occur via agistment by nearby landholders with an agistment agreement developed that would consider the guidance provided in the Guideline. All services required to manage the sheep and support grazing would be the responsibility of the grazier (including chemicals required, waste management etc). The grazier would have access to the necessary equipment for animal husbandry including equipment for shearing, treating the sheep and pest management.

Stocking rates would be trialled and amended over time however would commence with 10 sheep per hectare in accordance with the Guideline, subject to site conditions (e.g. drought etc).

Sheep would be periodically shorn, generally every nine months (or fewer in some instances), to reduce potential for their wool from being caught in the equipment. Whitehaven would explore the opportunity to include this in lease agreement and animal welfare/management.

An Agrisolar Management Plan would be prepared following the approval of the Project, in consultation with DPI Agriculture, to further develop a strategy for the accommodation of agrisolar practices on the Project land. This would involve specific measures relating to the following:

- Agrisolar infrastructure - the proposed sheep handling infrastructure such as fencing, yards and laneways under the solar array, watering/fodder, drainage and dust suppression arrangements, shelters, connectivity to other paddocks, camps and infrastructure such as woolshed, dip, chemical store, fodder store and yards etc.
- Sheep husbandry – explanation of the breed(s) (meat/wool) and breeding plan, sex and ages of sheep to be utilised (wethers/ewes/lambs etc), stocking rates, proposed welfare and animal health requirements such as integrated pest management.
- Pasture management – given that the property has been used for both grazing and cropping and the likelihood of weed invasion with introduction of pasture; details on the systems and stocking rates approach used to establish, manage and maintain pasture growth and weed management.
- Waste Management - plans for the disposal of used water, spent fodder, dead animals/animal products, chemicals and contaminated matter, etc.



The potential mitigation effect of implementing agrisolar at a rate of 10 sheep per hectare over a 95 ha areas within the Project Area (for the purpose of this assessment assuming approximately 22.4 ha area for site infrastructure placement) is presented in **Table 16**, and ranges from \$33,449 to \$38,456 per year.

Based on the estimated pre-Project agricultural productivity for Project Area of up to \$45,410 per year (as outlined in Section 3.1.3), agrisolar at the modelled rate offers the potential to mitigate these impacts by between 74% and 85%.

Table 16: LUCRA Moderate Risk Items and Risk Controls Summary

Enterprise	Estimated Gross Margin (\$/DSE/year)	DSE/Ha	Agrisolar Area (ha)	Gross Margin (\$/year)
Merino Ewes (20 micron) – Maternal rams (including fodder)	40.48	10	95	38,456
Merino Ewes (20 micron) – Merino rams (including fodder)	39.70	10	95	37,715
Merino Ewes (20 micron) – 25% Terminal rams (including fodder)	35.21	10	95	33,449

6.3 LAND AND SOIL DISTURBANCE MITIGATION

6.3.1 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.

Generally, channelised drainage patterns should be minimised and the Project should limit hard engineering solutions for erosion control and preference soft, vegetated structures.

Whitehaven would prepare an Erosion and Sediment Control Plan (ESCP) that addresses specific soil dispersion risks based on disturbance activity and phase of the Project. The ESCP should include the following:

Construction Phase

- Construction should proceed in stages, and within each stage the construction activities would be sequenced, such that the construction zone at any one time would only be a small proportion of the overall Project Area;
- 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 assessments and implementing erosion and sediment control accordingly. As a result, the existing vegetative cover and soil structure would be maintained intact across much of the Project Area;
- Solar arrays are typically pole mounted, with the poles being supported on a driven or screw pile, so that there is no excavation required other than for electrical cabling;
- Construction areas should be progressively revegetated with grass and pasture species as installation of solar panels proceeds across the Project Area;



- At locations where earthworks are necessary, such as for construction of sub-station pads, or site facilities, localised erosion and sediment controls would be placed in accordance with the Landcom (2004) guidelines;
- Preservation and stabilisation of drainageways and minimisation of the extent and duration of any surface disturbance would be prioritised during construction.
- If sodic subsoils 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 sewn with grass and pasture species with starter fertiliser to provide stabilising ground cover and a healthy topsoil to provide 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.
- During operation, mounted solar panels should change orientation during the day, with any rainfall runoff being distributed in the area around each panel, and not drained permanently to a single point on the ground.
- 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 Project.

Decommissioning and Rehabilitation Phase

- A detailed decommissioning and rehabilitation plan should be prepared within 5 years of the planned closure of the Project. This plan would 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 Sodosol unit, 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.

6.3.2 SOIL STRIPPING FOR REHABILITATION

The very minor amount of soil that is proposed to be disturbed during the Project would be stripped and re-used in construction and/or rehabilitation efforts in order to mitigate long term effects on the land and soil capability of the Project Area.

The entirety of the Project Area has been assessed to determine suitability for stripping and re-use. This would 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 3**) were used in conjunction with the field assessment to determine the suitability of 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 and lack of a soil bank for the site, it is anticipated that all soil stripping and re-use would be localised; that is, soil would be respread from where it is stripped, reinstating the soil profile to its original condition.

Additionally, soils would 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 would be displaced should be stripped of topsoil. If this is required, then the excavated subsoil 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 Geographical Information Systems (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. It is not anticipated the Project would involve major amounts of soil excavation requiring long-term stockpile solutions, however small scale potential soil stockpiling from trenched areas and hardstand locations should abide by the following measures where practicable:

- Strip soil material to maximum excavation depths only.
- Soil should ideally be stripped in a slightly moist condition. Where practicable, material should not be stripped in either an excessively dry or wet condition.
- 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.

- As a general rule, 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.
- 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 would provide sufficient competition to minimise the emergence of undesirable weed species. The annual pasture species would not persist in the rehabilitation areas but would 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 allow management of materials for planned rehabilitation activities.
- 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 Project does not anticipate large volumes of topsoil to require significant stockpile and resspreading management measures, however the following re-spreading and seedbank preparation techniques are recommended to prevent excessive soil deterioration and dispersion for any minor areas of topsoil removal.

- 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 would 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-tynd plough or disc harrow.

6.3.3 SOIL BIOLOGY MANAGEMENT

The design life for the Project is approximately 50 years; during this time soil hydrological and ecological processes may be impacted. In addition to reducing the landscape’s ability to support ecosystem services during the solar facility’s lifespan, these changes may leave legacy effects that persist long after the installation is removed, if effective rehabilitation is not undertaken post decommissioning.

Based on the intensity of the panel array layout, the soil would 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 would 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; and
- Weed management strategies to promote continued presence of pasture species and seedbank within topsoil.

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

6.4 PEST SPECIES

Weeds in general would be managed across the site through a pest and weed management measures incorporated within Project Construction and Operational Environmental Management Plans. This would include an ongoing effort to identify and eliminate existing weed populations on-site over the life of the project. The spread of declared noxious weeds would be prevented by using site specific measures such as direct spraying.

Weed control, if required, would be undertaken in a manner that would minimise soil disturbance. Any use of herbicides would be carried out in accordance with the regulatory requirements. Records would be maintained of weed infestations and control programs would be implemented according to best management practice for the weed species concerned.

Feral animal control may potentially be undertaken in consultation with neighbouring landholders, as required. Programs to control feral animals would 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 feral fauna species, or the occurrence of a previously unrecorded feral fauna 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.

Feral animals may include cats, foxes, rabbits, pigs, and dogs and would be controlled in accordance with Livestock Health and Pest Authority procedures.

With the effective implementation of measures to manage and control the spread of weeds and pest species within and around the project area, weeds and pests would not have an impact on agriculture within the Project locality.

6.5 BIOSECURITY

At the local level, the mitigation measures outlined for pest species would reduce biosecurity risks. On a regional level, any import of equipment or machinery from overseas would follow the standard procurement safeguards and quarantine procedures as per Australian requirements.

Further, agricultural biosecurity management measures would be incorporated within Project Construction and Operational Environmental Management Plans detailing construction and operational risks and controls in relation to pests, weeds, and diseases will be prepared for the project. Measures should be provided based on the following general control categories:

- Entry / exit procedures;
- Pest Management;
- Weed Management;
- Disease Management;
- Responsibilities;
- Training; and
- Auditing and Reporting.



As DPI Agriculture has noted for other similar large scale renewables projects, the agricultural biosecurity management measures should include controls to address the current elevated threat of foot-and-mouth disease (FMD), a serious and highly contagious animal disease that affects all cloven-hoofed animals including cattle and sheep. An incursion of the virus would have severe consequences for Australia's animal health and trade. Key controls should include adherence to government FMD awareness, prevention and preparedness programs and guidance.

6.6 MONITORING PROGRAMS

Monitoring programs are instituted to assess predicted verses actual impacts as the Project progresses in order to implement controls where required. All operations associated with the Project undertaken in accordance with approved Environmental Management Plans and Strategies. The management plans would include detailed environmental monitoring programs. Whitehaven continually monitors environmental performance and legislative compliance of the existing operations. Key management plans, or chapters housed within a larger Operation or Construction Environmental Management Plan, that would assist in managing impacts on agricultural land include:

- Erosion and Sediment Control Plan;
- Weed and Pest Management Plan;
- Surface Water Management and Monitoring Plan;

These management plans would be reviewed and revised where necessary to incorporate the requirements associated with the Project prior to commencement. A key component of this revision would be the development of trigger levels and Trigger Response Action Plans, in consultation with stakeholders. The monitoring programs and trigger points listed in **Table 17** below would form the basis in this regard.

Table 17: Monitoring Program and Trigger Responses

Risk	Monitoring/Inspections	Trigger Points	Trigger Response
Erosion and Sedimentation	Success of erosion and sediment controls	Evidence of, or the potential for, erosion and sedimentation	Implement additional erosion and sediment control measures and rectify instances of soil resource loss.
Weed spread	Success of weed species elimination	Evidence of potential weed infestations	Elimination of target weeds
Pest occurrence	Success of pest species control	Evidence of pest species	Elimination of pests according to specific pest removal methods
Surface Water	Suitability of run-off water quality, dam water quality, surface water flows	Water quality testing results failing to meet standards Evidence of surface water flows dispersing soils	Implement controls to increase quality of run-off and dam water quality. Implement additional erosion and sediment control measures and rectify instances of soil resource loss
Rehabilitation	Rehabilitation success criteria	Failure to meet rehabilitation objectives	Review strategy and implement controls to rectify failure



6.7 MITIGATION SUMMARY

The key mitigation measures pertaining to soils and agriculture that have been referenced in this assessment would form part of the Project approval commitments. A summary of these is presented in **Table 18**.

Table 18: Summary of Mitigation Measures

Risk Category	Mitigation Measure
Agrisolar	Include accommodation of agrisolar practices in the Project design, particularly sheep grazing, which would be subject to an initial trial to confirm suitability and carrying capacity on the Project land at a rate of 10 sheep per hectare over a 95 ha area of the Project Area.
Soils	All soil that is proposed to be disturbed during the Project would be stripped and re-used in construction and/or stockpiled for use in rehabilitation Channelised drainage patterns should be minimised and the Project should limit 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, would facilitate the rehabilitation in.
Erosion and Sedimentation	Suitable erosion and sedimentation controls, as outlined in Section 6.2, would be implemented.
Infrastructure	Stock fences, dams, and access tracks to be retained or reinstated at the completion of the Project.
Pest Species	Pest species will be managed in accordance with measures described in Section 6.4.
Biosecurity	Biosecurity will be managed in accordance with measures described in Section 6.5.



7 CONSULTATION

Consultation was carried with a range of stakeholder groups and individual stakeholders in the Scoping Report for 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:

- DPE;
- NSW Rural Fire Services;
- Environment Protection Authority;
- Department of Planning and Environment – Water;
- Mining, Exploration and Geoscience;
- NSW Resources Regulator;
- Biodiversity, Conservation and Science Directorate;
- Department of Primary Industries – Agriculture;
- Department of Climate Change, Energy, the Environment and Water;
- Energy Corporation of NSW;
- Essential Energy;
- Narrabri Mine Community Consultative Committee;
- DPI;
- Narrabri Shire Council;
- TransGrid;
- Local Aboriginal representatives;
- Neighbouring landowners; and
- The local community.

Direct consultation to inform this assessment was undertaken with land managers regarding current and historical management of land and agricultural practices on the Project Area and its surrounds, effects on local industry support services and agribusinesses, and employment reliant on the agricultural enterprises on the Project Area.



8 SUMMARY

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 as a result of the Project are determined to be minimal, temporary, and limited to the Project site. These impacts can be summarised as the following:

- Temporary removal of 117.4 ha from agricultural land use within the Project Area;
- Temporary removal of potential agricultural primary productivity to the estimated value of up to \$45,410 per year of Project life; and
- Temporary impacts on soil resources within the Project Area where surface disturbance occurs.

The temporary impacts on agriculture listed above are considered a negligible impact in the context of the gross commodity values and land use coverage of the agricultural industries operating within the Narrabri Shire LGA.

Whitehaven would include accommodation of agrisolar practices in the Project design, particularly sheep grazing, which would be subject to an initial trial to confirm suitability and carrying capacity on the Project land at a rate of 10 sheep per hectare over a 95 ha area of the Project Area. Agrisolar would result in significant mitigation of the impacts of the Project relating to land used for agriculture and agricultural productivity. With a potential agricultural primary productivity impact of up to \$45,410 per year of Project life, agrisolar at the modelled rate offers the potential to mitigate this impact by between \$33,449 and \$38,456 per year, or 74% to 85% per year.

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 would have no permanent negative impacts on agricultural resources or enterprises.

Mitigation measures and management recommendations have been provided 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 soil management practices during construction and operational phases of the Project, would assist to meet rehabilitation requirements and return the land to a pre-disturbance LSC 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 current 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 would undergo subdivision to accommodate residential or small-block rural developments. Accordingly, it is not expected that future changes to land use would occur that would 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

Consequence	Probability				
	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 and vibration impacts has been undertaken as part of the EIS Appropriate mitigation measures are specified within the EIS to minimise noise and vibration impacts. Based on the preliminary separation distances and the mitigation proposed, adverse impacts from noise and vibration during construction and operation are not predicted. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to noise and vibration impacts on agricultural land users. Ongoing consultation with stakeholders would identify and address concerns if they arise.	D	4	5	Any complaints from neighbours regarding effects to livestock can be managed within normal operations. No exceedances of adopted noise policy.
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. Appropriate mitigation measures are specified within the EIS to minimise the risk for dust to spread throughout the site and onto neighbouring land. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to air quality impacts. Separation distances for dust originating from the development (if applicable) would be included as a management strategy. Ongoing consultation with stakeholders would 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	Any complaints from neighbours can be managed within normal operations. No exceedances of adopted dust criteria.

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 and vibration impacts has been undertaken as part of the EIS. Appropriate mitigation measures are specified within the EIS to minimise noise and vibration impacts. Based on the preliminary separation distances and the mitigation proposed, adverse impacts from noise and vibration during construction and operation are not predicted. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to noise and vibration impacts on agricultural land users. Ongoing consultation with stakeholders would identify and address concerns if they arise.	D	4	5	Any complaints from neighbours can be managed within normal operations. No exceedances of adopted noise policy.
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 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 would 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	No reportable erosion or sedimentation of waterways. Any observed erosion can be repaired promptly and adequately.

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 Narrabri Mine 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 Road Transport Assessment. Appropriate mitigation measures are specified within the Road Transport Assessment to minimise impacts to the traffic environment. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to traffic for local users. Ongoing consultation with stakeholders would 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	2	4	No complaints from local agricultural or mine operators during the construction phase.
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, mine vehicles or wildlife on roads.	D	1	19	The assessment of potential traffic impacts has been undertaken via a Road Transport Assessment. Appropriate mitigation measures are specified within the Road Transport Assessment to minimise impacts to the traffic environment. Compliance with mitigation measures is anticipated to reduce the risk of conflict related to traffic for local users. Ongoing consultation with stakeholders would 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	No traffic incidents during construction that are directly related to the solar farm.
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 as part of the EIS. Levels of anticipated increased demand and appropriate mitigation measures are specified within the EIS to minimise the risk for logistical issues associated with the increased demand for existing infrastructure and services. Ongoing consultation with stakeholders would identify and address concerns if they arise.	D	5	2	No unreasonable additional pressure on local services and infrastructure during the construction phase.



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 construction activities associated with the solar farm may damage existing infrastructure including transmission lines and access roads used by local residents and Narrabri Mine.	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 would be detailed in a Construction Management Plan (or similar) 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 would 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 telecom connections (Optus tower in Lot 59, DP755621) and transmission lines during the construction phase.
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	No observed erosion or degradation of soils or sedimentation of waterways
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 this report for stakeholder consideration. A Rehabilitation and Decommissioning Management Plan (or similar) would ensure the land can be successfully returned to agricultural production following decommissioning.	D	4	5	Stakeholders are informed of assessment findings and have no concern regarding change in land use



Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
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 Impact Assessment. Anticipated impacts are determined to be negligible and presented in this report for land user consideration. Ongoing consultation with stakeholders would identify and address concerns if they arise.	D	5	2	Stakeholders are informed of assessment findings and have no concern regarding impacts to agricultural support infrastructure
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 or mine 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 Road Transport Assessment. Anticipated impacts are determined to be negligible and presented in the EIS for land user consideration. Ongoing consultation with stakeholders would identify and address concerns if they arise.	D	5	2	No complaints from agriculture enterprises or mine operators regarding increased traffic
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 would 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	3	6	No complaints from neighbours due to the solar farm activities. No exceedances of adopted dust criteria
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 and vibration impacts 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 would identify and address concerns if they arise.	D	5	2	No complaints from neighbours due to the solar farm activities. No exceedances of adopted noise policy.



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 reduce the risk of conflict related to visual amenity. Ongoing consultation with stakeholders would 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	No complaints from stakeholders regarding visual amenity
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. Anticipated impacts are determined to be negligible and presented in the EIS for stakeholder consideration. Ongoing consultation with stakeholders would identify and address concerns if they arise.	E	3	6	No complaints from neighbouring properties regarding glare and reflectivity of panels
Operation Visual Amenity	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 would identify and address concerns if they arise.	E	4	3	No complaints from agriculture-based tourism enterprise operating in the Project locality



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 Biodiversity Development Assessment Report (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 would 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	No introduction of weed, plant pest, plant disease or pest animals onto the Project site as a result of the Project, and no spread to surrounding properties
Operation Pest Control	Neighbouring property owners may be concerned about sprays from weed control adversely affecting adjacent land	D	4	5	Weed mitigation measures would be undertaken as per methodology specified in management plans identified in the EIS and/or consent conditions (if approved), including spraying in a manner to prevent spray drift. Ongoing consultation with stakeholders would identify and address concerns if they arise.	E	4	3	No complaints from neighbouring properties regarding overspray of herbicides
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 within the EIS 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 would identify and address concerns if they arise.	E	4	3	No introduction of weed, plant pest, plant disease or pest animals onto the Project site as a result of the Project, and no spread to surrounding properties



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 would 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	No observed erosion of soils or sedimentation of waterways
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	The Project incorporates management of bushfire risk (noting that the Project layout includes asset protection zones which would be maintained for the Project). Ongoing consultation with stakeholders would 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	No occurrence of fires beginning on the Project site and spreading to surrounding land
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 EIS. Anticipated impacts are determined to be negligible and outweighed by the employment opportunities of the Project. This finding is presented in the EIS for stakeholder consideration.	E	1	1	No unreasonable additional pressure to local employment



Activity	Potential Conflict	Initial Risk Rating			Risk Reduction Control	Final Risk Rating			Performance Target
		Probability	Consequence	Rating		Probability	Consequence	Rating	
General Operation	Neighbouring landowners may be concerned about livestock used for vegetation control on Project site entering adjacent properties	D	4	5	Operational management plans would 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 would identify and address concerns if they arise.	E	4	3	No breach of boundary fence.
General Operation	Neighbouring landowners may be concerned about their livestock entering the Project site and becoming injured or causing damage	D	4	5	Operational management plans would 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 would be made to ensure the animal is not distressed and kept away from public roads. Ongoing consultation with stakeholders would identify and address concerns if they arise.	E	4	3	No breach of boundary fence.
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 EIS. The report concludes that EMF exposure levels would not exceed the International Commission on Non-Ionizing Radiation Protection reference level for the general public. No adverse impacts to human health at the site or in the locality are therefore anticipated. This finding is presented in the EIS for stakeholder consideration.	E	5	1	Stakeholders are informed of assessment findings and have no concern regarding EMF

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 site.	C	3	13	Existing consultation and engagement for the project has not identified any intent for surrounding agricultural industries to expand operations onto the site 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	Successful consultation addresses stakeholder concerns
General Operation	Stakeholders may be concerned the placement of the solar farm on land that may be viable for coal mining may cause conflict with Narrabri Mine expanding its production onto the site in the future.	D	3	9	The Project land is owned by Narrabri Coal Operations Pty Ltd. The reversibility of the project would allow the site to be returned to its existing land use/ mining availability, therefore minimising potential for long term conflict.	E	3	6	Successful consultation addresses stakeholder concerns
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	Based on the outcomes of previous solar farm developments, this is not an anticipated impact Ongoing consultation with stakeholders would identify and address concerns if they arise.	E	3	6	Successful consultation addresses stakeholder concerns
General Operation	Landowners in the locality may be concerned about potential devaluation of properties due to proximity to solar farm infrastructure.	B	3	17	Given the size of the landholdings, it is likely that their agricultural production attributes provide a strong foundation for overall property value. The Project would not impact the agricultural resources or production value of properties proximate to the Project Area. Further, the change in visual amenity is not anticipated to have any noticeable effect on property values. Ongoing consultation with stakeholders would identify and address concerns if they arise.	E	2	10	Successful consultation addresses stakeholder concerns



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 increase in council rates as a result of the change in land use of the Project site.	C	3	13	Consideration of changes council rates is included in the EIS. The assessment determined that council rates would not change in the locality. Ongoing consultation with stakeholders would identify and address concerns if they arise.	E	3	6	Successful consultation addresses stakeholder concerns
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 would be mitigated by implementing standard operation measures specified in management plans identified in the EIS and/or consent conditions (if approved). Ongoing consultation with stakeholders would identify and address concerns if they arise.	E	5	1	No complaints from land users in the locality regarding waste.
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	Consideration of potential crime related impacts has been undertaken as part of the EIS. Appropriate mitigation measures are specified in the EIS to minimise the potential for crime to occur at or near the site. Compliance with crime management measures specified within the EIS is anticipated to reduce the risk of conflict related to the increased risk of vandalism and theft for surrounding residents. Ongoing consultation with stakeholders would 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	3	6	Successful consultation assures local residents of security mitigation measures alleviating concerns of perceived additional security risks.
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 has introduced the Project and the applicant (Whitehaven) to surrounding stakeholders. Previous notification to stakeholders outlined the applicant's ownership and consultation has provided an opportunity for stakeholders to provide feedback.	E	4	3	Successful consultation addresses stakeholder concerns



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 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 (ACHA). Appropriate mitigation measures are specified within the ACHAR to minimise impacts to heritage. Compliance with mitigation measures specified within the ACHAR 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	No complaints from stakeholders regarding impacts to heritage items or values at the Project site.
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 would identify and address concerns if they arise.	D	3	9	No complaints from stakeholders regarding impacts to biodiversity at the Project site.
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 site. Anticipated impacts are determined to be minor and presented in the EIS for Public Authority consideration.	D	3	9	Successful consultation addresses stakeholder concerns
General Operation	Dispersion of dust and/or agricultural/mining 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.



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 concerned about potential changes to flows during a flooding event as a result of the Project	C	3	13	Consideration of impacts to surrounding areas as a result of floods has been undertaken as part of the EIS. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved). Ongoing consultation with stakeholders would identify and address concerns if they arise.	D	4	5	No changes to flows during flooding events
General Operation	Stakeholders may be concerned about potential contamination of surface water and local waterways from the BESS during a flooding event	C	3	13	Consideration of impacts to surrounding areas as a result of floods has been undertaken as part of the EIS. Implement all measures specified in management plans identified in the EIS and/or consent conditions (if approved). Ongoing consultation with stakeholders would identify and address concerns if they arise.	D	4	5	No changes to water quality during flooding events
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 Rehabilitation and Decommissioning Management Plan (or similar) would be prepared to facilitate the land being successfully returned to pre-disturbance land and soil capability and final land use commitments following decommissioning.	E	2	10	Fulfilment of rehabilitation objectives

Appendix 2

Soil Profile Descriptions



Site Description – Site 1				
Site Reference	1	ASC Name	Haplic Eutrophic Brown Chromosol (AHKOVNR)	
Average Slope	1%	Land Use	Cropping	Coordinates
Landform Pattern	Hillslope	Soil Fertility	Moderately High	MGA 55
Landform Element	Upper Slope	Drainage	Moderate	X: 777935
Surface Condition	Loose	BSAL Status	Potential BSAL	Y: 6619445



Plate 1 – Soil Profile (1)



Plate 2 – Surface (1)



Plate 3 – Landscape (1)

Horizon	Depth (m)	Description					
A1	0.00 – 0.05	Dark Brown (Munsell 7.5YR 2.5/3) Sandy Loam with weak pedality. Neutral pH, non-saline and non-sodic. No coarse fragments. Many roots and well drained. Abrupt boundary.					
B2	0.05 – 0.80	Brown (Munsell 7.5YR 4/3 to 10YR 4/3) Medium Clay to Light Clay with strong pedality. Mildly alkaline to moderately alkaline pH, non-saline and non-sodic. No coarse fragments. Common roots and moderately drained. Clear boundary.					
C	0.80	Sandstone parent material.					
Sample Depth		ECe		pH _(1-5water)		ESP	
		dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.05		0.3	Non-saline	7.0	Neutral	1.4	Non sodic
0.20 – 0.30		0.5	Non-saline	7.5	Mildly Alkaline	1.1	Non sodic
0.40 – 0.50		0.7	Non-saline	8.0	Moderately Alkaline	1.8	Non sodic
0.65 – 0.75		0.7	Non-saline	8.3	Moderately Alkaline	2.6	Non sodic



Site Description – Site 2				
Site Reference	2	ASC Name	Vertic Subnatric Red Sodosol (BFLOWNR)	
Average Slope	2%	Land Use	Cropping	Coordinates
Landform Pattern	Hillslope	Soil Fertility	Moderately Low	MGA 55
Landform Element	Lower Slope	Drainage	Moderate	X: 778089
Surface Condition	Loose	BSAL Status	Non-BSAL	Y: 6619199



Plate 1 – Soil Profile (2)



Plate 2 – Surface (2)



Plate 3 – Landscape (2)

Horizon	Depth (m)	Description				
A1	0.00 – 0.10	Dark Reddish Brown (Munsell 2.5YR 3/3) Sandy Loam with weak pedality. Slightly acidic pH, non-saline and non-sodic. No coarse fragments. Many roots and well drained. Abrupt boundary.				
B2	0.10 – 0.80	Dark Reddish Brown (Munsell 2.5YR 2.5/4) Medium Clay trending to Heavy Clay and Light Medium Clay at depth with strong pedality. Mildly alkaline trending to very strongly alkaline pH, non-saline trending to slightly saline at depth, and sodic. No coarse fragments. Very few roots and moderately drained.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	0.3	Non-saline	6.3	Slightly Acidic	2.2	Non sodic
0.20 – 0.30	0.3	Non-saline	7.7	Mildly Alkaline	7.1	Sodic
0.40 – 0.50	0.7	Non-saline	8.9	Strongly Alkaline	10.7	Sodic
0.65 – 0.75	2.0	Slightly saline	9.1	Very Strongly Alkaline	15.6	Sodic

Site Description – Site 3				
Site Reference	3	ASC Name	Sodic Eutrophic Red Dermosol (BEMOWNR)	
Average Slope	1%	Land Use	Cropping	Coordinates
Landform Pattern	Hillslope	Soil Fertility	Moderately High	MGA 55
Landform Element	Lower Slope	Drainage	Moderate	X: 777958
Surface Condition	Hard Set	BSAL Status	Non-BSAL	Y: 6618852



Plate 1 – Soil Profile (3)



Plate 2 – Surface (3)



Plate 3 – Landscape (3)

Horizon	Depth (m)	Description				
A1	0.00 – 0.15	Dark Reddish Brown (Munsell 5YR 3/4) Clay Loam with weak pedality. Neutral pH, non-saline and non-sodic. No coarse fragments. Many roots and well drained. Gradual boundary.				
B21	0.15 – 0.60	Dark Reddish Brown (Munsell 5YR 3/4) Medium Clay to Light Clay with strong pedality. Moderately to strongly alkaline pH, non-saline and non-sodic. No coarse fragments. Common roots and moderately drained. Gradual boundary.				
B22	0.60 +	Dark Brown (Munsell 7.5YR 3/4) Light Medium Clay with strong pedality. Strongly alkaline pH, slightly saline and sodic. No coarse fragments. No roots and moderately drained.				
Sample Depth	ECe		pH _(1.5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	0.2	Non-saline	6.6	Neutral	1.6	Non sodic
0.20 – 0.30	0.3	Non-saline	8.2	Moderately Alkaline	3.3	Non sodic
0.40 – 0.50	0.5	Non-saline	8.8	Strongly Alkaline	5.0	Non sodic
0.65 – 0.75	2.8	Slightly saline	8.93	Strongly Alkaline	6.8	Sodic

Site Description – Site 4				
Site Reference	4	ASC Name	Sodic Eutrophic Red Dermosol (BEKMWNR)	
Average Slope	0%	Land Use	Cropping/ Grazing	Coordinates
Landform Pattern	Plain	Soil Fertility	Moderately High	MGA 55
Landform Element	Flat	Drainage	Moderate	X: 778354
Surface Condition	Hard Set	BSAL Status	Non-BSAL	Y: 6618691



Plate 1 – Soil Profile (4)



Plate 2 – Surface (4)



Plate 3 – Landscape (4)

Horizon	Depth (m)	Description				
A1	0.00 – 0.10	Dark Reddish Brown (Munsell 2.5YR 2.5/4) Sand with weak pedality. Mildly alkaline pH, non-saline and sodic. No coarse fragments. Many roots and well drained. Abrupt boundary.				
B21	0.10 – 0.35	Dark Reddish Brown (Munsell 5YR 3/4) Loam with moderate pedality. Very strongly alkaline pH, slightly saline and sodic. No coarse fragments. Common roots and moderately drained. Gradual boundary.				
B22	0.35 +	Strong Brown (Munsell 7.5YR 4/6) Clay Loam to Loam with moderate pedality. Very strongly alkaline pH, moderately saline and sodic. No coarse fragments. Very few roots and moderately drained.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	0.6	Non-saline	7.5	Mildly Alkaline	14.9	Sodic
0.20 – 0.30	3.3	Slightly saline	9.3	Very Strongly Alkaline	42.2	Sodic
0.40 – 0.50	7.2	Moderately saline	9.7	Very Strongly Alkaline	43.3	Sodic
0.65 – 0.75	5.7	Moderately saline	9.5	Very Strongly Alkaline	49.5	Sodic

Site Description – Site 5				
Site Reference	5	ASC Name	Sodic Eutrophic Red Dermosol (AELMWNR)	
Average Slope	0%	Land Use	Cropping	Coordinates
Landform Pattern	Plain	Soil Fertility	Moderately High	MGA 55
Landform Element	Flat	Drainage	Moderate	X: 778465
Surface Condition	Hard Set	BSAL Status	Non-BSAL	Y: 6618954



Plate 1 – Soil Profile (5)



Plate 2 – Surface (5)



Plate 3 – Landscape (5)

Horizon	Depth (m)	Description				
A1	0.00 – 0.05	Very Dark Brown (Munsell 7.5YR 2.5/3) Loam with weak pedality. Slightly acidic pH, non-saline and sodic. No coarse fragments. Many roots and well drained. Abrupt boundary.				
B21	0.05 – 0.30	Dark Reddish Brown (Munsell 2.5YR 2.5/3) Clay Loam with strong pedality. Strongly alkaline pH, non-saline and sodic. No coarse fragments. Common roots and moderately drained. Gradual boundary.				
B22	0.30 +	Dark Red to Dark Reddish Brown (Munsell 2.5YR 3/6 to 5YR 3/4) Clay Loam with strong pedality. Very strongly alkaline pH, non-saline trending to slightly saline at depth, and sodic. No coarse fragments. Very few roots and moderately drained.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	0.3	Non-saline	6.3	Slightly Acidic	6.8	Sodic
0.20 – 0.30	0.5	Non-saline	8.5	Strongly Alkaline	12.8	Sodic
0.40 – 0.50	0.8	Non-saline	9.2	Very Strongly Alkaline	17.1	Sodic
0.65 – 0.75	2.3	Slightly saline	9.4	Very Strongly Alkaline	23.4	Sodic

Site Description – Site 6				
Site Reference	6	ASC Name	Eutrophic Mesonatric Red Sodosol (AFLMWNR)	
Average Slope	0%	Land Use	Cropping	Coordinates
Landform Pattern	Plain	Soil Fertility	Moderately Low	MGA 55
Landform Element	Flat	Drainage	Moderate	X: 778319
Surface Condition	Hard Set	BSAL Status	Non-BSAL	Y: 6619375



Plate 1 – Soil Profile (6)



Plate 2 – Surface (6)



Plate 3 – Landscape (6)

Horizon	Depth (m)	Description				
A1	0.00 – 0.05	Very Dark Brown (Munsell 7.5YR 2.5/3) Sandy Loam with moderate pedality. Neutral pH, non-saline and sodic. No coarse fragments. Many roots and well drained. Abrupt boundary.				
B21	0.05 – 0.30	Dark Reddish Brown (Munsell 2.5YR 2.5/4) Clay Loam with strong pedality. Strongly alkaline pH, slightly saline and sodic. No coarse fragments. Common roots and moderately drained. Gradual boundary.				
B22	0.30 +	Strong Brown (Munsell 7.5YR 4/6) Clay Loam with strong pedality. Very strongly alkaline pH, moderately saline to highly saline, and sodic. No coarse fragments. Very few roots and moderately drained.				
Sample Depth	ECe		pH _(1.5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	0.4	Non-saline	6.8	Neutral	11.5	Sodic
0.20 – 0.30	2.3	Slightly saline	8.8	Strongly Alkaline	24.2	Sodic
0.40 – 0.50	6.8	Moderately saline	9.2	Very Strongly Alkaline	28.7	Sodic
0.65 – 0.75	9.0	Highly saline	9.1	Very Strongly Alkaline	34.6	Sodic



Site Description – Site 7				
Site Reference	7	ASC Name	Vertic Hypernatric Brown Sodosol (BELMWNR)	
Average Slope	0%	Land Use	Grazing	Coordinates
Landform Pattern	Plain	Soil Fertility	Moderately Low	MGA 55
Landform Element	Drainage Flat	Drainage	Moderate	X: 778717
Surface Condition	Hard Set	BSAL Status	Non-BSAL	Y: 6619295



Plate 1 – Soil Profile (7)



Plate 2 – Surface (7)



Plate 3 – Landscape (7)

Horizon	Depth (m)	Description				
A1	0.00 – 0.10	Very Dark Brown (Munsell 7.5YR 2.5/3) Sandy Loam with weak pedality. Mildly alkaline pH, non-saline and sodic. No coarse fragments. Many roots and well drained. Abrupt boundary.				
B21	0.10 – 0.40	Brown (Munsell 7.5YR 4/4) Clay Loam with strong pedality. Strongly alkaline pH, moderately saline and sodic. No coarse fragments. Common roots and moderately drained. Gradual boundary.				
B22	0.40 +	Strong Brown (Munsell 7.5YR 4/6) Loam with strong pedality. Strongly alkaline to very strongly alkaline pH, moderately saline and sodic. 10% coarse fragments 10 – 30mm. Very few roots and moderately drained.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	1.3	Non-saline	7.4	Mildly Alkaline	18.3	Sodic
0.20 – 0.30	4.0	Moderately saline	8.6	Strongly Alkaline	29.9	Sodic
0.40 – 0.50	5.2	Moderately saline	8.9	Strongly Alkaline	33.3	Sodic
0.65 – 0.75	7.1	Moderately saline	9.3	Very Strongly Alkaline	29.3	Sodic

Site Description – Site 8				
Site Reference	8	ASC Name	Eutrophic Hypernatric Red Sodosol (BFLMWNR)	
Average Slope	0%	Land Use	Grazing	Coordinates
Landform Pattern	Plain	Soil Fertility	Moderately Low	MGA 55
Landform Element	Drainage Flat	Drainage	Moderate	X: 779148
Surface Condition	Hard Set	BSAL Status	Non-BSAL	Y: 6619195



Plate 1 – Soil Profile (8)



Plate 2 – Surface (8)



Plate 3 – Landscape (8)

Horizon	Depth (m)	Description				
A1	0.00 – 0.12	Very Dark Brown (Munsell 7.5YR 2.5/3) Sandy Loam with weak pedality. Neutral pH, non-saline and sodic. No coarse fragments. Many roots and well drained. Clear boundary.				
B21	0.12 – 0.35	Dark Reddish Brown (Munsell 5YR 3/4) Clay Loam with strong pedality. Very strongly alkaline pH, slightly saline and sodic. No coarse fragments. Common roots and moderately drained. Gradual boundary.				
B22	0.35 +	Strong Brown (Munsell 7.5YR 4/6) Loam with strong pedality. Very strongly alkaline pH, moderately to highly saline and sodic. 15% coarse fragments 10 – 30mm. Very few roots and moderately drained.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	0.4	Non-saline	7.1	Neutral	9.8	Sodic
0.20 – 0.30	2.4	Slightly saline	9.2	Very Strongly Alkaline	26.4	Sodic
0.40 – 0.50	7.1	Moderately saline	9.2	Very Strongly Alkaline	32.5	Sodic
0.65 – 0.75	9.5	Highly saline	9.0	Strongly Alkaline	38.0	Sodic

Site Description – Site 9				
Site Reference	9	ASC Name	Eutrophic Mesonatric Brown Sodosol (AEKOWNR)	
Average Slope	0%	Land Use	Cropping	Coordinates
Landform Pattern	Plain	Soil Fertility	Moderately Low	MGA 55
Landform Element	Flat	Drainage	Moderate	X: 778864
Surface Condition	Loose	BSAL Status	Non-BSAL	Y: 6619080



Plate 1 – Soil Profile (9)



Plate 2 – Surface (9)



Plate 3 – Landscape (9)

Horizon	Depth (m)	Description				
A1	0.00 – 0.05	Very Dark Brown (Munsell 7.5YR 2.5/3) Sandy Loam with weak pedality. Slightly acidic pH, non-saline and sodic. No coarse fragments. Many roots and well drained. Abrupt boundary.				
B21	0.05 – 0.30	Dark Brown (Munsell 7.5YR 3/4) Light Clay with strong pedality. Strongly alkaline pH, non-saline and sodic. No coarse fragments. Common roots and moderately drained. Gradual boundary.				
B22	0.30 +	Dark Brown to Dark Yellowish Brown (Munsell 7.5YR 3/4 to 10YR 4/6) Light Clay with strong pedality. Very strongly alkaline pH, moderately saline and sodic. No coarse fragments. Very few roots and moderately drained.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	0.2	Non-saline	6.5	Slightly Acidic	10.5	Sodic
0.20 – 0.30	1.2	Non-saline	8.5	Strongly Alkaline	22.6	Sodic
0.40 – 0.50	4.5	Moderately saline	9.3	Very Strongly Alkaline	29.0	Sodic
0.65 – 0.75	6.1	Moderately saline	9.4	Very Strongly Alkaline	26.1	Sodic

Site Description – Site 10				
Site Reference	10	ASC Name	Eutrophic Hypernatric Brown Sodosol (BEKOWNR)	
Average Slope	0%	Land Use	Cropping	Coordinates
Landform Pattern	Plain	Soil Fertility	Moderately Low	MGA 55
Landform Element	Flat	Drainage	Imperfect	X: 779258
Surface Condition	Soft	BSAL Status	Non-BSAL	Y: 6618893



Plate 1 – Soil Profile (10)



Plate 2 – Surface (10)



Plate 3 – Landscape (10)

Horizon	Depth (m)	Description				
A1	0.00 – 0.20	Very Dark Brown (Munsell 7.5YR 2.5/3) apedal Sandy Loam. Moderately acidic pH, non-saline and sodic. No coarse fragments. Many roots and well drained. Clear boundary.				
A2	0.20 – 0.35	Light Grey (Munsell 10YR 7/1) apedal Sand. Slightly acidic pH, non-saline and sodic. No coarse fragments. Common roots and moderately drained. Clear boundary.				
B22	0.35 +	Yellowish Brown to Dark Yellowish Brown (Munsell 10YR 5/4 to 10YR 4/4) Medium Clay to Light Clay with strong pedality. Neutral trending to mildly alkaline pH, non-saline trending to slightly saline at depth, and sodic. No coarse fragments. Very few roots and imperfectly drained. 40% distinct grey mottling.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	0.2	Non-saline	6.0	Moderately Acidic	9.0	Sodic
0.20 – 0.30	0.3	Non-saline	6.5	Slightly Acidic	10.7	Sodic
0.40 – 0.50	1.5	Non-saline	6.7	Neutral	25.2	Sodic
0.65 – 0.75	2.6	Slightly saline	7.3	Mildly Alkaline	30.7	Sodic



Site Description – Site 11				
Site Reference	11	ASC Name	Eutrophic Mesonatric Brown Sodosol (CEKMWNR)	
Average Slope	0%	Land Use	Cropping	Coordinates
Landform Pattern	Plain	Soil Fertility	Moderately Low	MGA 55
Landform Element	Flat	Drainage	Imperfect	X: 779507
Surface Condition	Soft	BSAL Status	Non-BSAL	Y: 6619199



Plate 1 – Soil Profile (11)



Plate 2 – Surface (11)



Plate 3 – Landscape (11)

Horizon	Depth (m)	Description				
A1	0.00 – 0.30	Very Dusky Red (Munsell 2.5YR 2.5/2) apedal Sandy Loam. Slightly acidic pH, non-saline and non-sodic. No coarse fragments. Many roots and well drained. Gradual boundary.				
A2	0.30 – 0.50	Dark Brown to Reddish Brown (Munsell 7.5YR 3/4 to 2.5YR 4/3) apedal Loamy Sand. Neutral pH, non-saline and sodic. No coarse fragments. Common roots and moderately drained. Clear boundary.				
B2	0.50 +	Strong Brown (Munsell 7.5YR 5/6) Clay Loam with strong pedality. Moderately alkaline pH, non-saline and sodic. No coarse fragments. Very few roots and moderately drained. 40% distinct grey mottling.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0.00 – 0.10	0.7	Non-saline	6.4	Slightly Acidic	3.7	Non sodic
0.20 – 0.30	0.3	Non-saline	6.6	Neutral	3.9	Non sodic
0.40 – 0.50	0.3	Non-saline	7.1	Neutral	9.7	Sodic
0.65 – 0.75	0.4	Non-saline	8.2	Moderately Alkaline	17.7	Sodic

Appendix 3
Laboratory Certificates of Analysis



GRAIN SIZE ANALYSIS (hydrometer and sieving techniques)

44 soil samples supplied by Minesoils Pty. Ltd. on 6th December 2022 - Lab Job No. N5342

Analysis requested by Clayton Richards. Job Ref. MS-086 Narrabri Solar Soils & BSAL

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 0-5	N5342/1	2.2%	23.9%	19.7%	4.2%	32.0%	32.4%	2.1%	9.6%
1 20-30	N5342/2	13.6%	0.9%	0.4%	0.4%	22.4%	26.9%	4.6%	45.2%
1 40-50	N5342/3	12.9%	0.6%	0.0%	0.6%	27.3%	28.7%	8.1%	35.3%
1 65-75	N5342/4	13.6%	0.0%	0.0%	0.0%	28.0%	30.7%	4.4%	36.9%
2 0-5	N5342/5	3.2%	6.5%	4.3%	2.2%	29.2%	41.2%	6.9%	16.2%
2 20-30	N5342/6	13.9%	0.4%	0.0%	0.4%	18.0%	25.2%	9.1%	47.2%
2 40-50	N5342/7	13.5%	0.3%	0.0%	0.3%	15.7%	26.1%	7.9%	50.1%
2 65-75	N5342/8	12.1%	1.2%	0.0%	1.2%	19.5%	31.4%	6.8%	41.0%
3 0-5	N5342/9	6.6%	1.0%	0.0%	1.0%	33.2%	29.3%	9.0%	27.4%
3 20-30	N5342/10	13.7%	0.4%	0.0%	0.4%	27.4%	21.3%	4.3%	46.6%
3 40-50	N5342/11	10.7%	1.7%	0.0%	1.7%	30.7%	22.7%	8.0%	36.8%
3 65-75	N5342/12	13.0%	3.7%	0.7%	3.0%	26.4%	19.6%	11.2%	39.0%
4 0-5	N5342/13	1.4%	0.6%	0.0%	0.6%	58.5%	33.1%	1.3%	6.6%
4 20-30	N5342/14	10.4%	0.9%	0.0%	0.9%	37.0%	25.4%	17.1%	19.5%
4 40-50	N5342/15	9.9%	1.6%	0.0%	1.6%	34.2%	26.8%	13.0%	24.5%
4 65-75	N5342/16	8.2%	2.5%	0.8%	1.7%	41.5%	26.1%	17.5%	12.4%
5 0-5	N5342/17	3.7%	0.7%	0.0%	0.7%	38.0%	31.9%	11.3%	18.1%
5 20-30	N5342/18	10.7%	0.5%	0.0%	0.5%	31.3%	24.9%	12.9%	30.5%
5 40-50	N5342/19	12.3%	0.5%	0.0%	0.5%	26.5%	23.9%	17.1%	32.0%
5 65-75	N5342/20	12.7%	0.6%	0.0%	0.6%	26.5%	27.9%	17.0%	28.1%
6 0-5	N5342/21	2.0%	5.9%	3.3%	2.6%	36.8%	36.0%	8.5%	12.8%
6 20-30	N5342/22	10.9%	3.0%	0.8%	2.3%	24.9%	28.4%	13.9%	29.7%
6 40-50	N5342/23	12.1%	1.8%	0.0%	1.8%	22.0%	31.4%	20.4%	24.4%
6 65-75	N5342/24	14.3%	7.0%	4.5%	2.4%	23.2%	29.9%	14.6%	25.2%
7 0-5	N5342/25	4.3%	1.1%	0.0%	1.1%	47.5%	29.9%	6.8%	14.7%
7 20-30	N5342/26	9.6%	1.0%	0.4%	0.5%	31.1%	25.5%	11.6%	30.9%
7 40-50	N5342/27	11.9%	0.4%	0.0%	0.4%	31.7%	28.0%	17.4%	22.4%
7 65-75	N5342/28	11.9%	1.1%	0.4%	0.7%	30.5%	25.9%	21.4%	21.2%
8 0-5	N5342/29	2.5%	3.6%	2.3%	1.2%	50.6%	25.4%	9.1%	11.2%
8 20-30	N5342/30	10.2%	0.6%	0.0%	0.6%	35.9%	27.6%	8.7%	27.2%
8 40-50	N5342/31	11.0%	0.8%	0.0%	0.8%	30.8%	28.0%	11.0%	29.4%
8 65-75	N5342/32	12.8%	0.4%	0.0%	0.4%	35.4%	33.4%	15.6%	15.2%
9 0-5	N5342/33	1.5%	1.1%	0.0%	1.1%	54.8%	35.0%	0.5%	8.6%
9 20-30	N5342/34	12.7%	0.3%	0.0%	0.3%	35.1%	23.1%	6.0%	35.5%
9 40-50	N5342/35	14.2%	2.7%	1.2%	1.5%	32.1%	24.0%	5.9%	35.3%
9 65-75	N5342/36	10.9%	3.7%	1.7%	2.1%	31.0%	22.1%	10.4%	32.8%
10 0-5	N5342/37	6.7%	1.0%	0.6%	0.4%	57.7%	32.7%	0.4%	8.2%
10 20-30	N5342/38	7.0%	6.8%	5.9%	0.9%	56.3%	29.7%	4.2%	3.0%
10 40-50	N5342/39	15.4%	0.2%	0.0%	0.2%	32.1%	18.3%	3.2%	46.2%
10 65-75	N5342/40	14.1%	0.5%	0.0%	0.5%	33.2%	25.1%	7.6%	33.7%
11 0-5	N5342/41	9.1%	0.6%	0.0%	0.6%	52.5%	37.8%	3.8%	5.4%
11 20-30	N5342/42	9.1%	0.8%	0.0%	0.8%	54.6%	31.7%	6.0%	6.9%
11 40-50	N5342/43	9.1%	1.9%	1.4%	0.5%	51.8%	36.2%	4.7%	5.3%
11 65-75	N5342/44	11.6%	2.8%	0.4%	2.4%	37.9%	25.6%	10.2%	23.6%

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 20/12/2022.

AGRICULTURAL SOIL ANALYSIS REPORT

44 samples supplied by Minesoils Pty. Ltd. on 06/12/2022. Lab Job No.N5342

Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

Analysis requested by Clayton Richards. Field No: 1506. Rainfall total: 6.6 mm. PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 1	Sample 2	Sample 3	Sample 4
		Crop:	1 0-5	1 20-30	1 40-50	1 65-75
		Client:	N/G	N/G	N/G	N/G
			Resource Strategies	Resource Strategies	Resource Strategies	Resource Strategies
	Parameter	Method reference	N5342/1	N5342/2	N5342/3	N5342/4
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.99	7.49	7.96	8.26
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.019	0.062	0.085	0.085
	Exchangeable Calcium	(cmol./kg)	2.7	9.3	9.0	7.4
		(kg/ha)	1,219	4,186	4,040	3,318
		(mg/kg)	544	1,869	1,804	1,481
	Exchangeable Magnesium	(cmol./kg)	1.3	7.6	9.3	9.6
		(kg/ha)	358	2,072	2,520	2,606
		(mg/kg)	160	925	1,125	1,163
	Exchangeable Potassium	(cmol./kg)	0.53	0.64	0.54	0.49
		(kg/ha)	463	562	474	428
		(mg/kg)	207	251	212	191
	Exchangeable Sodium	(cmol./kg)	0.07	0.19	0.34	0.48
		(kg/ha)	35	96	177	245
		(mg/kg)	15	43	79	109
	Exchangeable Aluminium	(cmol./kg)	0.02	0.02	0.01	0.01
		(kg/ha)	4.1	3.3	2.9	2.9
		(mg/kg)	1.8	1.5	1.3	1.3
	Exchangeable Hydrogen	(cmol./kg)	<0.01	<0.01	<0.01	<0.01
		(kg/ha)	<1	<1	<1	<1
		(mg/kg)	<1	<1	<1	<1
	Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	4.6	18	19	18
	Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	58	52	47	41
	Magnesium (%)		28	43	48	53
	Potassium (%)		11	3.6	2.8	2.7
	Sodium - ESP (%)		1.4	1.1	1.8	2.6
	Aluminium (%)		0.44	0.09	0.08	0.08
	Hydrogen (%)		0.00	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)	2.1	1.2	0.97	0.77
	Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	..	02	..	..
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	7.5 YR 2.5/3 Very Dark Brown	7.5 YR 4/3 Brown	10 YR 5/3 Brown	10 YR 4/3 Brown
	Mottles Munsell Colour		..	2.5 YR 5/8	..	..
	Degree of Mottling (%)		..	Red	..	..
			..	2.00	..	..

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood.
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
- Conversions for 1 cmol./kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
- ** NATA accreditation does not cover the performance of this service.
- Analysis conducted between sample arrival date and reporting date.
- This report is not to be reproduced except in full. Results only relate to the item tested.
- All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer [SCU.edu.au/eal/t&cs](http://scu.edu.au/eal/t&cs)).
- This report was issued on 19/12/2022.

Quality Checked: Kris Saville
Agricultural Co-Ordinator

KS



AGRICULTURAL SOIL ANALYSIS REPORT

44 samples supplied by Minesoils Pty. Ltd. on 06/12/2022. Lab Job No.N5342

Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 5	Sample 6	Sample 7	Sample 8
		Crop:	2 0-5	2 20-30	2 40-50	2 65-75
		Client:	N/G Resource Strategies	N/G Resource Strategies	N/G Resource Strategies	N/G Resource Strategies
Parameter	Method reference		N5342/5	N5342/6	N5342/7	N5342/8
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		6.25	7.68	8.85	9.13
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.024	0.047	0.115	0.236
Exchangeable Calcium	(cmol./kg)		2.4	9.7	9.9	8.9
	(kg/ha)		1,075	4,353	4,428	3,998
	(mg/kg)		480	1,943	1,977	1,785
Exchangeable Magnesium	(cmol./kg)		1.6	9.4	11	9.5
	(kg/ha)		449	2,554	2,881	2,574
	(mg/kg)		200	1,140	1,286	1,149
Exchangeable Potassium	(cmol./kg)		0.51	0.28	0.26	0.22
	(kg/ha)		445	247	232	193
	(mg/kg)		199	110	103	86
Exchangeable Sodium	(cmol./kg)		0.11	1.5	2.5	3.4
	(kg/ha)		56	762	1,278	1,764
	(mg/kg)		25	340	571	788
Exchangeable Aluminium	(cmol./kg)		0.20	0.02	0.01	<0.01
	(kg/ha)		41	3.3	2.3	2.0
	(mg/kg)		18	1.5	1.0	<1
Exchangeable Hydrogen	(cmol./kg)		0.06	<0.01	<0.01	<0.01
	(kg/ha)		1.4	<1	<1	<1
	(mg/kg)		<1	<1	<1	<1
Effective Cation Exchange Capacity (CEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		4.9	21	23	22
Calcium (%)			49	46	43	40
Magnesium (%)			33	45	46	43
Potassium (%)			10	1.4	1.1	1.00
Sodium - ESP (%)			2.2	7.1	11	16
Aluminium (%)			4.1	0.08	0.05	0.04
Hydrogen (%)			1.2	0.00	0.00	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)		1.5	1.0	0.93	0.94
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	02	..	..
Moist Munsell Colour			2.5 YR 3/3 Dark Reddish Brown	2.5 YR 2.5/4 Dark Reddish Brown	2.5 YR 2.5/4 Dark Reddish Brown	2.5 YR 2.5/4 Dark Reddish Brown
Mottles Munsell Colour			..	..	..	..
Degree of Mottling (%)			..	..	..	..

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil test'
- Conversions for 1 cmol./kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
- ** NATA accreditation does not cover the performance of this service.
- Analysis conducted between sample arrival date and reporting date.
- This report is not to be reproduced except in full. Results only relate to the item tested.
- All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions
- This report was issued on 19/12/2022.

Quality Checked: Kris Saville
Agricultural Co-Ordinator

KS

AGRICULTURAL SOIL ANALYSIS REPORT

44 samples supplied by Minesoils Pty. Ltd. on 06/12/2022. Lab Job No.N5342

Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 9	Sample 10	Sample 11	Sample 12
		Crop:	3 0-5	3 20-30	3 40-50	3 65-75
		Client:	N/G Resource Strategies	N/G Resource Strategies	N/G Resource Strategies	N/G Resource Strategies
Parameter	Method reference		N5342/9	N5342/10	N5342/11	N5342/12
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		6.56	8.17	8.77	8.93
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.019	0.037	0.054	0.330
Exchangeable Calcium	(cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	8.1	10	7.6	18
	(kg/ha)		3,628	4,562	3,391	8,173
	(mg/kg)		1,620	2,037	1,514	3,648
Exchangeable Magnesium	(cmol./kg)		5.3	11	11	14
	(kg/ha)		1,442	3,114	2,906	3,833
	(mg/kg)		644	1,390	1,297	1,711
Exchangeable Potassium	(cmol./kg)		0.29	0.25	0.20	0.19
	(kg/ha)		254	222	176	171
	(mg/kg)		113	99	79	76
Exchangeable Sodium	(cmol./kg)		0.22	0.75	0.98	2.4
	(kg/ha)		113	386	503	1,229
	(mg/kg)		51	172	225	548
Exchangeable Aluminium	(cmol./kg)	**Inhouse S37 (KCl)	0.01	<0.01	<0.01	<0.01
	(kg/ha)		2.3	1.8	1.3	1.1
	(mg/kg)		1.0	<1	<1	<1
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01
	(kg/ha)		<1	<1	<1	<1
	(mg/kg)		<1	<1	<1	<1
Effective Cation Exchange Capacity (CEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		14	23	19	35
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / CEC x 100		58	45	39	52
Magnesium (%)			38	51	55	40
Potassium (%)			2.1	1.1	1.0	0.56
Sodium - ESP (%)			1.6	3.3	5.0	6.8
Aluminium (%)			0.08	0.04	0.03	0.02
Hydrogen (%)			0.00	0.00	0.00	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)		1.5	0.89	0.71	1.3
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	02	..	..
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		5 YR 3/4 Dark Reddish Brown	5 YR 3/4 Dark Reddish Brown	5 YR 3/4 Dark Reddish Brown	7.5 YR 3/4 Dark Brown
Mottles Munsell Colour			..	..	..	7.5 YR 8/3
Degree of Mottling (%)			..	..	..	Pink
			..	..	..	7.00

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil test'
- Conversions for 1 cmol./kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
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- This report was issued on 19/12/2022.

Quality Checked: Kris Saville
Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

44 samples supplied by Minesoils Pty. Ltd. on 06/12/2022. Lab Job No.N5342

Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

Analysis requested by Clayton Richards. Field No: 1500. Rainfall Station: 23402
PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 13	Sample 14	Sample 15	Sample 16
		Crop:	4 0-5	4 20-30	4 40-50	4 65-75
		Client:	N/G Resource Strategies	N/G Resource Strategies	N/G Resource Strategies	N/G Resource Strategies
	Parameter	Method reference	N5342/13	N5342/14	N5342/15	N5342/16
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.47	9.29	9.70	9.46
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.025	0.343	0.840	0.599
	Exchangeable Calcium (cmol./kg) (kg/ha) (mg/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	1.2	2.6	4.1	2.3
			524	1,150	1,862	1,012
			234	513	831	452
	Exchangeable Magnesium (cmol./kg) (kg/ha) (mg/kg)		1.2	7.6	7.9	7.1
			328	2,078	2,160	1,929
			147	928	964	861
	Exchangeable Potassium (cmol./kg) (kg/ha) (mg/kg)		<0.12	0.21	0.29	0.30
			<112	187	252	265
			<50	83	112	119
	Exchangeable Sodium (cmol./kg) (kg/ha) (mg/kg)		0.44	7.6	9.5	9.5
			227	3,918	4,875	4,873
			101	1,749	2,176	2,175
Exchangeable Aluminium (cmol./kg) (kg/ha) (mg/kg)	**Inhouse S37 (KCl)	0.04	<0.01	<0.01	<0.01	
		8.0	1.2	1.1	<1	
		3.6	<1	<1	<1	
Exchangeable Hydrogen (cmol./kg) (kg/ha) (mg/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01	
		<1	<1	<1	<1	
		<1	<1	<1	<1	
	Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	3.0	18	22	19
	Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	39	14	19	12
	Magnesium (%)		41	42	36	37
	Potassium (%)		3.8	1.2	1.3	1.6
	Sodium - ESP (%)		15	42	43	50
	Aluminium (%)		1.3	0.03	0.02	0.03
	Hydrogen (%)		0.00	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)	0.97	0.34	0.52	0.32
	Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	..	02	..	..
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	2.5 YR 2.5/4 Dark Reddish Brown	5 YR 3/4 Dark Reddish Brown	7.5 YR 4/6 Strong Brown	7.5 YR 4/6 Strong Brown
	Mottles Munsell Colour		..	..	..	..
	Degree of Mottling (%)		..	..	..	..
			..	..	..	..

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil test'
- Conversions for 1 cmol./kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
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Quality Checked: Kris Saville
Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

44 samples supplied by Minesoils Pty. Ltd. on 06/12/2022. Lab Job No.N5342

Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 17	Sample 18	Sample 19	Sample 20
		Crop:	5 0-5	5 20-30	5 40-50	5 65-75
		Client:	N/G	N/G	N/G	N/G
			Resource Strategies	Resource Strategies	Resource Strategies	Resource Strategies
Parameter	Method reference		N5342/17	N5342/18	N5342/19	N5342/20
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		6.31	8.48	9.24	9.41
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.028	0.059	0.089	0.263
Exchangeable Calcium	(cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	3.4	6.1	6.5	7.0
	(kg/ha)		1,512	2,746	2,904	3,142
	(mg/kg)		675	1,226	1,296	1,403
Exchangeable Magnesium	(cmol./kg)		2.7	6.5	9.7	11
	(kg/ha)		736	1,780	2,644	3,054
	(mg/kg)		329	795	1,180	1,363
Exchangeable Potassium	(cmol./kg)		0.40	0.20	0.25	0.32
	(kg/ha)		347	172	218	279
	(mg/kg)		155	77	97	125
Exchangeable Sodium	(cmol./kg)		0.49	1.9	3.4	5.7
	(kg/ha)		251	969	1,741	2,924
	(mg/kg)		112	433	777	1,305
Exchangeable Aluminium	(cmol./kg)	**Inhouse S37 (KCl)	0.10	<0.01	<0.01	<0.01
	(kg/ha)		21	1.5	1.3	1.3
	(mg/kg)		9.3	<1	<1	<1
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.13	<0.01	<0.01	<0.01
	(kg/ha)		2.8	<1	<1	<1
	(mg/kg)		1.3	<1	<1	<1
Effective Cation Exchange Capacity (CEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		7.2	15	20	24
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / CEC x 100		47	41	33	29
Magnesium (%)			38	44	49	46
Potassium (%)			5.5	1.3	1.3	1.3
Sodium - ESP (%)			6.8	13	17	23
Aluminium (%)			1.4	0.05	0.03	0.03
Hydrogen (%)			1.8	0.00	0.00	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)		1.2	0.94	0.67	0.62
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	02	..	..
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		7.5 YR 2.5/3 Very Dark Brown	2.5 YR 2.5/3 Dark Reddish Brown	2.5 YR 3/6 Dark Red	5 YR 3/4 Dark Reddish Brown
Mottles Munsell Colour			..	..	..	..
Degree of Mottling (%)			..	..	..	..
			..	..	..	..

Notes:

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- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil test'
- Conversions for 1 cmol./kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
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Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

44 samples supplied by Minesoils Pty. Ltd. on 06/12/2022. Lab Job No.N5342

Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 21	Sample 22	Sample 23	Sample 24
		Crop:	6 0-5	6 20-30	6 40-50	6 65-75
		Client:	N/G	N/G	N/G	N/G
			Resource Strategies	Resource Strategies	Resource Strategies	Resource Strategies
Parameter	Method reference		N5342/21	N5342/22	N5342/23	N5342/24
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		6.84	8.81	9.20	9.11
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.030	0.266	0.788	1.052
Exchangeable Calcium	(cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	2.1	7.0	9.9	8.1
	(kg/ha)		930	3,137	4,461	3,652
	(mg/kg)		415	1,400	1,992	1,630
Exchangeable Magnesium	(cmol./kg)		1.7	7.8	10	12
	(kg/ha)		473	2,118	2,796	3,172
	(mg/kg)		211	945	1,248	1,416
Exchangeable Potassium	(cmol./kg)		0.34	0.21	0.31	0.34
	(kg/ha)		295	187	270	298
	(mg/kg)		132	83	120	133
Exchangeable Sodium	(cmol./kg)		0.56	4.8	8.3	11
	(kg/ha)		288	2,460	4,250	5,491
	(mg/kg)		129	1,098	1,897	2,451
Exchangeable Aluminium	(cmol./kg)	**Inhouse S37 (KCl)	0.14	0.01	<0.01	<0.01
	(kg/ha)		29	2.2	1.7	1.9
	(mg/kg)		13	<1	<1	<1
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01
	(kg/ha)		<1	<1	<1	<1
	(mg/kg)		<1	<1	<1	<1
Effective Cation Exchange Capacity (CEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		4.9	20	29	31
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / CEC x 100		43	35	35	26
Magnesium (%)			36	39	36	38
Potassium (%)			7.0	1.1	1.1	1.1
Sodium - ESP (%)			12	24	29	35
Aluminium (%)			3.0	0.06	0.03	0.03
Hydrogen (%)			0.00	0.00	0.00	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)		1.2	0.90	0.97	0.70
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	02	..	..
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		7.5 YR 2.5/3 Very Dark Brown	2.5 YR 2.5/4 Dark Reddish Brown	7.5 YR 4/6 Strong Brown	7.5 YR 4/6 Strong Brown
Mottles Munsell Colour			..	..	..	..
Degree of Mottling (%)			..	..	..	..
			..	..	..	..

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil test'
- Conversions for 1 cmol./kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
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Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

44 samples supplied by Minesoils Pty. Ltd. on 06/12/2022. Lab Job No.N5342

Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

Analysis requested by Clayton Richards. Field No: 1500. National Soil Colour & pH
PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 25	Sample 26	Sample 27	Sample 28
		Crop:	7 0-5	7 20-30	7 40-50	7 65-75
		Client:	N/G Resource Strategies	N/G Resource Strategies	N/G Resource Strategies	N/G Resource Strategies
	Parameter	Method reference	N5342/25	N5342/26	N5342/27	N5342/28
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.39	8.62	8.85	9.30
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.094	0.469	0.553	0.744
	Exchangeable Calcium (cmol./kg) (kg/ha) (mg/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	6.3	6.3	6.1	11
			2,829	2,843	2,758	4,823
			1,263	1,269	1,231	2,153
	Exchangeable Magnesium (cmol./kg) (kg/ha) (mg/kg)		6.0	7.6	9.9	10
			1,632	2,080	2,691	2,834
			729	929	1,201	1,265
	Exchangeable Potassium (cmol./kg) (kg/ha) (mg/kg)		0.17	0.17	0.24	0.28
			152	150	208	247
			68	67	93	110
	Exchangeable Sodium (cmol./kg) (kg/ha) (mg/kg)		2.8	6.0	8.1	8.9
			1,438	3,110	4,187	4,570
			642	1,388	1,869	2,040
Exchangeable Aluminium (cmol./kg) (kg/ha) (mg/kg)	**Inhouse S37 (KCl)	<0.01	<0.01	<0.01	<0.01	
		1.9	1.8	1.8	1.9	
		<1	<1	<1	<1	
Exchangeable Hydrogen (cmol./kg) (kg/ha) (mg/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01	
		<1	<1	<1	<1	
		<1	<1	<1	<1	
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	15	20	24	30	
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	41	31	25	35	
Magnesium (%)		39	38	40	34	
Potassium (%)		1.1	0.85	0.97	0.93	
Sodium - ESP (%)		18	30	33	29	
Aluminium (%)		0.06	0.04	0.04	0.03	
Hydrogen (%)		0.00	0.00	0.00	0.00	
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)	1.1	0.83	0.62	1.0	
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	..	02	..	..	
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	7.5 YR 2.5/3 Very Dark Brown	7.5 YR 4/4 Brown	7.5 YR 4/6 Strong Brown	7.5 YR 4/6 Strong Brown	
Mottles Munsell Colour		..	..	..	..	
Degree of Mottling (%)		..	..	..	..	
		..	..	..	..	

Notes:

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- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
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- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
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AGRICULTURAL SOIL ANALYSIS REPORT

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Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 29	Sample 30	Sample 31	Sample 32
		Crop:	8 0-5	8 20-30	8 40-50	8 65-75
		Client:	N/G Resource Strategies	N/G Resource Strategies	N/G Resource Strategies	N/G Resource Strategies
Parameter	Method reference		N5342/29	N5342/30	N5342/31	N5342/32
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		7.12	9.20	9.21	8.95
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.026	0.281	0.830	1.000
Exchangeable Calcium	(cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	2.3	4.5	5.5	4.7
	(kg/ha)		1,038	2,012	2,490	2,131
	(mg/kg)		463	898	1,112	951
Exchangeable Magnesium	(cmol./kg)		2.0	7.2	9.9	13
	(kg/ha)		557	1,969	2,686	3,430
	(mg/kg)		248	879	1,199	1,531
Exchangeable Potassium	(cmol./kg)		0.23	0.18	0.26	0.38
	(kg/ha)		199	156	227	334
	(mg/kg)		89	70	102	149
Exchangeable Sodium	(cmol./kg)		0.50	4.3	7.5	11
	(kg/ha)		258	2,194	3,882	5,589
	(mg/kg)		115	980	1,733	2,495
Exchangeable Aluminium	(cmol./kg)	**Inhouse S37 (KCl)	<0.01	<0.01	<0.01	<0.01
	(kg/ha)		1.8	1.3	<1	<1
	(mg/kg)		<1	<1	<1	<1
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01
	(kg/ha)		<1	<1	<1	<1
	(mg/kg)		<1	<1	<1	<1
Effective Cation Exchange Capacity (CEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		5.1	16	23	29
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / CEC x 100		45	28	24	17
Magnesium (%)			40	45	42	44
Potassium (%)			4.5	1.1	1.1	1.3
Sodium - ESP (%)			9.8	26	32	38
Aluminium (%)			0.17	0.04	0.02	0.01
Hydrogen (%)			0.00	0.00	0.00	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)		1.1	0.62	0.56	0.38
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	02	..	..
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		7.5 YR 2.5/3 Very Dark Brown	5 YR 3/4 Dark Reddish Brown	7.5 YR 4/6 Strong Brown	7.5 YR 5/6 Strong Brown
Mottles Munsell Colour			..	..	..	..
Degree of Mottling (%)			..	..	..	..
			..	..	..	..

Notes:

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Agricultural Co-Ordinator

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Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 33	Sample 34	Sample 35	Sample 36
		Crop:	9 0-5	9 20-30	9 40-50	9 65-75
		Client:	N/G	N/G	N/G	N/G
			Resource Strategies	Resource Strategies	Resource Strategies	Resource Strategies
Parameter	Method reference		N5342/33	N5342/34	N5342/35	N5342/36
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		6.46	8.47	9.25	9.44
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.016	0.137	0.522	0.707
Exchangeable Calcium	(cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	1.2	4.4	5.8	9.8
	(kg/ha)		523	1,981	2,582	4,421
	(mg/kg)		234	884	1,153	1,974
Exchangeable Magnesium	(cmol./kg)		0.84	7.1	9.0	9.0
	(kg/ha)		229	1,939	2,444	2,438
	(mg/kg)		102	866	1,091	1,088
Exchangeable Potassium	(cmol./kg)		0.27	0.17	0.26	0.29
	(kg/ha)		233	152	226	257
	(mg/kg)		104	68	101	115
Exchangeable Sodium	(cmol./kg)		0.29	3.4	6.1	6.7
	(kg/ha)		149	1,765	3,152	3,470
	(mg/kg)		67	788	1,407	1,549
Exchangeable Aluminium	(cmol./kg)	**Inhouse S37 (KCl)	0.10	<0.01	<0.01	<0.01
	(kg/ha)		19	<1	<1	<1
	(mg/kg)		8.6	<1	<1	<1
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.10	<0.01	<0.01	<0.01
	(kg/ha)		2.1	<1	<1	<1
	(mg/kg)		<1	<1	<1	<1
Effective Cation Exchange Capacity (CEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		2.8	15	21	26
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / CEC x 100		42	29	27	38
Magnesium (%)			31	47	43	35
Potassium (%)			9.7	1.1	1.2	1.1
Sodium - ESP (%)			11	23	29	26
Aluminium (%)			3.5	0.01	0.02	0.00
Hydrogen (%)			3.5	0.00	0.00	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)		1.4	0.62	0.64	1.1
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	02	..	..
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		7.5 YR 2.5/3 Very Dark Brown	7.5 YR 3/4 Dark Brown	7.5 YR 3/4 Dark Brown	10 YR 4/6 Dark Yellowish Brown
Mottles Munsell Colour			..	..	..	..
Degree of Mottling (%)			..	..	..	..
			..	..	..	..

Notes:

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- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil test'
- Conversions for 1 cmol./kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
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Quality Checked: Kris Saville
Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

44 samples supplied by Minesoils Pty. Ltd. on 06/12/2022. Lab Job No.N5342

Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 37	Sample 38	Sample 39	Sample 40
		Crop:	10 0-5	10 20-30	10 40-50	10 65-75
		Client:	N/G	N/G	N/G	N/G
			Resource Strategies	Resource Strategies	Resource Strategies	Resource Strategies
Parameter	Method reference		N5342/37	N5342/38	N5342/39	N5342/40
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		5.98	6.49	6.70	7.31
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.015	0.014	0.199	0.306
Exchangeable Calcium (cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)		0.89	0.44	1.1	0.65
(kg/ha)			399	198	505	291
(mg/kg)			178	88	225	130
Exchangeable Magnesium (cmol./kg)			0.68	0.41	9.7	11
(kg/ha)			186	112	2,639	2,897
(mg/kg)			83	50	1,178	1,293
Exchangeable Potassium (cmol./kg)			0.29	<0.12	0.23	0.30
(kg/ha)			258	<112	199	267
(mg/kg)			115	<50	89	119
Exchangeable Sodium (cmol./kg)			0.23	0.12	3.7	5.1
(kg/ha)			120	64	1,916	2,648
(mg/kg)			53	28	855	1,182
Exchangeable Aluminium (cmol./kg)	**Inhouse S37 (KCl)		0.28	0.04	0.02	<0.01
(kg/ha)			57	8.5	3.7	<1
(mg/kg)			25	3.8	1.7	<1
Exchangeable Hydrogen (cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)		0.21	0.04	<0.01	<0.01
(kg/ha)			4.7	<1	<1	<1
(mg/kg)			2.1	<1	<1	<1
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		2.6	1.1	15	17
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100		34	38	7.6	3.9
Magnesium (%)			26	36	66	64
Potassium (%)			11	7.7	1.5	1.8
Sodium - ESP (%)			9.0	11	25	31
Aluminium (%)			11	3.7	0.13	0.00
Hydrogen (%)			8.1	3.6	0.00	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)		1.3	1.1	0.12	0.06
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	..	02	..
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		7.5 YR 2.5/3 Very Dark Brown	5 YR 4/3 Reddish Brown	10 YR 5/4 Yellowish Brown	10 YR 4/4 Dark Yellowish Brown
Mottles Munsell Colour			..	..	10 YR 7/1	..
Degree of Mottling (%)			..	..	White	..
			..	..	1.00	..

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil test'
- Conversions for 1 cmol./kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
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Quality Checked: Kris Saville
Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

44 samples supplied by Minesoils Pty. Ltd. on 06/12/2022. Lab Job No.N5342

Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 41	Sample 42	Sample 43	Sample 44
		Crop:	11 0-5	11 20-30	11 40-50	11 65-75
		Client:	N/G	N/G	N/G	N/G
			Resource Strategies	Resource Strategies	Resource Strategies	Resource Strategies
Parameter	Method reference		N5342/41	N5342/42	N5342/43	N5342/44
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		6.44	6.57	7.08	8.22
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.029	0.015	0.013	0.049
Exchangeable Calcium (cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)		1.8	0.91	0.57	2.0
(kg/ha)			827	410	255	911
(mg/kg)			369	183	114	407
Exchangeable Magnesium (cmol./kg)			0.74	0.34	0.59	4.2
(kg/ha)			202	93	159	1,145
(mg/kg)			90	42	71	511
Exchangeable Potassium (cmol./kg)			0.58	0.42	0.17	0.19
(kg/ha)			505	372	145	170
(mg/kg)			226	166	65	76
Exchangeable Sodium (cmol./kg)			0.12	0.07	0.14	1.4
(kg/ha)			64	36	73	712
(mg/kg)			29	16	33	318
Exchangeable Aluminium (cmol./kg)	**Inhouse S37 (KCl)		0.01	0.04	<0.01	<0.01
(kg/ha)			2.9	8.1	<1	<1
(mg/kg)			1.3	3.6	<1	<1
Exchangeable Hydrogen (cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)		0.04	<0.01	<0.01	<0.01
(kg/ha)			<1	<1	<1	<1
(mg/kg)			<1	<1	<1	<1
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		3.3	1.8	1.5	7.8
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100		55	51	39	26
Magnesium (%)			22	19	40	54
Potassium (%)			17	24	11	2.5
Sodium - ESP (%)			3.7	3.9	9.7	18
Aluminium (%)			0.43	2.3	0.02	0.01
Hydrogen (%)			1.2	0.00	0.00	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)		2.5	2.7	0.97	0.48
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	..	02	02
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		2.5 YR 2.5/2 Very Dusky Red	7.5 YR 3/4 Dark Brown	2.5 YR 4/3 Reddish Brown	7.5 YR 5/6 Strong Brown
Mottles Munsell Colour			..	..	..	1.5 R 4/6 7.5 R 8/1 Strong Brown
Degree of Mottling (%)			..	..	..	White 30 5
			..	..	..	..

Notes:

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- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
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Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

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Analysis requested by Clayton Richards. Your Job: MS-086 Narrabri Solar Soils & BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Heavy Soil	Medium Soil	Light Soil	Sandy Soil				
Sample ID:									
Crop:									
Client:		Clay	Clay Loam	Loam	Loamy Sand				
	Parameter	Method reference				Indicative guidelines - refer to Notes 6 and 8			
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)				6.5	6.5	6.3	6.3
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)				0.200	0.150	0.120	0.100
	Exchangeable Calcium	(cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	15.6	10.8	5.0	1.9		
		(kg/ha)		7000	4816	2240	840		
		(mg/kg)		3125	2150	1000	375		
	Exchangeable Magnesium	(cmol./kg)		2.4	1.7	1.2	0.60		
		(kg/ha)		650	448	325	168		
		(mg/kg)		290	200	145	75		
	Exchangeable Potassium	(cmol./kg)		0.60	0.50	0.40	0.30		
		(kg/ha)		526	426	336	224		
		(mg/kg)		235	190	150	100		
	Exchangeable Sodium	(cmol./kg)		0.3	0.26	0.22	0.11		
		(kg/ha)		155	134	113	57		
		(mg/kg)		69	60	51	25		
Exchangeable Aluminium	(cmol./kg)	**Inhouse S37 (KCl)	0.6	0.5	0.4	0.2			
	(kg/ha)		121	101	73	30			
	(mg/kg)		54	45	32	14			
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.6	0.5	0.4	0.2			
	(kg/ha)		13	11	8	3			
	(mg/kg)		6	5	4	2			
	Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)				20.1	14.3	7.8	3.3
	Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100				77.6	75.7	65.6	57.4
	Magnesium (%)					11.9	11.9	15.7	18.1
	Potassium (%)					3.0	3.5	5.2	9.1
	Sodium - ESP (%)					1.5	1.8	2.9	3.3
	Aluminium (%)					6.0	7.1	10.5	12.1
	Hydrogen (%)								
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)				6.5	6.4	4.2	3.2
	Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017				Class 3-8			
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification				..			
	Mottles Munsell Colour					..			
	Degree of Mottling (%)					..			

Notes:

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