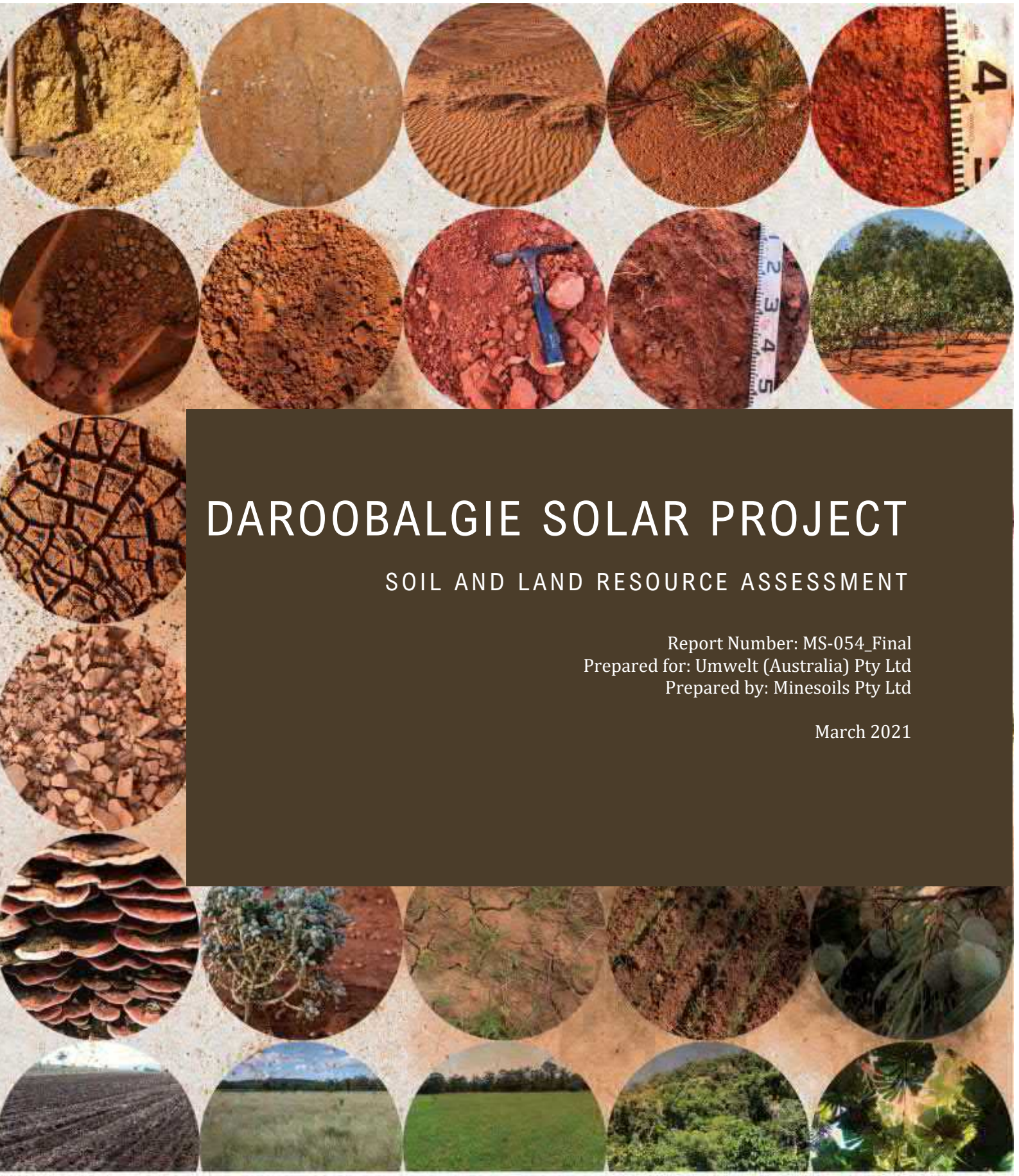
Appendix F Soil and Land Resource Assessment



DAROOBALGIE SOLAR PROJECT

SOIL AND LAND RESOURCE ASSESSMENT

Report Number: MS-054_Final
Prepared for: Umwelt (Australia) Pty Ltd
Prepared by: Minesoils Pty Ltd

March 2021

MINESOILS
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DOCUMENT CONTROL

Reference	Date	Prepared by	Approved
MS-054_Draft v1	February	Clayton Richards	Clayton Richards
MS-054_Draft v2	March	Clayton Richards	Clayton Richards
MS-054_Final	March	Clayton Richards	Clayton Richards

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1. INTRODUCTION

1.1 PROJECT BACKGROUND

The Daroobalgie Solar Farm Project (the Project) is owned and operated by the Pacific Hydro Australia Developments Pty Ltd (the Proponent), and is located approximately 11 km northeast of Forbes, New South Wales (refer to **Figure 1**). The Proponent is seeking development approval under Part 4 of the NSW Environment and Planning Assessment Act 1979, for construction of a solar photovoltaic (PV) energy generation facility with an estimated capacity of 100MW, consisting of ground mounted single axis tilting solar arrays supported on shallow lightly loaded footings. Other associated infrastructure includes power conversion units, a substation, battery storage area and ancillary buildings, tracks and fencing. The Project is expected to operate for between 30 to 50 years providing near and long-term local employment opportunities. The Project is obliged to decommission the plant and rehabilitate the site at the end of its operational life if the lease is not renewed. This would remove all above ground infrastructure and return the site to its existing land capacity. This assessment forms part of the associated planning application material.

The proposed solar farm site is approximately 300 ha, with an 8km transmission line to a switching yard located approximately 6 km north of Forbes Town Centre. The soil survey included sampling locations across the solar farm site and the small switching yard site (Refer to **Figure 2**).

1.2 PROJECT OBJECTIVES AND SCOPE

The objectives of the Agricultural Land & Soil Assessment undertaken by Minesoils are as follows:

Objective 1: Classify and determine the soil profile types within the Project area using the Australian Soil Classification (ASC) System (Isbell, 2002), including a description and figure showing the distribution of each soil type.

Objective 2: Provide a description of the land capability within the Project area using The Land and Soil Capability Assessment Scheme: Second Approximation (Office of Environment and Heritage (OEH), 2013).

Objective 3: Identification of potential erosion issues with identified soil types.

Objective 4: Confirm there is negligible risk of Acid Sulfate Soils (ASS) to impact the project.

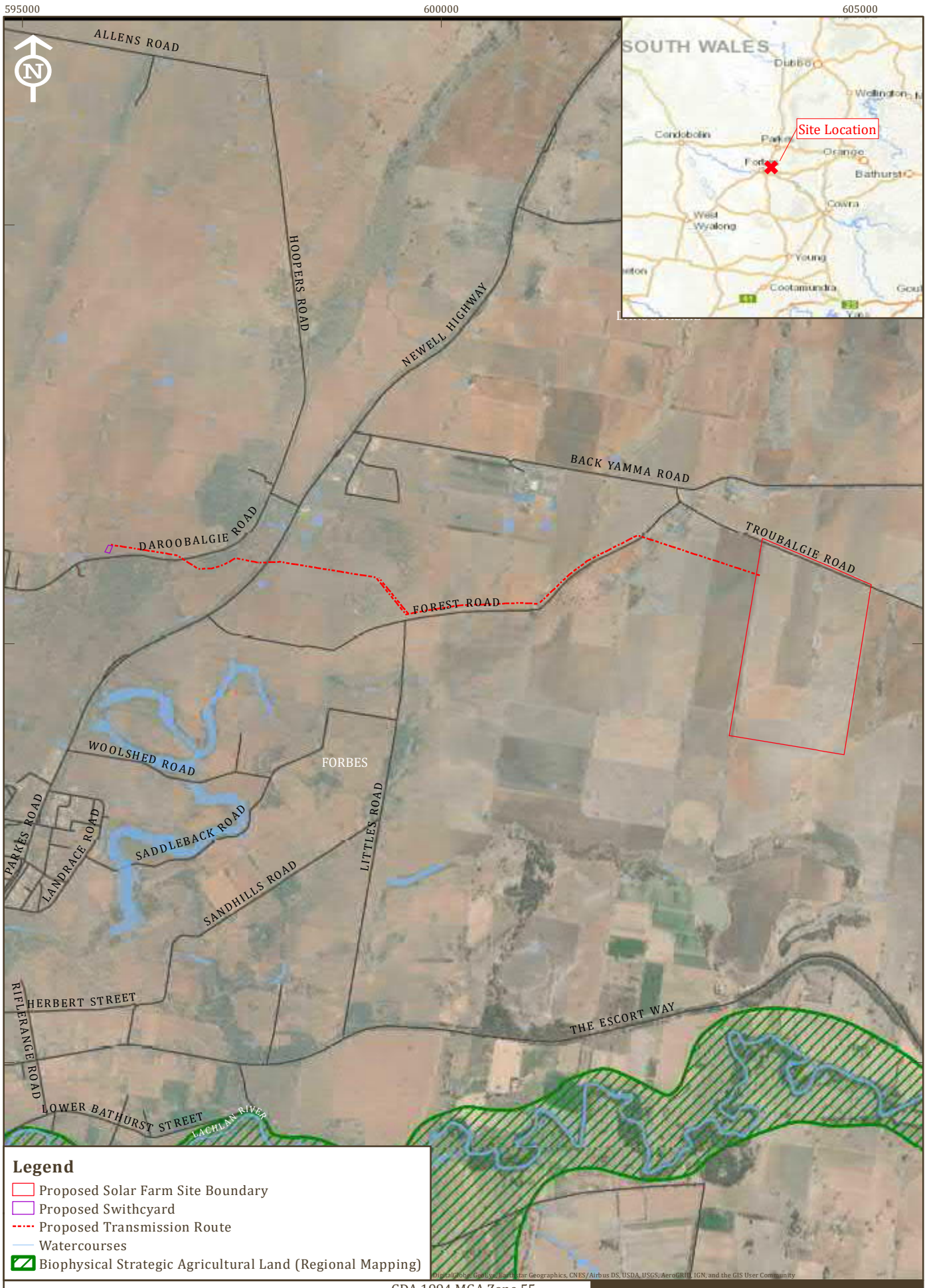
Objective 5: Provision of a land remediation strategy following decommissioning.

1.3 LEGISLATIVE FRAMEWORK

The Secretary's Environmental Assessment Requirements (SEARs) for SSD-10387 according to Section 4.12(8A) of the Environmental Planning and Assessment Act and Schedule 2 of the Environmental Planning and Assessment Regulation 2000 require an assessment of land and agricultural resources, specifically:

***Land** – including:*

- *an assessment of the potential impact of the development on existing land uses of the site and adjacent land, including:*
  - *a soil survey to determine the soil characteristics and consider the potential for erosion or to occur.*



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Regional Context

FIGURE 1

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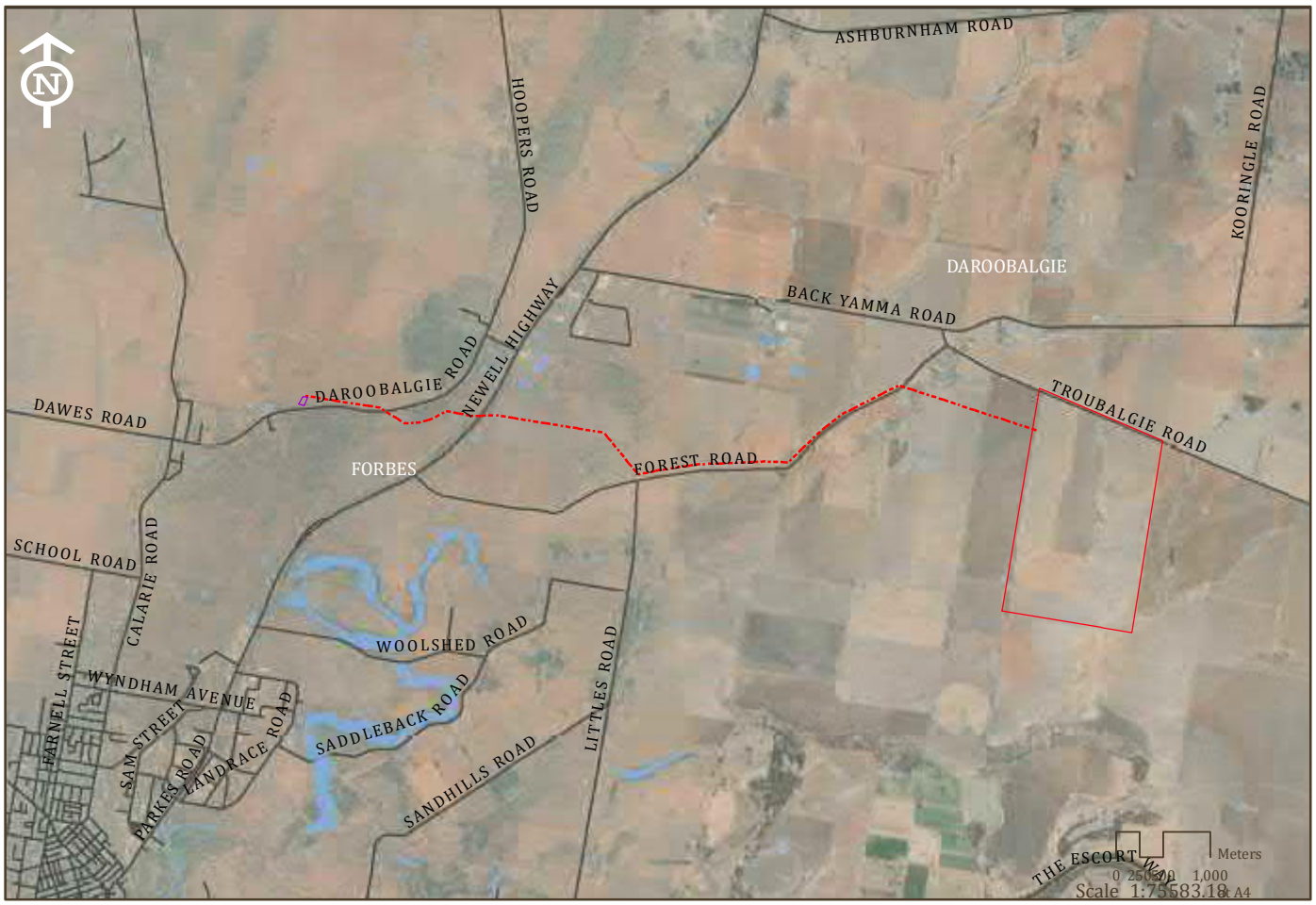

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Study Area

FIGURE 2

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2 EXISTING ENVIRONMENT

2.1 REGIONAL CLIMATE

The Bureau of Meteorology (BOM) classifies the Project area as being located in a semi-arid climate zone, characterised by hot dry summers and cool winters. Summer rainfall tends to be dominated by storms whilst winter rainfall is steadier. The average annual rainfall for the area is 493 mm (Forbes Airport AWS). The average Summer temperatures are max 34.6°C and min 18.4°C, and in Winter are Max 14.7°C and min 2.5°C (BOM 2021).

2.2 GEOLOGY & TOPOGRAPHY

The geology is quaternary alluvium over the Project area, transmission corridor and switching yard. There may be some influence of colluvial material near the switching yard given the elevated topography to the north of the site. The Lachlan River runs East-West approximately 3km to the south of the Project area. The plains extend from the Lachlan River through the entire Project area and to the north for another 3km before elevation increases to gently undulating terrain. Surface water drainage is generally North to South through the project area as there are minor depressions which transport water off site generally to the South.

2.3 SOIL LANDSCAPES

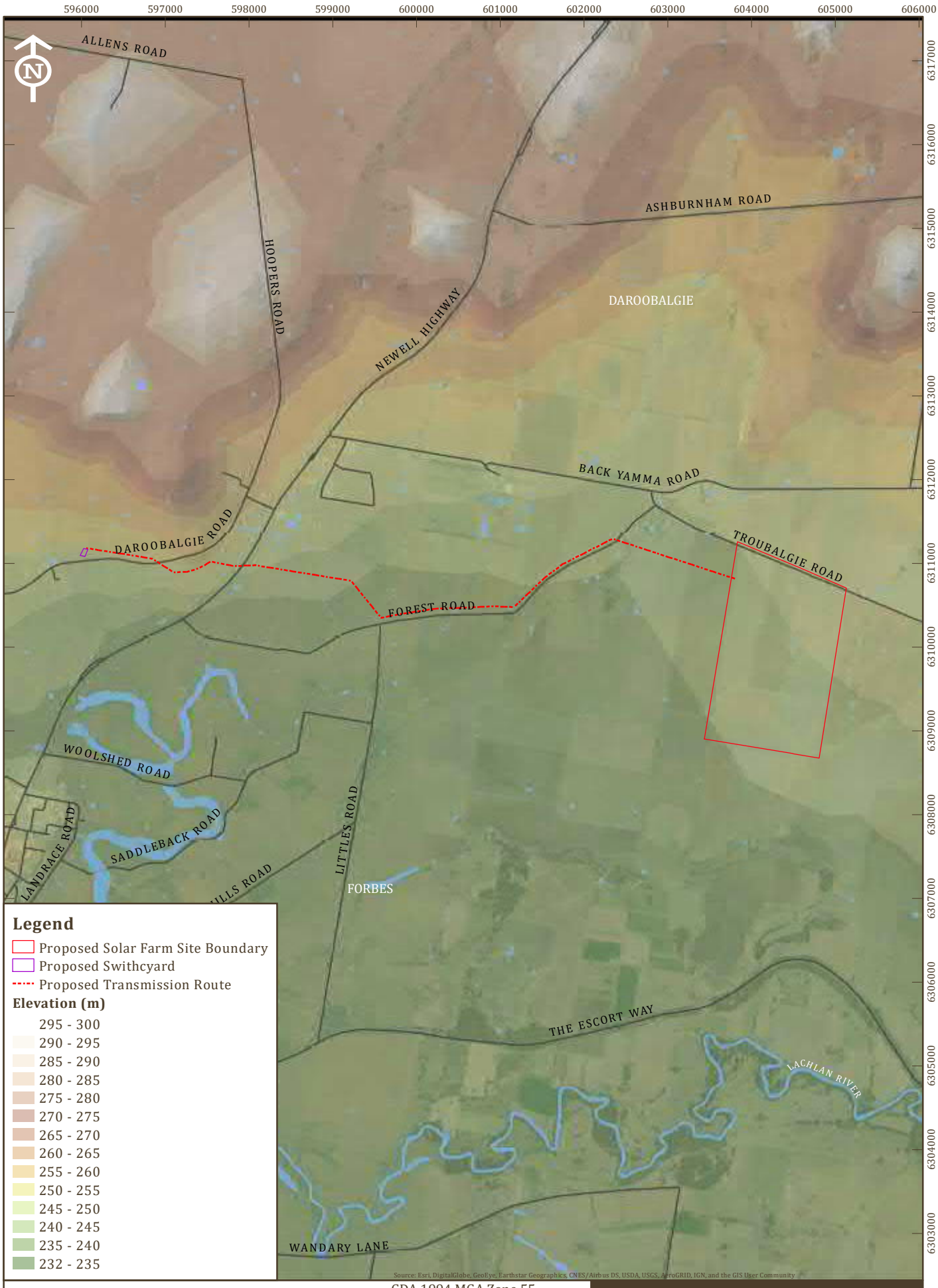
There are two Soil Landscapes within the solar farm site, namely Daroobalgie and Broglan Plain. The proposed transmission line transects Broglan Plain, Waughan, Daroobalgie and Parkes Soil Landscapes. The switching yard is located on Parkes Soil Landscape. A summary of the key landscape features of these Soil Landscapes are below.

Daroobalgie: The landform consists of normal gilgai and melonhole gilgai with small-rounded closed depressions separated by mounds. Local relief is <9 m and slope gradients are level. Gilgai development is seldom pronounced with vertical distance between depression and mound mostly <1 m and horizontal distance mostly <10 m. Partially to extensively cleared open- woodland. The solar farm site has recently been used for cropping. Soils display rapid changes over short distances with Grey Clays characteristic of gilgai depressions and Red Brown Earths characteristic of gilgai crests.

Broglan Plain: The landform consists of level to gently undulating plains. Slope gradients are 0-2%. Local relief is <10 m. Elevation is 225- 340 m. Rare flooding occurs from flood overflows of the Goobang Creek system. Extensively cleared open-woodland with grazing and dryland and irrigated winter crop production being significant land uses. Limited summer cropping for sorghum, millet and other fodder crops is undertaken on some properties. Lucerne pasture production is common. Dominant soils are deep (>100 cm), imperfectly drained Red Brown Earths/Dermosols.

Waughan: The landform consists of higher level floodplains and terraces of the Lachlan River subject to periodic inundation from flood overflows from the Lachlan River. Elevation ranges from 225 to 250 m. Prior streams and abandoned channels occur and some of these streams are re-activated during high water flow events, being supplied with water from overflows from the Lachlan River. Small isolated areas with gilgai microrelief occur. Extensively cleared open-woodland with lucerne production often under irrigation. Cereal crops and associated crops (oilseed and legume) are also grown. Soils are generally deep (>150 cm), imperfectly drained Red Brown Earths.

Parkes: The landform consists of narrow crests (<100 m) and gently inclined sideslopes. Slope gradients 2-5%. Occasional lower slopes are <2%. Local relief is <30 m. Elevation is 280 m to 400 m. Extensively cleared open-woodland with agricultural uses including dryland cropping and livestock production. Soils are typically shallow to moderately deep (<60cm), moderately well drained Red Earths.



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Topography

FIGURE 3

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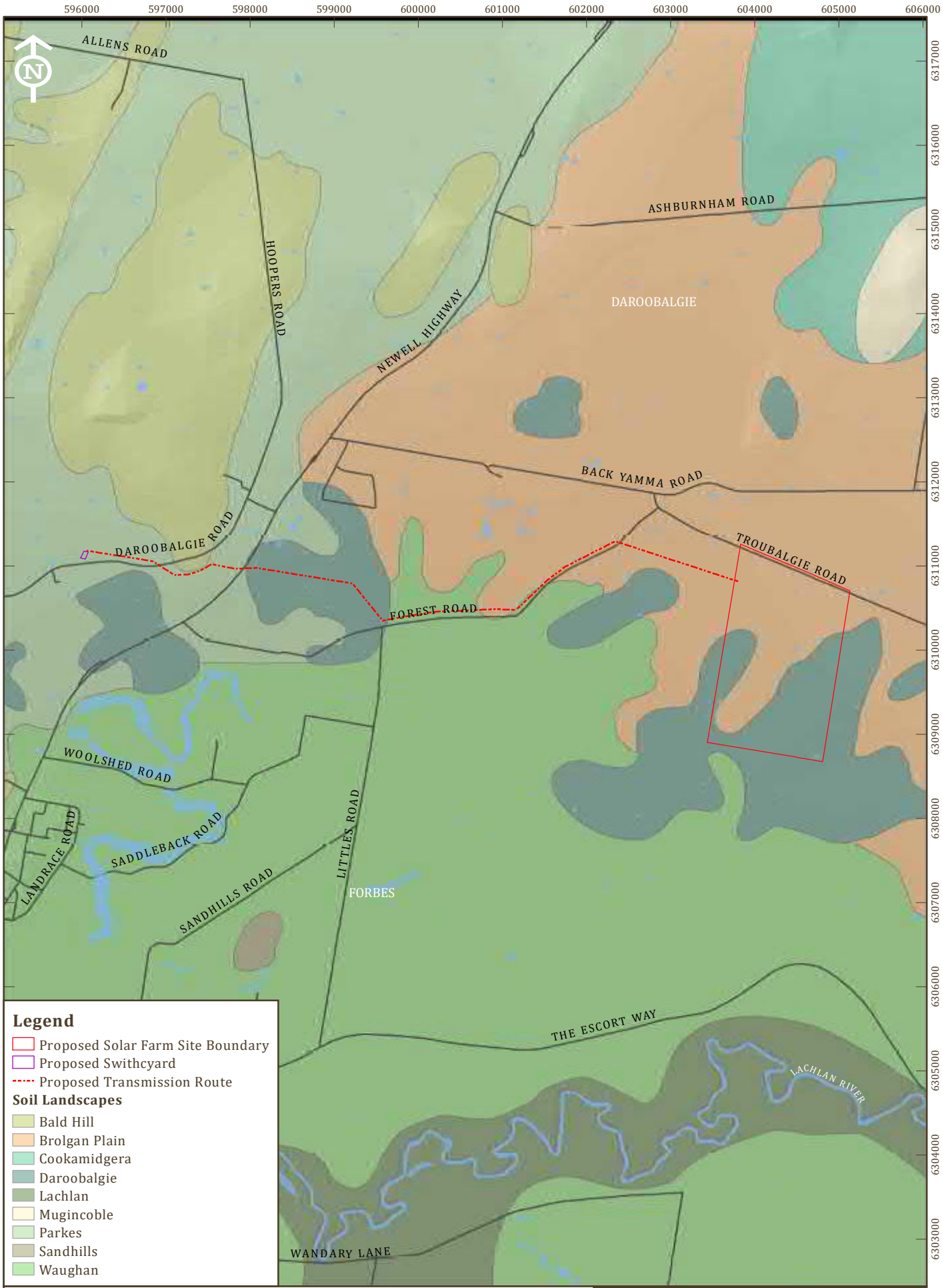

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Soil Landscapes

FIGURE 4

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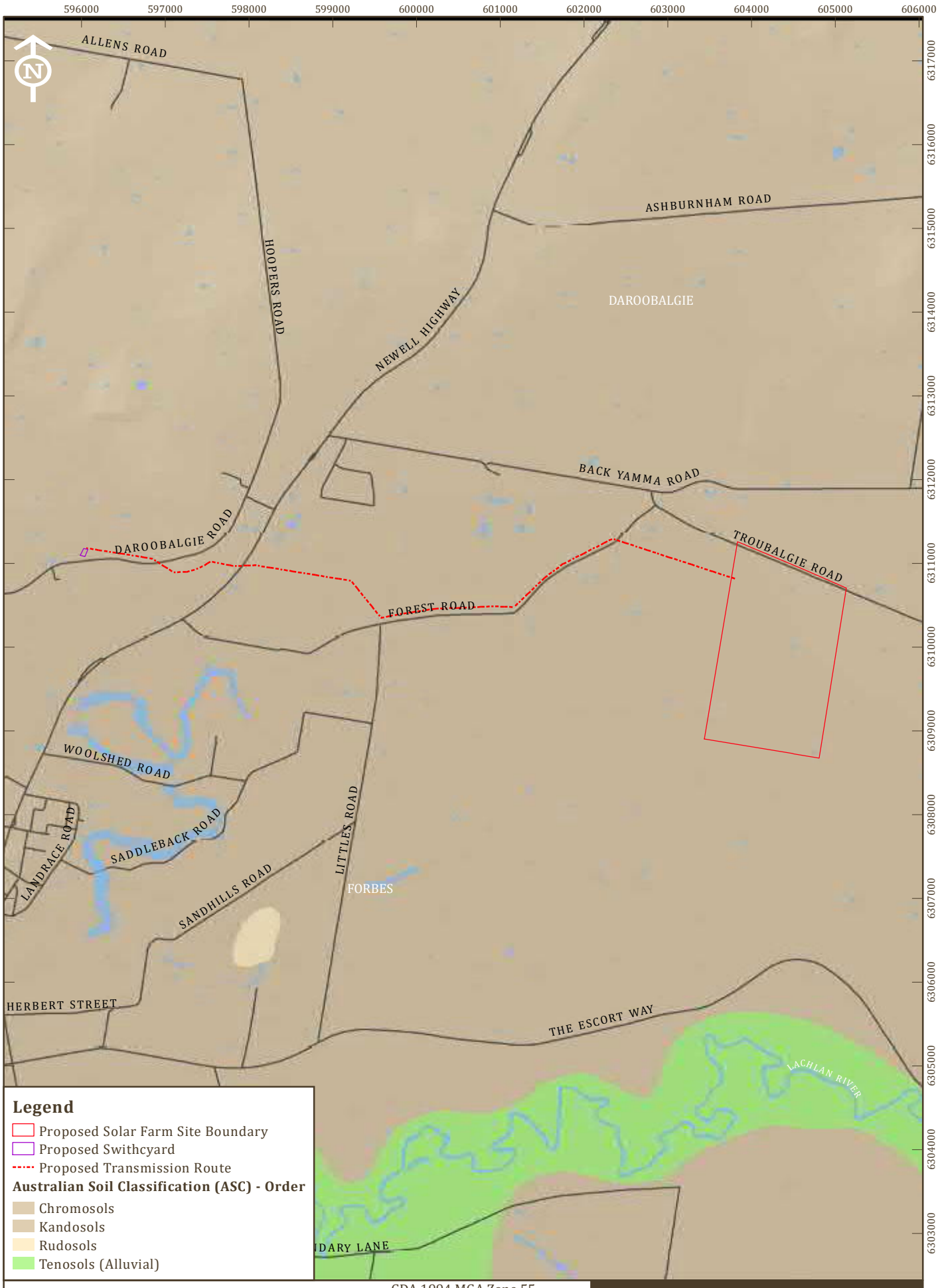

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Soil Classification

FIGURE 5

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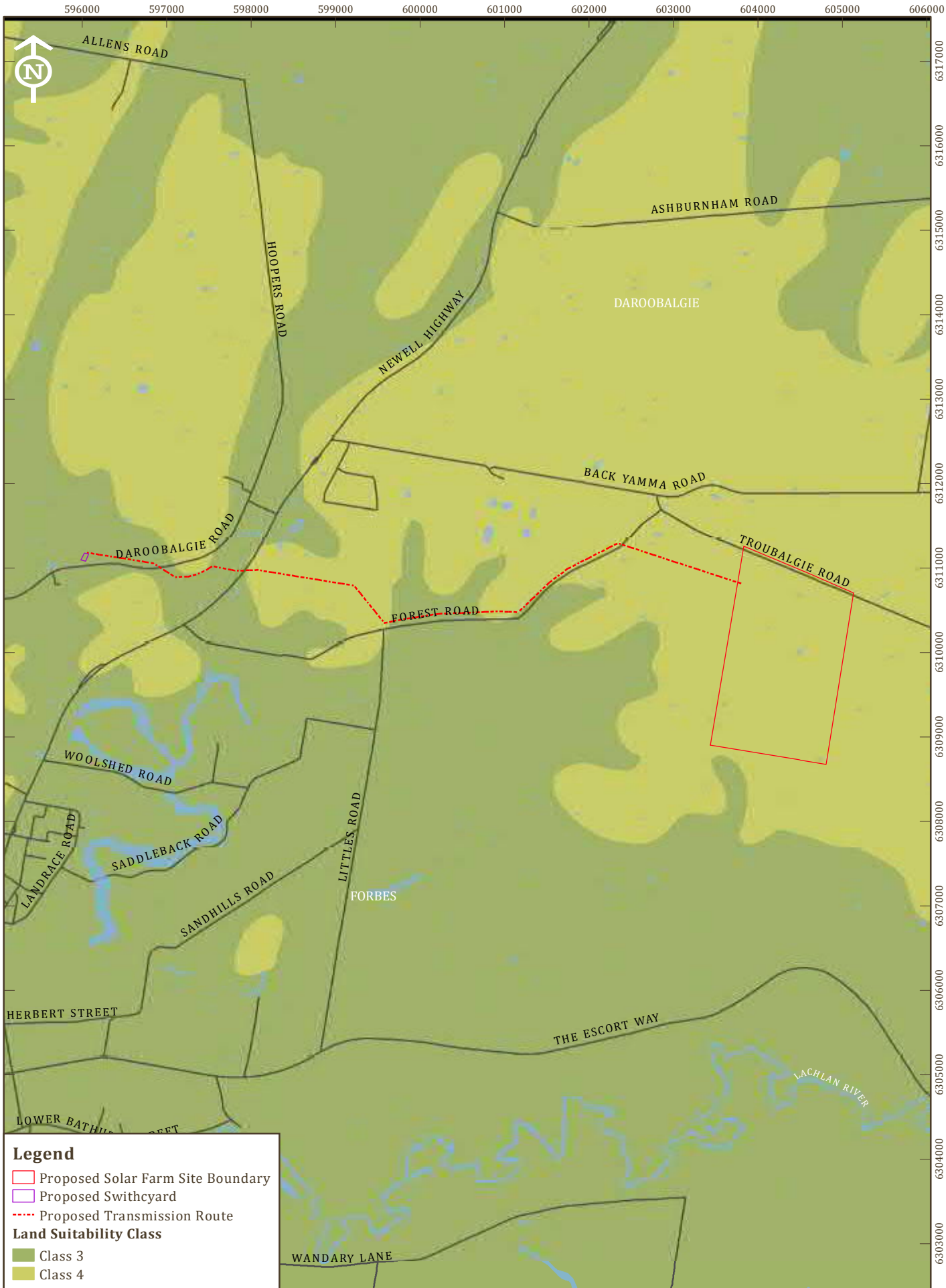

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Land Suitability Class

FIGURE 6

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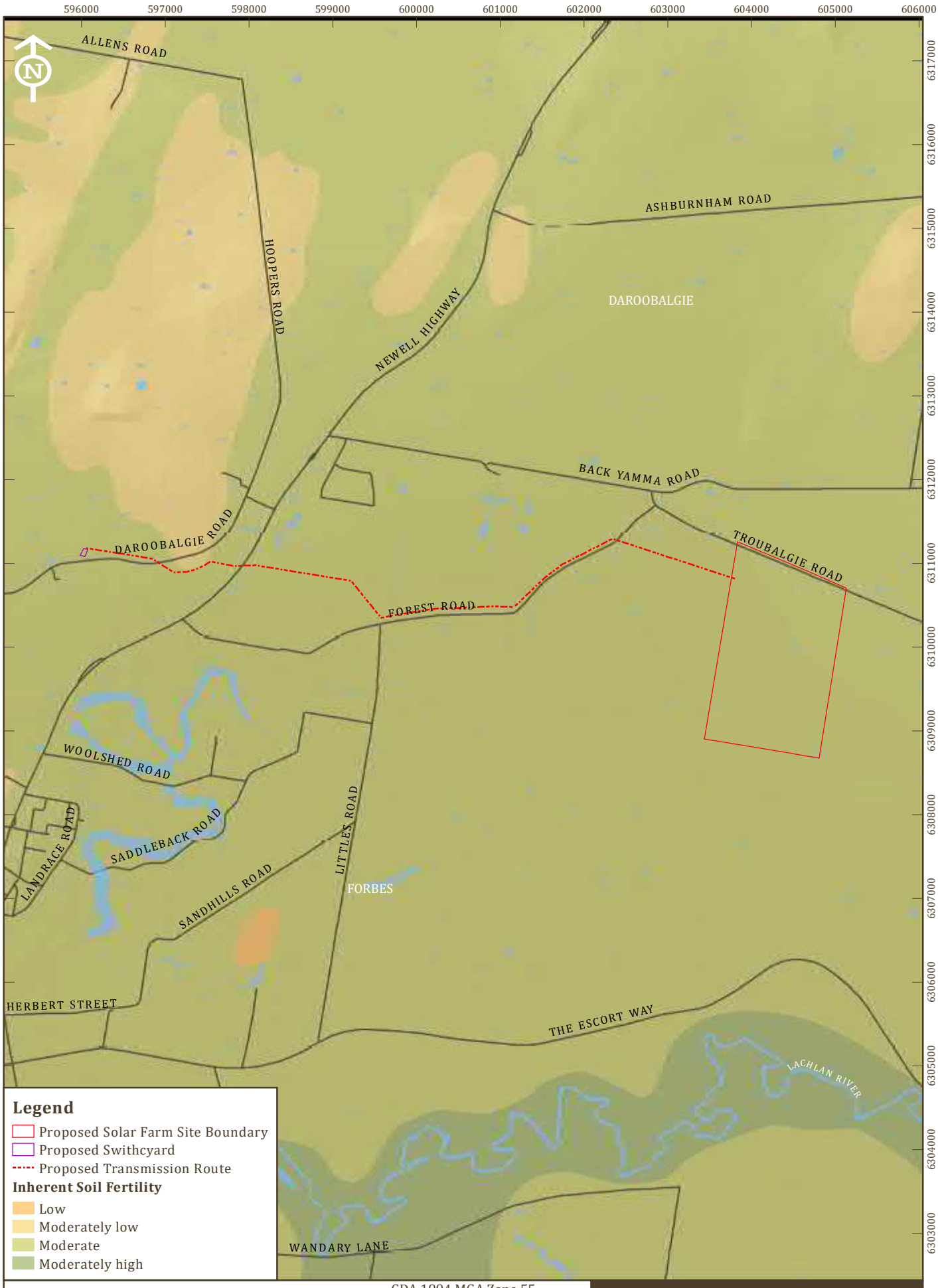

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Inherent Soil Fertility

FIGURE 7

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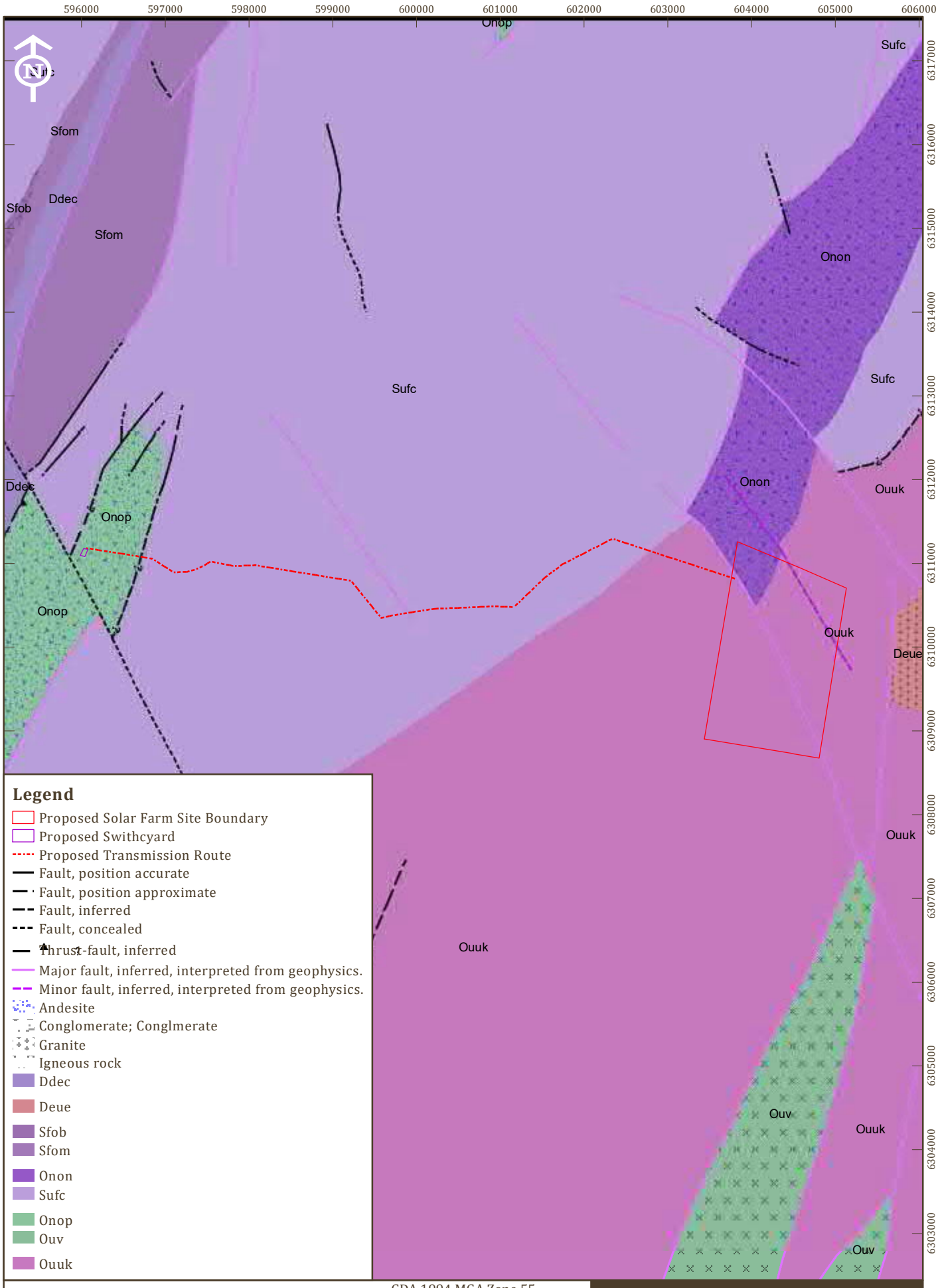

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Regional Geology

FIGURE 8

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3 SOIL SURVEY

3.1 METHODOLOGY

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

- Soil survey and assessment, identifying soil types, soil qualities and risks including erosion ASS and salinity;
- Land and soil capability (LSC) Assessment;
- Management and mitigation measures for handling soil during construction, solar farm operations and rehabilitation.

The objective of Minesoils proposed 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:

- EIS soil survey and mapping: This is recommended to be undertaken soil survey between a 1:25,000 and 1:50,000 survey intensity (1 site every 50 ha), and requires collection of landform pattern and element information, soil profile data, and taxonomic parameters to distinguish soil types according to the Australian Soil Classification criteria, within the project area.
- EIS land and soil capability (LSC): The information required for the LSC assessment will be 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.
- EIS soil qualities: Additional information will be 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. Observations were made on risks of ASS and salinity.

The field program was designed as an integrated free survey. An integrated survey assumes that many land characteristics are interdependent and tend to occur in correlated sets (NSCT, 2008). Survey points are irregularly located according to the survey teams' judgement to enable the delineation of soil boundaries. Soil boundaries can be abrupt or gradual, and catena and toposequences are used to aid the description of gradual variation. Soil pits excavated by hand tools (shovel & digging bar) to 0.8 m. Site clearances and dial before you dig (DBYD) plans were provided as part of the excavation requirements.

The survey area was 308ha, and therefore the number of soil investigation sites was 7 sites (including two sites within site 3 and 5 to account for gilgai) and samples were collected and tested at all sites. Three samples were collected from each site and depths were typically at 0-10 cm, 30-40 cm, and 60-70 cm. The laboratory testing suite for these sites is detailed in the **Table 1** below.

Duplicate samples at every site were collected during the fieldwork and stored at Minesoils' office in Tamworth until the project is finalised. This duplication process offers insurance in the event of samples being lost in transit, laboratory accidents or inadequate soil volume for destructive tests and eliminates the need for additional site visits if any of the above occurs.

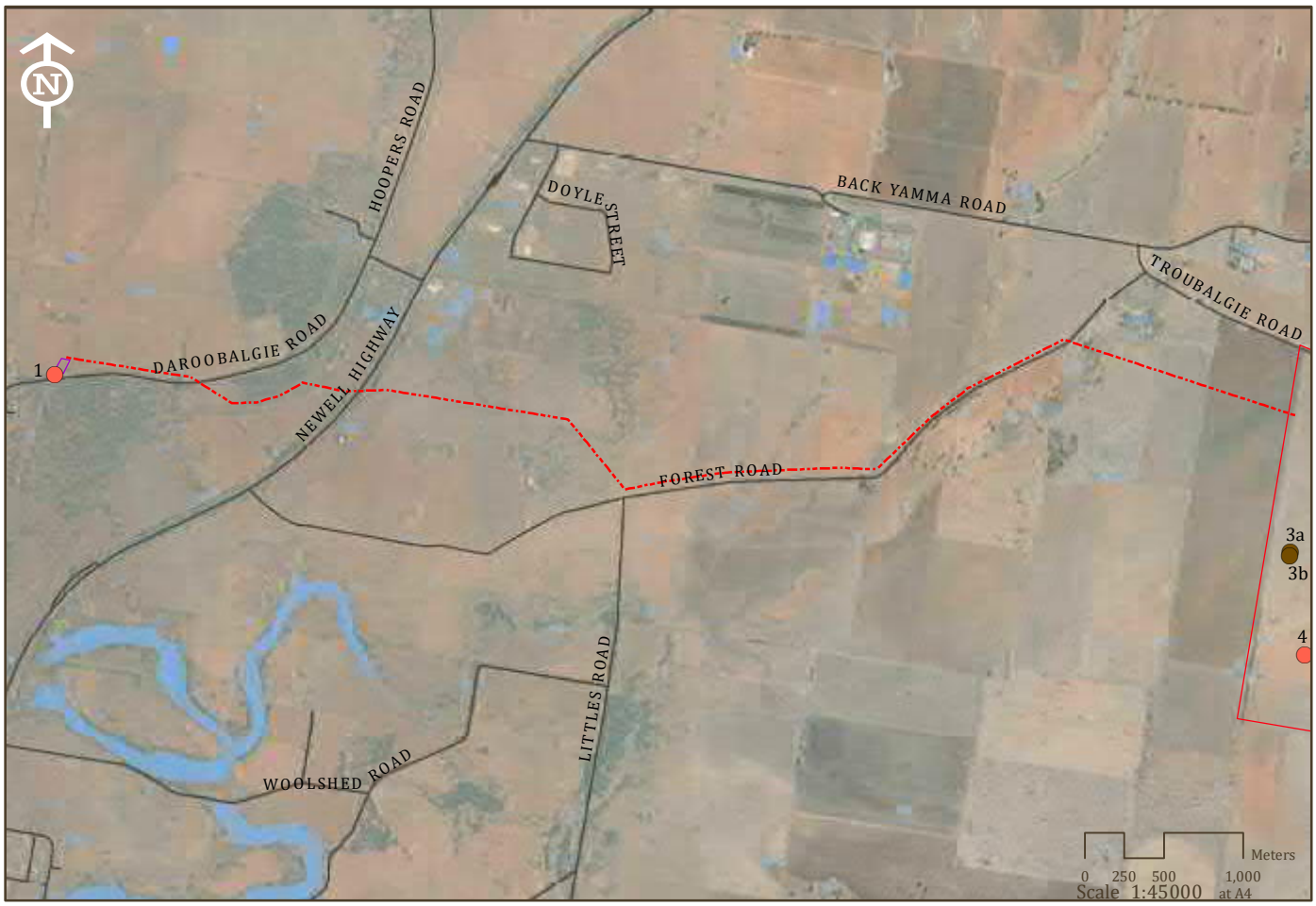
Soil profiles within the Project are (refer to **Figure 9**) were assessed in accordance with the Australian Soil and Land Survey Field Handbook soil classification procedures (NCST, 2009). Detailed soil profile descriptions were recorded covering the major parameters specified in **Table 2** below. Soil profile logging was undertaken in the field using Minesoils soil data sheets, including GPS recordings and photographs of the landforms and soil profiles. Soils were keyed out in accordance with the Australian Soil Classification (ASC) Revised Edition (2008).

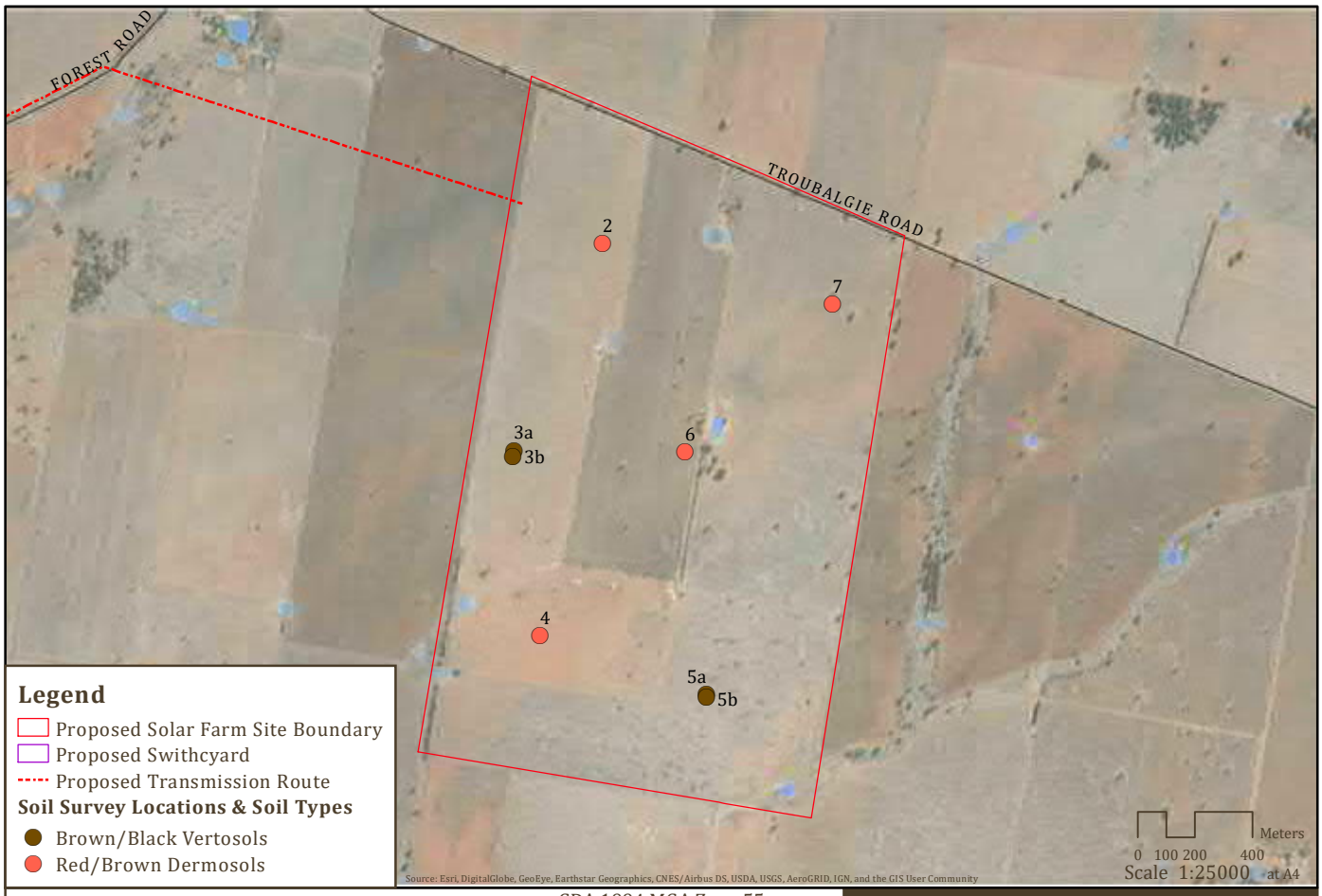
Table 1: Laboratory Testing Suites Proposed for the Project

Soil Testing Parameters	Method Reference
pH and EC (1:5 water), pH (CaCl)	Rayment & Lyons 2011-4A1 Rayment & Lyons 2011-3A1
Available Ammonium, Nitrate, Sulfur	Rayment & Lyons 2011-15D3
Exchangeable Sodium, Potassium, Calcium, Magnesium, Hydrogen, Aluminium	Rayment & Lyons 2011 15M1
Cation Exchange Capacity	Rayment & Lyons 2011-15J1
Colwell Phosphorus	Rayment & Lyons 2011-9B2
Available Micronutrients Zinc, Manganese, Iron, Copper, Boron, Silicon	Rayment & Lyons 2011-12A1
Total Carbon (TC)	Rayment & Lyons 2011-6B2b
Total Nitrogen (TN)	Rayment & Lyons 2011-7A5
TC/TN Ratio	Rayment & Lyons 2011-8A1
Organic Matter	% C x 1.75
Basic Colour	Munsell Colour Chart
Basic Texture	CSIRO 'Yellow Book'
Emerson Aggregate test (EAT)	AS1289.3.8.1

Table 2: Field Assessment 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





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Soil Survey

FIGURE 9

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4 RESULTS

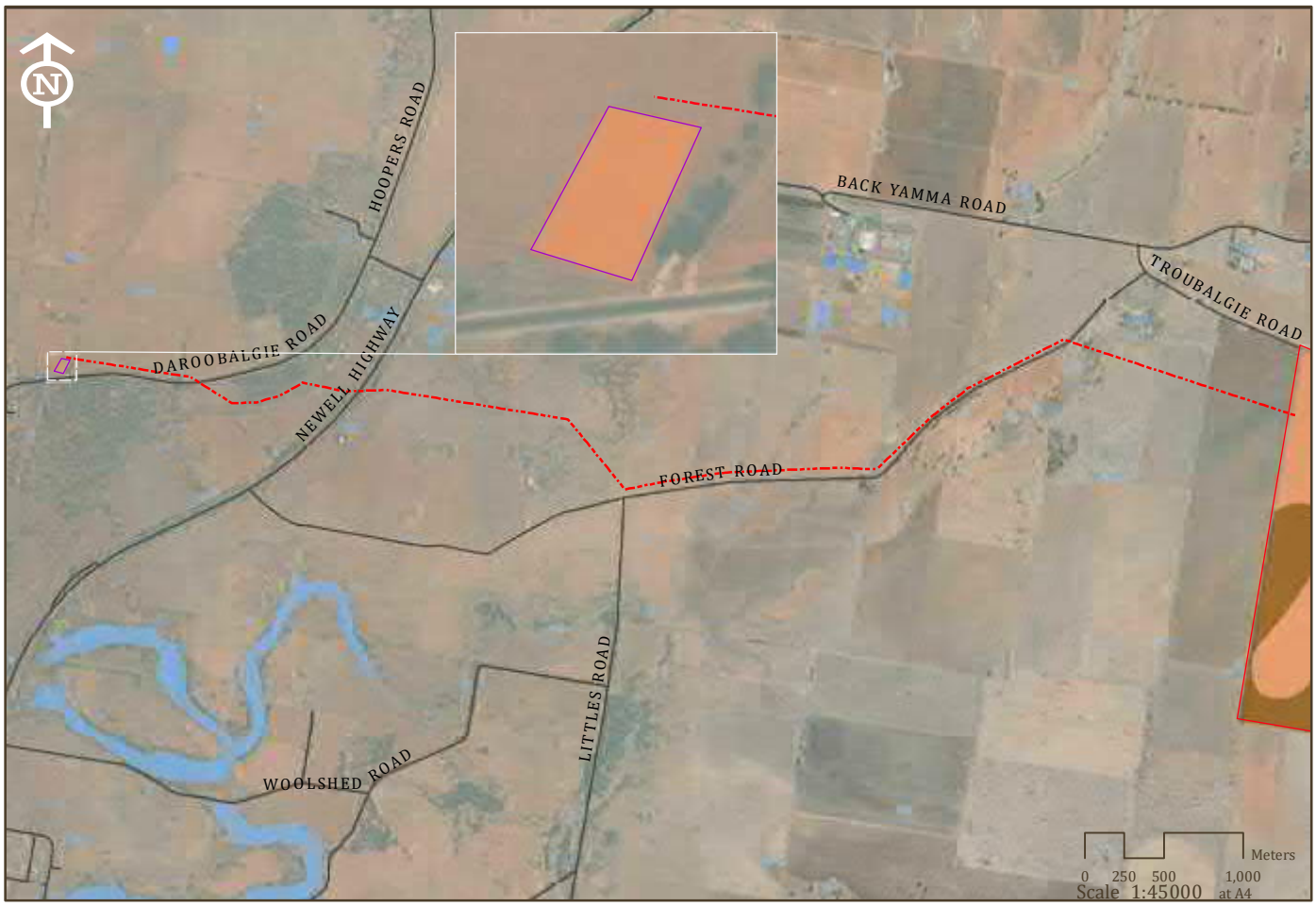
The soil survey undertaken by Minesoils found the Project area to contain two dominant soil types: 1. Deep Red to Brown Dermosols and 2. Gilgai Brown to Black Vertosols (refer to **Figure 10**). A summary of the soil types is provided below with detailed soil profile descriptions for each site follows.

Deep Red to Brown Dermosols (5 sites) – 170 ha Project area and 0.5 ha Switching Yard

Dermosols are soils with structured B2 horizons and lacking strong texture contrast between the A and B horizons. The sub order, great group and sub group categories included Sodic Eutrophic Brown and Red Dermosols. Refer to the following soil profiles for detailed descriptions: DS-1, DS-2, DS-4, DS-6 and DS-7.

Gilgai Brown to Black Vertosols (4 sites - 2 depression sites and 2 rise sites) – 137 ha Project area

Vertosols are clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates. Although many soils exhibit gilgai micro-relief, this feature is not used in their definition. The two sites assessed within the gilgai landform consisted of Haplic to Endocalcareous Crusty Black Vertosols in the depressions and Episodic-Endocalcareous to Endocalcareous Crusty Brown Vertosol on the rises.



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Soil Types

FIGURE 10

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Site Description – Site 1				
Site Reference	DS-1	**ASC Name**	Sodic Eutrophic Brown Dermosol (BGLOW)	
Average Slope	Flat (0%)	**Soil Fertility**	Moderate	**Coordinates**
Land Use	Road Easement	**LSC Class**	4	GDA94 MGA55
Landform Element	Plain	**Micro-Relief**	Nil	X: 595981
Surface Condition	Loose (Gravelly)	**Vegetation**	Native Grasses	Y: 6311074

Plate 1 – Soil Profile (DS-1)

Plate 2 – Surface (DS-1)

Plate 3 – Landscape (DS-1)

Horizon	Depth (m)	Description
A1	0.00 – 0.30	Dark brown (Munsell 7.5YR 3/4) Sandy Loam with moderate pedality and moderate consistence. Neutral pH, non-saline and non-sodic. 10% coarse fragments 5 to 20mm. Many fine roots and moderately drained. Gradual boundary. Stone layer 0.10 to 0.30m 80% course fragments increasing clay content. Gradual boundary to B21
B21	0.30 – 0.60	Dark reddish brown (Munsell 5YR 3/4) Light Medium Clay with moderate pedality and moderate consistence. Strongly acidic pH, non-saline and marginally sodic. Nil coarse fragments. Few fine roots and moderately drained. Gradual boundary.
B22	0.60 – 0.80+	Dark reddish brown (Munsell 5YR 3/4) Silty Clay Loam with moderate pedality and moderate consistence. Strongly alkaline pH, non-saline and strongly sodic. Nil coarse fragments. Trace roots and moderately drained. Layer continues.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.5	Non-saline	6.52	Neutral	0.83	Non-Sodic
0.30-0.40	1.1	Non-saline	5.28	Strongly Acidic	5.6	Sodic
0.65-0.75	1.5	Non-saline	8.61	Strongly Alkaline	15.0	Strongly Sodic

Site Description – Site 2				
Site Reference	DS-2	**ASC Name**	Sodic Eutrophic Brown Dermosol (BELOX)	
Average Slope	Flat (0%)	**Soil Fertility**	Moderate	**Coordinates**
Land Use	Cropping	**LSC Class**	6	GDA94 MGA55
Landform Element	Alluvial Plan	**Micro-Relief**	Nil	X: 604080
Surface Condition	Crust (Cultivated)	**Vegetation**	Crop Stubble (Nil Trees)	Y: 6310678

Plate 4 – Soil Profile (DS-2)

Plate 5 – Surface (DS-2)

Plate 6 – Landscape (DS-2)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very dark brown (Munsell 7.5YR 2.5/2) Clay Loam with moderate pedality and moderate consistence. Moderately Acidic pH, non-saline and sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
B21	0.10 – 0.50	Very dark brown (Munsell 7.5YR 2.5/3) Heavy Clay with strong pedality and firm consistence. Very strongly alkaline pH, non-saline and strongly-sodic. Nil coarse fragments. Few fine roots and moderately drained. gradual boundary.
B22	0.50 – 0.80+	Dark brown (Munsell 7.5YR 3/3) Heavy Clay with strong pedality and firm consistence. Very strongly alkaline pH, non-saline and strongly sodic. Nil coarse fragments. Few roots and moderately drained. Layer Continues.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.0	Non-saline	5.87	Moderately Acidic	6.7	Sodic
0.30-0.40	0.9	Non-saline	9.01	Very Strongly Alkaline	16.0	Strongly Sodic
0.65-0.75	2.1	Non-saline	9.33	Very Strongly Alkaline	16.0	Strongly Sodic

Site Description – Site 3a				
Site Reference	DS-3a (Depression)	**ASC Name**	Haplic Crusty Black Vertosol (EQRW)	
Average Slope	Flat (0%)	**Soil Fertility**	High	**Coordinates**
Land Use	Cropping	**LSC Class**	4	GDA94 MGA55
Landform Element	Alluvial Plan	**Micro-Relief**	Gilgai (0.3m deep)	X: 603771
Surface Condition	Crust	**Vegetation**	Grass/Crop Stubble (Nil Trees)	Y: 6309955

Plate 7 – Soil Profile (DS-3a)

Plate 8 – Surface (DS-3a)

Plate 9 – Landscape (DS-3a)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Very dark brown (Munsell 7.5YR 3/2) Light Clay with moderate pedality and moderate consistence. Moderately alkaline pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
B2	0.20 – 0.80+	Dark brown to very dark grey (Munsell 7.5YR 3/2 to 3/1) Heavy Clay with strong pedality, smooth face peds and firm consistence. Moderately alkaline pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and moderately drained. Layer continues.

Sample Depth	ECe		pH(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.9	Non-saline	8.17	Moderately Alkaline	1.1	Non-Sodic
0.30-0.40	0.3	Non-saline	8.39	Moderately Alkaline	2.2	Non-Sodic
0.65-0.75	0.3	Non-saline	8.30	Moderately Alkaline	3.6	Non-Sodic

Site Description – Site 3b				
Site Reference	DS-3b (Rise)	**ASC Name**	Endocalcareous Crusty Brown Vertosol (ERRW)	
Average Slope	Flat (0%)	**Soil Fertility**	High	**Coordinates**
Land Use	Cropping	**LSC Class**	4	GDA94 MGA55
Landform Element	Alluvial Plan	**Micro-Relief**	Gilgai	X: 603767
Surface Condition	Crust (Cultivated)	**Vegetation**	Crop Stubble (Nil Trees)	Y: 6309933

Plate 10 – Soil Profile (DS-3b)

Plate 11 – Surface (DS-3b)

Plate 12 – Landscape (DS-3b)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Very dark brown (Munsell 7.5YR 3/4) Medium Clay with moderate pedality and moderate consistence. Strongly alkaline pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
B2	0.20 – 0.80+	Brown to dark brown (Munsell 7.5YR 3/4 to 4/4) Heavy Clay with strong pedality, smooth face peds and firm consistence. Very Strongly to strongly alkaline pH, non-saline to moderately saline and sodic. Nil coarse fragments. Few fine roots and moderately drained. Layer continues.

Sample Depth	ECe		pH(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.1	Non-saline	8.88	Strongly alkaline	2.4	Non-Sodic
0.30-0.40	1.5	Non-saline	9.34	Very strongly alkaline	7.6	Sodic
0.65-0.75	5.7	Mod saline	8.70	Strongly alkaline	13.0	Sodic

Site Description – Site 4				
Site Reference	DS-4	**ASC Name**	Sodic Eutrophic Red Dermosol (BELOX)	
Average Slope	Flat (0%)	**Soil Fertility**	Moderate	**Coordinates**
Land Use	Cropping	**LSC Class**	6	GDA94 MGA55
Landform Element	Alluvial Plan	**Micro-Relief**	Nil	X: 603864
Surface Condition	Crust (Cultivated)	**Vegetation**	Crop Stubble (Nil Trees)	Y: 6309310

Plate 13 – Soil Profile (DS-4)

Plate 14 – Surface (DS-4)

Plate 15 – Landscape (DS-4)

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark reddish brown (Munsell 5YR 3/4) Clay Loam with moderate pedality and moderate consistence. Strongly acidic pH, non-saline and sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
B21	0.15 – 0.50	Dark reddish brown (Munsell 5YR 3/4) Heavy Clay with strong pedality and firm consistence. Moderately alkaline pH, non-saline and strongly-sodic. Nil coarse fragments. Few fine roots and moderately drained. gradual boundary.
B22	0.50 – 0.80+	Dark reddish brown (Munsell 5YR 3/4) Heavy Clay with strong pedality and firm consistence. Very strongly alkaline pH, non-saline and strongly sodic. Nil coarse fragments. Few roots and moderately drained. Layer Continues.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.9	Non-saline	5.17	Strongly Acidic	8.5	Sodic
0.30-0.40	0.6	Non-saline	8.31	Moderately Alkaline	15.0	Strongly Sodic
0.65-0.75	1.0	Non-saline	9.07	Very Strongly Alkaline	17.0	Strongly Sodic

Site Description – Site 5a				
Site Reference	DS-5a (Depression)	**ASC Name**	Endocalcareous Crusty Black Vertosol (ERRW)	
Average Slope	Flat (0%)	**Soil Fertility**	High	**Coordinates**
Land Use	Cropping	**LSC Class**	4	GDA94 MGA55
Landform Element	Alluvial Plain	**Micro-Relief**	Gilgai (0.5m deep)	X: 604443
Surface Condition	Crust	**Vegetation**	Crop Stubble (Nil Trees)	Y: 6309105

Plate 16 – Soil Profile (DS-5a)

Plate 17 – Surface (DS-5a)

Plate 18 – Landscape (DS-5a)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Dark Grey (Munsell 7.5YR 4/1) Medium Clay with moderate pedality and moderate consistence. Neutral pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
B2	0.20 – 0.80+	Very dark grey to Black (Munsell 5YR 3/1 to 7.5YR 2.5/1) Heavy Clay with strong pedality, smooth face peds and firm consistence. Mildly alkaline to moderately alkaline pH, non-saline and sodic. Nil coarse fragments. Few fine roots and moderately drained. 30% soft calcareous nodules. Layer continues.

Sample Depth	ECe		$pH_{(1\text{-}5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.0	Non-saline	6.68	Neutral	4.9	Non-Sodic
0.30-0.40	0.4	Non-saline	7.38	Mildly alkaline	7.4	Sodic
0.65-0.75	0.5	Non-saline	8.21	Moderately alkaline	14.0	Sodic

Site Description – Site 5b				
Site Reference	DS-5b (Rise)	**ASC Name**	Episodic-Endocalcareous Crusty Brown Vertosol (EQRW)	
Average Slope	Flat (0%)	**Soil Fertility**	High	**Coordinates**
Land Use	Cropping	**LSC Class**	6	GDA94 MGA55
Landform Element	Alluvial Plain	**Micro-Relief**	Gilgai	X: 604442
Surface Condition	Crust (Cultivated)	**Vegetation**	Crop Stubble (Nil Trees)	Y: 6309094

Plate 19 – Soil Profile (DS-5b)

Plate 20 – Surface (DS-5b)

Plate 21 – Landscape (DS-5b)

Horizon	Depth (m)	Description
A1	0.00 – 0.25	Dark yellowish brown (Munsell 10YR 4/4) Light Clay with moderate pedality and moderate consistence. Very strongly alkaline pH, slightly saline and sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
B2	0.25 – 0.80+	Pale brown to Brown (Munsell 10YR 6/3 to 5/3) Light Medium Clay to Medium Clay with strong pedality, smooth face peds and firm consistence. Very Strongly to moderately alkaline pH, highly saline to extremely saline and strongly sodic. Nil coarse fragments. Few fine roots and moderately drained. Layer continues.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	3.0	Slightly-saline	9.21	Very strongly alkaline	14.0	Sodic
0.30-0.40	8.2	Highly-saline	9.32	Very strongly alkaline	30.0	Strongly Sodic
0.65-0.75	27.9	Extremely-saline	8.18	Moderately alkaline	28.0	Strongly Sodic

Site Description – Site 6				
Site Reference	DS-6	**ASC Name**	Sodic Eutrophic Red Dermosol (BELOX)	
Average Slope	Flat (0%)	**Soil Fertility**	Moderate	**Coordinates**
Land Use	Cropping	**LSC Class**	4	GDA94 MGA55
Landform Element	Alluvial Plan	**Micro-Relief**	Nil	X: 604369
Surface Condition	Crust (Cultivated)	**Vegetation**	Crop Stubble (Nil Trees)	Y: 6309951

Plate 22 – Soil Profile (DS-6)

Plate 23 – Surface (DS-6)

Plate 24 – Landscape (DS-6)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark reddish brown (Munsell 5YR 3/4) Clay Loam with moderate pedality and moderate consistence. Strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
B21	0.10 – 0.50	Dark reddish brown (Munsell 5YR 3/4) Clay Loam with moderate pedality and moderate consistence. Neutral pH, non-saline and sodic. Nil coarse fragments. Few fine roots and moderately drained. gradual boundary.
B22	0.50 – 0.80+	Strong brown (Munsell 7.5YR 4/6) Heavy Clay with strong pedality and firm consistence. Strongly alkaline pH, non-saline and strongly sodic. Nil coarse fragments. Few roots and moderately drained. Layer Continues.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.1	Non-saline	5.28	Strongly Acidic	5.6	Non-Sodic
0.30-0.40	0.4	Non-saline	6.72	Neutral	12.0	Sodic
0.65-0.75	0.7	Non-saline	8.55	Strongly Alkaline	17.0	Strongly Sodic

Site Description – Site 7				
Site Reference	DS-7	**ASC Name**	Sodic Eutrophic Red Dermosol (BELOX)	
Average Slope	Flat (0%)	**Soil Fertility**	Moderate	**Coordinates**
Land Use	Cropping	**LSC Class**	6	GDA94 MGA55
Landform Element	Alluvial Plan	**Micro-Relief**	Nil	X: 604882
Surface Condition	Crust (Cultivated)	**Vegetation**	Crop Stubble (Nil Trees)	Y: 6310466

Plate 25 – Soil Profile (DS-7)

Plate 26 – Surface (DS-7)

Plate 27 – Landscape (DS-7)

Horizon	Depth (m)	Description
A1	0.00 – 0.30	Dark reddish brown (Munsell 5YR 3/4) Loam with moderate pedality and moderate consistence. Moderately acidic pH, non-saline and sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
B21	0.30 – 0.50	Dark reddish brown (Munsell 5YR 3/4) Medium Clay with Strong pedality and firm consistence. Strongly alkaline pH, non-saline and sodic. Nil coarse fragments. Few fine roots and moderately drained. gradual boundary.
B22	0.50 – 0.80+	Dark reddish brown (Munsell 5YR 3/4) Heavy Clay with strong pedality and firm consistence. Strongly alkaline pH, non-saline and sodic. Nil coarse fragments. Few roots and moderately drained. Layer Continues.

Sample Depth	ECe		pH(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.3	Non-saline	5.93	Moderately Acidic	8.7	Sodic
0.30-0.40	0.5	Non-saline	8.42	Strongly Alkaline	11.0	Sodic
0.65-0.75	0.5	Non-saline	8.77	Strongly Alkaline	14.0	Sodic

5 LAND AND SOIL CAPABILITY (LSC)

5.1 METHODOLOGY

The LSC Assessment was undertaken during the same fieldwork program. The LSC is required across the entire Project Area for mapping and input into the agricultural component of the impact assessment of the EIS.

The LSC classification was applied for the Project Area in accordance with the OEH guideline *The Land and Soil Capability Assessment Scheme; Second approximation* (OEH 2013). This 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 (refer to **Table 3** below).

Table 3 Land and Soil Capability Descriptions

LSC Class	General Definition	
Land capable of a wide variety of land uses (cropping, grazing, horticulture forestry, conservation, nature conservation)		
1	*Extremely high capability land* No limitations	No special land management practices required. Land capable of all rural land uses and land management practices.
2	Very high capability land Slight limitations	Limitations 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* Moderate limitations	Is capable of sustaining high-impact land uses, such as cropping with cultivation using more intensive and widely accepted management practices. However careful management of the 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* Moderate to high limitations for high-impact land uses	Limitations 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* High limitations for high-impact land uses	Limitations will 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 of a limited set of land uses (grazing, forestry and nature conservation, some horticulture)		
6	*Low capability land* Very high limitations for high-impact land uses	Land 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* Severe limitations that restrict most land uses	Limitations generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations are not managed. There should be minimal disturbance of native vegetation.
8	*Extremely low capability land*	Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

The 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 described below.

Hazard 1: Water Erosion

The Project area lies within the Eastern and Central NSW Division, and the appropriate criteria for this division were used in the assessment. Assessment of water erosion hazard is almost solely dependent on the slope percentage of the land, based on each Soil Landscape Unit. The only exception is land which falls within the slope range of 10 to 20%, which may be designated LSC Class 4 or LSC Class 5 depending on the presence of gully erosion and/or sodic/dispersible soils.

Hazard 2: Wind Erosion

There are four factors used to assess wind erosion hazard for each soil type. Three criteria were assessed to be consistent for each soil type:

- Average rainfall determines the capacity of the land to maintain vegetative cover and keep soil wet. As noted in Section 2.1, average rainfall for the region is 493 mm (Forbes Airport AWS), and therefore the Study Area lies within the "300-500 mm rainfall" category for the purpose of assessing wind erosion hazard.
- Wind erosive power for the Study Area has been mapped as "Low", while exposure of the land to wind was determined to be "Intermediate".

The determining factor with regard to wind erosion hazard was therefore the erodibility of each soil type as determined by soil texture according the LSC Guideline surface soil texture is low (loam, clay loam or clay).

Hazard 3: Soil Structure Decline

Soil structure decline is assessed on soil characteristics, including surface soil texture, sodicity (laboratory tested) and degree of self-mulching (field tested). These parameters assess the soil structure, stability and resilience of the soil.

Hazard 4: Soil Acidification

The soil acidification hazard is assessed using three criteria, being soil buffering capacity, pH and mean annual rainfall. In this assessment, soil buffering capacity was based on soil Great Soil Group; surface soil pH and a regional mean "annual rainfall range of less than 550 mm".

Hazard 5: Salinity

The salinity hazard is determined through a range of data and criteria. The recharge potential for the site was determined based on an average annual rainfall of 493 mm (BOM, 2021). This would suggest a "low recharge" and "low discharge" potential. The Project area according to the Salt Store Map of NSW, is located in an area of "moderate salt store".

Hazard 6: Water Logging

Water logging was determined by the soil drainage characteristics, specifically field sample evidence of mottling, soil texture attributes as well as slope and climate.

Hazard 7: Shallow Soils and Rockiness

The shallow soils and rockiness hazard is determined by an estimated exposure of rocky outcrops and average soil depth.

Hazard 8: Mass Movement

The mass movement hazard is assessed through a combination of three criteria; mean annual rainfall, presence of mass movement and slope class.

5.2 LSC ASSESSMENT RESULTS

The LSC class was determined for each soil profile site. Site 1 within the switching yard was determined to be LSC Class 4 Moderate Agricultural Capability rating with moderate to high limitations for high-impact land uses. The Project area was a mix of LSC Class 4 (rating as above) and Class 6 Low capability land with very high limitations for high-impact land uses. The regional mapping had mapped the solar farm site as LSC Class 4 however sites 2, 4 and 5b had moderately sodic topsoils which pushed the LSC from Class 4 to Class 6.

Table 4 Land and Soil Capability Assessment Results

Soil Type		Hazard Criteria								
Site	ASC Name	1	2	3	4	5	6	7	8	LSC
1	Sodic Eutrophic Brown Dermosol	2	2	4	3	4	2	1	1	4
2	Sodic Eutrophic Brown Dermosol	1	2	6	3	4	2	1	1	6
3a	Haplic Crusty Black Vertosol	1	2	2	1	4	4	1	1	4
3b	Endocalcareous Crusty Brown Vertosol	1	2	2	1	4	2	1	1	4
4	Sodic Eutrophic Red Dermosol	1	2	6	4	4	2	1	1	6
5a	Endocalcareous Crusty Black Vertosol	1	2	4	2	4	4	1	1	4
5b	Episodic-Endocalcareous Crusty Brown Vertosol	1	2	6	1	4	2	1	1	6
6	Sodic Eutrophic Red Dermosol	1	2	4	4	4	2	1	1	4
7	Sodic Eutrophic Red Dermosol	1	2	6	3	4	2	1	1	6

6 EROSION POTENTIAL

The landform within the Project area is considered flat plains with negligible opportunity for soil to erode and be transported via gully erosion. There was some minor evidence on site that rill erosion may occur where constructed tracks or infrastructure provide a slight gradient and concentrated flow, however this scenario is considered only minor concern. There is potential for sheet erosion of the surface soil and any excavated subsoils.

Two laboratory tests were conducted on all samples to indicate the risk of soil erosion in situ, these were Exchangeable Sodium Percentage (ESP) and Emerson Aggregate Test (EAT).

Sodicity occurs when exchangeable sodium on the cation exchange complex leads to clay dispersion in the soil. The sodicity rating of soils may influence the ability for a soil aggregate to hold it's structure when saturated. ESP ratings of >6 indicate the soil is sodic and may be prone to the associated problems. Soils with ESP >14 are considered strongly sodic and amelioration and/or restricted surface impacts would be required to minimise soil erosion.

Emerson Aggregate Testing (EAT) was undertaken on all of the soil profiles to determine the soils erosive potential. In general topsoils within the Project area are slightly to moderately dispersive with EAT results of 2 or 3 indicating that remoulded soil peds at field water-holding capacity will disperse in distilled water. Some lower subsoils showed EAT of 1 which is highly dispersive and ameliorative care should be taken if excavating these soils and placing them at the surface.

The results of these two tests are shown below in Table 5.

The soils in the Project area do exhibit moderate to high levels of risk associated with sodicity and dispersion. The flatness of the site provides a level of control for erosion and sediment transport, given that surface runoff can only move at very low velocities. Due to this flat surface slope within the Project area, there is low run-off potential and due to a lack of exposure of subsoils during the construction and operational phases of the Project, the potential for soil erosion to occur is minimal. It is recommended to apply gypsum as an ameliorant when construction exposes strongly sodic and/or highly dispersive (high ESP, low EAT) soils to run-on or run-off water and slope. The gypsum will displace the sodium and provide the soil with a stronger aggregate and therefore hold structure better when wet.

Table 5: Soil Erosion Risk

Site	ASC Soil Type	Sample Depth	ESP	Rating	EAT	Rating
1	Brown Dermosol	0 – 10 cm	0.83	Non sodic	2	Moderately dispersive
		30 – 40 cm	5.6	Non sodic	2	Moderately dispersive
		65 – 75 cm	15	Strongly Sodic	2	Moderately dispersive
2	Brown Dermosol	0 – 10 cm	6.7	Marginally Sodic	3	Slightly dispersive
		30 – 40 cm	16	Strongly Sodic	2	Moderately dispersive
		65 – 75 cm	16	Strongly Sodic	2	Moderately dispersive
3a	Black Vertosol	0 – 10 cm	1.1	Non sodic	3	Slightly dispersive
		30 – 40 cm	2.2	Non sodic	3	Slightly dispersive
		65 – 75 cm	3.6	Non sodic	3	Slightly dispersive
3b	Brown Vertosol	0 – 10 cm	2.4	Non sodic	2	Moderately dispersive
		30 – 40 cm	7.6	Marginally Sodic	2	Moderately dispersive
		65 – 75 cm	13	Sodic	2	Moderately dispersive
4	Red Dermosol	0 – 10 cm	8.5	Marginally Sodic	2	Moderately dispersive
		30 – 40 cm	15	Strongly Sodic	2	Moderately dispersive
		65 – 75 cm	17	Strongly Sodic	2	Moderately dispersive
5a	Black Vertosol	0 – 10 cm	4.9	Non sodic	2	Moderately dispersive
		30 – 40 cm	7.4	Marginally Sodic	2	Moderately dispersive
		65 – 75 cm	14	Sodic	2	Moderately dispersive
5b	Brown Vertosol	0 – 10 cm	14	Sodic	2	Moderately dispersive
		30 – 40 cm	30	Strongly Sodic	2	Moderately dispersive
		65 – 75 cm	28	Strongly Sodic	2	Moderately dispersive
6	Red Dermosol	0 – 10 cm	5.6	Non sodic	3	Slightly dispersive
		30 – 40 cm	12	Sodic	2	Non-dispersive
		65 – 75 cm	17	Strongly Sodic	1	Highly dispersive
7	Red Dermosol	0 – 10 cm	8.7	Marginally Sodic	3	Slightly dispersive
		30 – 40 cm	11	Sodic	2	Moderately dispersive
		65 – 75 cm	14	Sodic	1	Highly dispersive

The Project will not result in changes to existing drainage or erosive potential within the Project area. Measures for effective erosion and sediment control will still be undertaken where soil surface disturbance occurs. These will include approaches for the construction and operational phases.

Construction Phase

- Construction will proceed in stages, and within each stage the construction activities will be sequenced, such that the construction zone at any one time will only be a small proportion of the overall Project area area;
- The Project will utilise the existing landform and no broad-scale re-contouring of the existing ground levels is proposed. Hence the existing vegetative cover and soil structure will be maintained intact across much

of the Project area;

- Solar arrays will be 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 will be progressively revegetated with grass and pasture species as installation of solar panels proceeds across the site;
- At locations where earthworks are necessary, such as for construction of sub-station pads, or site facilities, localised erosion and sediment controls will 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 will be prioritised during construction.

Operational Phase

Soil disturbance during operation of the Project will be minimal and limited to maintenance activities, which will involve very small localised disturbance areas on an infrequent basis. Standard erosion and sediment control measures will 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 and are likely to include measures such as sediment fencing, localised sediment traps, and progressive stabilisation with vegetation.

During operation the single-tracking system mounted panels would constantly change orientation during the day, with runoff being distributed in the area around each panel, and not drained permanently to a single place on the ground. Measures to manage any bare areas and erosion that develop beneath the solar arrays over time would be included in a land or groundcover management plan for implementation during ongoing operation of the proposal. It is anticipated that an effective management tool for maintaining adequate low grass cover is to use livestock (sheep) grazing throughout the solar farm. This provides an opportunity to keep grasses low and therefore encouraged to spread sideways to provide a greater and more effective ground cover, as well as adding nutrients via manure back into the soil.

7 ACID SULFATE SOILS

The potential for acid generation from disturbed material (topsoil and subsoil) within the Project is very low. Acid Sulphate Soils (ASS), which are the main cause of acid generation within the soil mantle, are commonly found less than five metres above sea level, particularly in low-lying coastal areas such as mangroves, salt marshes, floodplains, swamps, wetlands, estuaries, and brackish or tidal lakes. The Project area is located within the Central West region of NSW (which is approximately 280 kilometres from the coast at >250 metres AHD). There has been little history of acid generation from disturbed soil or regolith material within this region. A search of the NSW Natural Resources Atlas indicated no occurrences of ASS in the region.

8 GENERAL LAND REMEDIATION

A detailed Decommissioning and Rehabilitation Plan will be prepared within 5 years of the planned closure of the Project. This plan will detail all aspects of decommissioning and removal of all infrastructure not wanted for post project land use. Therefore, at the conclusion of the Project, all infrastructure relating to the Project will be removed from the site, however the landholder may wish to keep the office, maintenance shed and any constructed internal roads as part of the "agricultural infrastructure" for the ongoing use of the Project area as a viable agricultural enterprise, if this is the intended land use. There is limited impact on land and soil capability for the overall project and therefore once infrastructure is removed, typical agricultural activities including cultivation may be resumed.

During decommissioning, where potential erosive impacts have been identified due to the disturbance of sodic topsoil or subsoil, gypsum will be applied for any remediation earthworks where sodic soils (ESP>6) are present. The application of gypsum will minimise the potential for runoff, sheet, rill and tunnel erosion to occur on areas of disturbed soil. Gypsum should be applied at between 2 to 5 tonnes per ha (0.2 to 0.5 kg/m2) for soils with ESP 6% to 10%. Strongly sodic subsoils (ESP >10%) should be treated with 5 to 10 tonnes per ha of Gypsum. Standard temporary erosion and sediment control measures are to be put in place for high disturbance areas.

There are limited soil stripping and stockpiling activities proposed within the Project area. Where stripping activities are required soil should preferably be stripped in a slightly moist condition, where possible. Material should not be stripped in either an excessively dry or wet condition to avoid pulverisation and compaction impacts on the soil. If soil is required to be stockpiled, the stockpile height should not exceed 2m.

All areas disturbed during construction, operations or decommissioning 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 long term protection against erosion.

Upon decommissioning and rehabilitation of the Project area, final land use of agriculture is proposed, consistent with pre-development land uses such as grazing and winter cereal cropping.

9 SUMMARY

This Soil and Land Resource Assessment has been conducted based on the findings of a field investigation and a desktop review of reference information. Key findings include:

- ASC soil types within the Project area are dominated by Sodic Eutrophic Brown Dermosols, with gilgai areas consisting of Haplic to Endocalcareous Crusty Black Vertosol in the depressions and Episodic-Endocalcareous Crusty Brown Vertosols on the rises;
- The Project area is mapped as LSC Class 4 land, which is considered to have moderate agricultural capability, however sites 2, 4, 5b and 7 were classified as LSC Class 6 due to sodic topsoils which have low agricultural capability;
- Agricultural production will be limited to grazing only during the life of the Project, allowing the Project area to potentially generate income from both agriculture and solar energy production;
- Subsoils within the Project area are generally alkaline, and sodic with slight to high EAT dispersion rating;
- Minor soil stripping and stockpiling activities within the Project area are anticipated as a result of construction of the office and maintenance areas; and
- The entire Project area will be remediated back to an area suitable for agricultural production, such as grazing or winter cereal cropping, once full site rehabilitation has been undertaken.

Management recommendations based on these findings are presented in this assessment and are a guide to mitigating the negligible soil and land resource impacts associated the proposed Project.

The soil laboratory analysis results are attached in **Appendix 1**.

10 REFERENCES

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Appendix 1
Laboratory Results

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ABN: 41 995 651 524

AGRICULTURAL SOIL ANALYSIS REPORT

27 samples supplied by Minesoils Pty. Ltd. on 14/01/2021. Lab Job No.K2353
Analysis requested by Clayton Richards. Your Job: MS-054 Soils
PO BOX 11034 TAMWORTH NSW 2340

Parameter		Method reference	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Sample ID:			DS-1 0-10	DS-1 30-40	DS-1 65-75	DS-2 0-10	DS-2 30-40	DS-2 65-75
Crop:			N/G	N/G	N/G	N/G	N/G	N/G
Client:			Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
			K2353/1	K2353/2	K2353/3	K2353/4	K2353/5	K2353/6
Soluble Calcium (mg/kg)		**Inhouse S10 - Morgan 1	537	..	..	503	..	..
Soluble Magnesium (mg/kg)			175	..	..	308	..	..
Soluble Potassium (mg/kg)			247	..	..	185	..	..
Soluble Phosphorus (mg/kg)			1.9	..	..	2.3	..	..
Phosphorus (mg/kg P)		**Rayment & Lyons 2011 - 9E2 (Bray 1)	3.8	..	..	18	..	..
		**Rayment & Lyons 2011 - 9B2 (Colwell)	6.6	..	..	66	..	..
		**Inhouse S3A (Bray 2)	7.2	..	..	34	..	..
Nitrate Nitrogen (mg/kg N)		**Inhouse S37 (KCl)	0.78	..	..	3.8	..	..
Ammonium Nitrogen (mg/kg N)			1.2	..	..	0.59	..	..
Sulfur (mg/kg S)			2.7	..	..	5.4	..	..
pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.52	5.28	8.61	5.87	9.01	9.33
Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.033	0.127	0.175	0.112	0.159	0.362
Estimated Organic Matter (% OM)		**Calculation: Total Carbon x 1.75	3.4	..	..	3.1	..	..
Exchangeable Calcium	(cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	5.0	4.5	7.5	4.9	10	16
	(kg/ha)		2,240	2,009	3,369	2,201	4,562	7,197
	(mg/kg)		1,000	897	1,504	983	2,037	3,213
Exchangeable Magnesium	(cmol+/kg)		2.2	1.2	12	4.3	12	13
	(kg/ha)		593	339	3,235	1,174	3,349	3,606
	(mg/kg)		265	151	1,444	524	1,495	1,610
Exchangeable Potassium	(cmol+/kg)		1.3	1.1	1.5	1.2	0.46	0.46
	(kg/ha)		1,102	999	1,293	1,060	401	404
	(mg/kg)		492	446	577	473	179	180
Exchangeable Sodium	(cmol+/kg)		0.07	0.45	3.6	0.76	4.3	5.5
	(kg/ha)		36	232	1,868	389	2,216	2,847
	(mg/kg)		16	103	834	174	989	1,271
Exchangeable Aluminium	(cmol+/kg)	**Inhouse S37 (KCl)	0.01	0.46	<0.01	0.05	0.02	<0.01
	(kg/ha)		2.0	92	1.3	9.8	3.1	1.9
	(mg/kg)		<1	41	<1	4.4	1.4	<1
Exchangeable Hydrogen	(cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	0.33	<0.01	<0.01	<0.01	<0.01
	(kg/ha)		<1	7.3	<1	<1	<1	<1
	(mg/kg)		<1	3.3	<1	<1	<1	<1
Effective Cation Exchange Capacity (ECEC) (cmol+/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	8.5	8.1	24	11	27	35
Calcium (%)		**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	59	55	31	44	37	45
Magnesium (%)			26	15	49	38	45	38
Potassium (%)			15	14	6.0	11	1.7	1.3
Sodium - ESP (%)			0.83	5.6	15	6.7	16	16
Aluminium (%)			0.12	5.6	0.03	0.43	0.06	0.03
Hydrogen (%)			0.00	4.0	0.00	0.00	0.00	0.00
Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol+/kg)	2.3	3.6	0.63	1.1	0.83	1.2

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AGRICULTURAL SOIL ANALYSIS REPORT

27 samples supplied by Minesoils Pty. Ltd. on 14/01/2021. Lab Job No.K2353
Analysis requested by Clayton Richards. Your Job: MS-054 Soils
PO BOX 11034 TAMWORTH NSW 2340

	Parameter	Method reference	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
	Sample ID:		DS-1 0-10	DS-1 30-40	DS-1 65-75	DS-2 0-10	DS-2 30-40	DS-2 65-75
	Crop:		N/G	N/G	N/G	N/G	N/G	N/G
	Client:		Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
			K2353/1	K2353/2	K2353/3	K2353/4	K2353/5	K2353/6
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	1.3	..	..	<0.5	..	..
	Manganese (mg/kg)		37	..	..	65	..	..
	Iron (mg/kg)		31	..	..	59	..	..
	Copper (mg/kg)		1.3	..	..	1.3	..	..
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.54	..	..	1.1	..	..
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	59	..	..	79	..	..
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	2.0	..	..	1.8	..	..
	Total Nitrogen (%)		0.12	..	..	0.10	..	..
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	16	..	..	18	..	..
	Basic Texture	**Inhouse S65	Clay Loam	..	..	Clay Loam	..	..
	Basic Colour		Brownish	..	..	Brownish	..	..
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	21	82	112	72	102	232
	Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	2	2	2	3	2	2
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	7.5 YR 3/4 Dark Brown	5 YR 3/4 Dark Reddish Brown	5 YR 3/4 Dark Reddish Brown	7.5 YR 2.5/2 Very Dark Brown	7.5 YR 2.5/3 Very Dark Brown	7.5 YR 3/3 Dark Brown
	Mottles Munsell Colour		..	..	..	..	..	..
	Degree of Mottling (%)		..	..	..	..	..	..

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
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17. This report was issued on 22/01/2021.

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AGRICULTURAL SOIL ANALYSIS REPORT

27 samples supplied by Minesoils Pty. Ltd. on 14/01/2021. Lab Job No.K2353
Analysis requested by Clayton Richards. Your Job: MS-054 Soils
PO BOX 11034 TAMWORTH NSW 2340

			Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
		Sample ID:	DS-3a 0-10	DS-3a 30-40	DS-3a 65-75	DS-3b 0-10	DS-3b 30-40	DS-3b 65-75
		Crop:	N/G	N/G	N/G	N/G	N/G	N/G
		Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
	Parameter	Method reference	K2353/7	K2353/8	K2353/9	K2353/10	K2353/11	K2353/12
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	1,960	..	..	8,535	..	..
	Soluble Magnesium (mg/kg)		360	..	..	1,062	..	..
	Soluble Potassium (mg/kg)		189	..	..	108	..	..
	Soluble Phosphorus (mg/kg)		3.9	..	..	1.8	..	..
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	23	..	..	4.3	..	..
		**Rayment & Lyons 2011 - 9B2 (Colwell)	86	..	..	11	..	..
		**Inhouse S3A (Bray 2)	58	..	..	16	..	..
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	8.9	..	..	4.9	..	..
	Ammonium Nitrogen (mg/kg N)		0.34	..	..	<0.1	..	..
	Sulfur (mg/kg S)		15	..	..	6.1	..	..
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	8.17	8.39	8.30	8.88	9.34	8.70
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.105	0.054	0.051	0.147	0.252	0.983
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	2.3	..	..	2.2	..	..
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	17	18	18	25	23	24
	Exchangeable Calcium (kg/ha)		7,609	7,880	7,922	11,182	10,167	10,678
	Exchangeable Calcium (mg/kg)		3,397	3,518	3,537	4,992	4,539	4,767
	Exchangeable Magnesium (cmol+/kg)		5.0	6.6	7.4	9.0	12	11
	Exchangeable Magnesium (kg/ha)		1,363	1,790	2,003	2,442	3,387	2,878
	Exchangeable Magnesium (mg/kg)		608	799	894	1,090	1,512	1,285
	Exchangeable Potassium (cmol+/kg)		1.6	0.92	0.76	0.88	0.45	0.59
	Exchangeable Potassium (kg/ha)		1,404	807	662	768	396	519
	Exchangeable Potassium (mg/kg)		627	360	296	343	177	232
	Exchangeable Sodium (cmol+/kg)		0.26	0.57	0.96	0.87	2.9	5.3
	Exchangeable Sodium (kg/ha)		135	293	492	446	1,497	2,717
	Exchangeable Sodium (mg/kg)		60	131	220	199	668	1,213
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.02	0.02	0.01	0.02	0.01	0.01
	Exchangeable Aluminium (kg/ha)		3.3	3.3	2.1	3.5	2.4	2.1
	Exchangeable Aluminium (mg/kg)		1.5	1.5	<1	1.6	1.1	<1
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Exchangeable Hydrogen (kg/ha)		<1	<1	<1	<1	<1	<1
	Exchangeable Hydrogen (mg/kg)		<1	<1	<1	<1	<1	<1
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	24	26	27	36	38	40
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	71	68	66	70	59	59
	Magnesium (%)		21	26	28	25	32	26
	Potassium (%)		6.7	3.6	2.8	2.5	1.2	1.5
	Sodium - ESP (%)		1.1	2.2	3.6	2.4	7.6	13
	Aluminium (%)		0.07	0.06	0.04	0.05	0.03	0.03
	Hydrogen (%)		0.00	0.00	0.00	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	3.4	2.7	2.4	2.8	1.8	2.2

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AGRICULTURAL SOIL ANALYSIS REPORT

27 samples supplied by Minesoils Pty. Ltd. on 14/01/2021. Lab Job No.K2353
Analysis requested by Clayton Richards. Your Job: MS-054 Soils
PO BOX 11034 TAMWORTH NSW 2340

	Parameter	Method reference	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
	Sample ID:		DS-3a 0-10	DS-3a 30-40	DS-3a 65-75	DS-3b 0-10	DS-3b 30-40	DS-3b 65-75
	Crop:		N/G	N/G	N/G	N/G	N/G	N/G
	Client:		Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
			K2353/7	K2353/8	K2353/9	K2353/10	K2353/11	K2353/12
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	<0.5	..	..	<0.5	..	..
	Manganese (mg/kg)		15	..	..	4.5	..	..
	Iron (mg/kg)		23	..	..	6.6	..	..
	Copper (mg/kg)		1.5	..	..	1.00	..	..
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.81	..	..	1.7	..	..
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	24	..	..	10	..	..
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	1.3	..	..	1.3	..	..
	Total Nitrogen (%)		0.09	..	..	0.04	..	..
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	15	..	..	34	..	..
	Basic Texture	**Inhouse S65	Clay Loam	..	..	Clay Loam	..	..
	Basic Colour		Brownish	..	..	Brownish	..	..
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	67	35	32	94	161	629
	Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	3	3	3	2	2	2
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	7.5 YR 3/2 Dark Brown	7.5 YR 3/2 Dark Brown	7.5 YR 3/1 Very Dark Gray	7.5 YR 3/4 Dark Brown	7.5 YR 3/4 Dark Brown	7.5 YR 4/4 Brown
	Mottles Munsell Colour		..	..	..	..	..	..
	Degree of Mottling (%)		..	..	..	..	..	..

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,
   Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium,
    122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimat
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AGRICULTURAL SOIL ANALYSIS REPORT

27 samples supplied by Minesoils Pty. Ltd. on 14/01/2021. Lab Job No.K2353
Analysis requested by Clayton Richards. Your Job: MS-054 Soils
PO BOX 11034 TAMWORTH NSW 2340

	Parameter	Method reference	Sample 13	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18
	Sample ID:		DS-4 0-10	DS-4 30-40	DS-4 65-75	DS-5a 0-10	DS-5a 30-40	DS-5a 65-75
	Crop:		N/G	N/G	N/G	N/G	N/G	N/G
	Client:		Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
			K2353/13	K2353/14	K2353/15	K2353/16	K2353/17	K2353/18
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	332	..	..	1,045	..	..
	Soluble Magnesium (mg/kg)		103	..	..	364	..	..
	Soluble Potassium (mg/kg)		235	..	..	112	..	..
	Soluble Phosphorus (mg/kg)		1.2	..	..	1.6	..	..
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	21	..	..	15	..	..
		**Rayment & Lyons 2011 - 9B2 (Colwell)	71	..	..	67	..	..
		**Inhouse S3A (Bray 2)	40	..	..	34	..	..
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	13	..	..	28	..	..
	Ammonium Nitrogen (mg/kg N)		6.4	..	..	1.8	..	..
	Sulfur (mg/kg S)		12	..	..	13	..	..
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.17	8.31	9.07	6.68	7.38	8.21
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.224	0.099	0.174	0.130	0.075	0.086
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	3.0	..	..	2.3	..	..
	Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	3.0	9.0	8.9	13	13	12
	Exchangeable Calcium (kg/ha)		1,350	4,025	4,011	5,640	5,685	5,472
	Exchangeable Calcium (mg/kg)		603	1,797	1,791	2,518	2,538	2,443
	Exchangeable Magnesium (cmol$_+$/kg)		1.3	9.2	11	6.7	8.4	9.3
	Exchangeable Magnesium (kg/ha)		361	2,513	2,923	1,826	2,280	2,536
	Exchangeable Magnesium (mg/kg)		161	1,122	1,305	815	1,018	1,132
	Exchangeable Potassium (cmol$_+$/kg)		1.4	0.46	0.40	1.1	0.88	0.70
	Exchangeable Potassium (kg/ha)		1,241	400	349	940	771	614
	Exchangeable Potassium (mg/kg)		554	179	156	420	344	274
	Exchangeable Sodium (cmol$_+$/kg)		0.62	3.2	4.2	1.1	1.8	3.5
	Exchangeable Sodium (kg/ha)		321	1,661	2,148	542	907	1,795
	Exchangeable Sodium (mg/kg)		143	742	959	242	405	801
	Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	0.53	0.02	0.02	0.02	0.01	0.02
	Exchangeable Aluminium (kg/ha)		106	3.3	3.4	3.7	2.8	3.3
	Exchangeable Aluminium (mg/kg)		47	1.5	1.5	1.7	1.3	1.5
	Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.46	<0.01	<0.01	<0.01	<0.01	<0.01
	Exchangeable Hydrogen (kg/ha)		10	<1	<1	<1	<1	<1
	Exchangeable Hydrogen (mg/kg)		4.6	<1	<1	<1	<1	<1
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	7.4	22	24	21	24	26
	Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	41	41	37	59	53	47
	Magnesium (%)		18	42	44	31	35	36
	Potassium (%)		19	2.1	1.6	5.0	3.7	2.7
	Sodium - ESP (%)		8.5	15	17	4.9	7.4	14
	Aluminium (%)		7.2	0.07	0.07	0.09	0.06	0.06
	Hydrogen (%)		6.3	0.00	0.00	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol$_+$/kg)	2.3	0.97	0.83	1.9	1.5	1.3

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27 samples supplied by Minesoils Pty. Ltd. on 14/01/2021. Lab Job No.K2353
Analysis requested by Clayton Richards. Your Job: MS-054 Soils
PO BOX 11034 TAMWORTH NSW 2340

	Parameter	Method reference	Sample 13	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18
	Sample ID:		DS-4 0-10	DS-4 30-40	DS-4 65-75	DS-5a 0-10	DS-5a 30-40	DS-5a 65-75
	Crop:		N/G	N/G	N/G	N/G	N/G	N/G
	Client:		Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
			K2353/13	K2353/14	K2353/15	K2353/16	K2353/17	K2353/18
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	0.74	..	..	<0.5	..	..
	Manganese (mg/kg)		181	..	..	29	..	..
	Iron (mg/kg)		98	..	..	89	..	..
	Copper (mg/kg)		1.2	..	..	2.1	..	..
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	1.1	..	..	1.1	..	..
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	52	..	..	56	..	..
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	1.7	..	..	1.3	..	..
	Total Nitrogen (%)		0.11	..	..	0.10	..	..
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	16	..	..	13	..	..
	Basic Texture	**Inhouse S65	Clay	..	..	Clay	..	..
	Basic Colour		Grey	..	..	Brownish	..	..
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	143	63	111	83	48	55
	Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	2	2	2	2	2	2
	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 4/1 Dark Gray	5 YR 3/1 Very Dark Gray	7.5 YR 2.5/1 Black
	Mottles Munsell Colour		..	..	..	..	..	..
	Degree of Mottling (%)		..	..	..	..	..	..

Notes:

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3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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AGRICULTURAL SOIL ANALYSIS REPORT

27 samples supplied by Minesoils Pty. Ltd. on 14/01/2021. Lab Job No.K2353
Analysis requested by Clayton Richards. Your Job: MS-054 Soils
PO BOX 11034 TAMWORTH NSW 2340

	Parameter		Method reference	Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24
	Sample ID:			DS-5b 0-10	DS-5b 30-40	DS-5b 65-75	DS-6 0-10	DS-6 30-40	DS-6 65-75
	Crop:			N/G	N/G	N/G	N/G	N/G	N/G
	Client:			Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
				K2353/19	K2353/20	K2353/21	K2353/22	K2353/23	K2353/24
	Soluble Calcium (mg/kg)		**Inhouse S10 - Morgan 1	2,647	..	..	402	..	..
	Soluble Magnesium (mg/kg)			536	..	..	96	..	..
	Soluble Potassium (mg/kg)			49	..	..	189	..	..
	Soluble Phosphorus (mg/kg)			1.4	..	..	1.6	..	..
	Phosphorus (mg/kg P)		**Rayment & Lyons 2011 - 9E2 (Bray 1)	7.1	..	..	25	..	..
			**Rayment & Lyons 2011 - 9B2 (Colwell)	14	..	..	88	..	..
			**Inhouse S3A (Bray 2)	14	..	..	47	..	..
	Nitrate Nitrogen (mg/kg N)		**Inhouse S37 (KCl)	5.0	..	..	21	..	..
	Ammonium Nitrogen (mg/kg N)			1.2	..	..	1.2	..	..
	Sulfur (mg/kg S)			23	..	..	18	..	..
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	9.21	9.32	8.18	5.28	6.72	8.55
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.351	0.954	3.714	0.127	0.049	0.113
	Estimated Organic Matter (% OM)		**Calculation: Total Carbon x 1.75	0.96	..	..	3.2	..	..
	Exchangeable Calcium	(cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	19	14	28	4.5	4.5	7.7
		(kg/ha)		8,442	6,133	12,604	2,009	2,010	3,438
		(mg/kg)		3,769	2,738	5,627	897	897	1,535
	Exchangeable Magnesium	(cmol+/kg)		7.2	8.3	8.8	1.2	3.0	8.1
		(kg/ha)		1,956	2,256	2,388	339	809	2,196
		(mg/kg)		873	1,007	1,066	151	361	981
	Exchangeable Potassium	(cmol+/kg)		0.51	0.35	0.42	1.1	0.44	0.47
		(kg/ha)		447	308	364	999	387	409
		(mg/kg)		199	137	163	446	173	182
	Exchangeable Sodium	(cmol+/kg)		4.2	9.4	15	0.45	1.1	3.4
		(kg/ha)		2,150	4,865	7,600	232	581	1,732
		(mg/kg)		960	2,172	3,393	103	260	773
	Exchangeable Aluminium	(cmol+/kg)	**Inhouse S37 (KCl)	<0.01	0.01	0.02	0.46	0.13	0.02
		(kg/ha)		1.8	2.1	3.9	92	26	3.8
		(mg/kg)		<1	<1	1.7	41	12	1.7
	Exchangeable Hydrogen	(cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	0.33	<0.01	<0.01
		(kg/ha)		<1	<1	<1	7.3	<1	<1
		(mg/kg)		<1	<1	<1	3.3	<1	<1
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	31	32	52	8.1	9.1	20
	Calcium (%)		**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	61	43	54	55	49	39
	Magnesium (%)			23	26	17	15	32	41
	Potassium (%)			1.7	1.1	0.80	14	4.8	2.4
	Sodium - ESP (%)			14	30	28	5.6	12	17
	Aluminium (%)			0.03	0.03	0.04	5.6	1.4	0.10
	Hydrogen (%)			0.00	0.00	0.00	4.0	0.00	0.00
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol+/kg)	2.6	1.6	3.2	3.6	1.5	0.95

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Analysis requested by Clayton Richards. Your Job: MS-054 Soils
PO BOX 11034 TAMWORTH NSW 2340

	Parameter	Method reference	Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24
	Sample ID:		DS-5b 0-10	DS-5b 30-40	DS-5b 65-75	DS-6 0-10	DS-6 30-40	DS-6 65-75
	Crop:		N/G	N/G	N/G	N/G	N/G	N/G
	Client:		Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
			K2353/19	K2353/20	K2353/21	K2353/22	K2353/23	K2353/24
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	<0.5	..	..	<0.5	..	..
	Manganese (mg/kg)		3.9	..	..	97	..	..
	Iron (mg/kg)		9.0	..	..	96	..	..
	Copper (mg/kg)		0.85	..	..	1.1	..	..
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	1.7	..	..	0.98	..	..
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	14	..	..	64	..	..
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	0.55	..	..	1.8	..	..
	Total Nitrogen (%)		0.03	..	..	0.11	..	..
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	18	..	..	16	..	..
	Basic Texture	**Inhouse S65	Clay	..	..	Clay Loam	..	..
	Basic Colour		Brownish	..	..	Brownish	..	..
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	225	611	2,377	82	32	72
	Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	2	2	2	3	2	1
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10 YR 4/4 Dark Yellowish Brown	10 YR 6/3 Pale Brown	10 YR 5/3 Brown	5 YR 3/4 Dark Reddish Brown	5 YR 3/4 Dark Reddish Brown	7.5 YR 4/6 Strong Brown
	Mottles Munsell Colour		..	..	..	..	..	..
	Degree of Mottling (%)		..	..	..	..	..	..

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
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PO BOX 11034 TAMWORTH NSW 2340

			Sample 25	Sample 26	Sample 27	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	DS-7 0-10	DS-7 30-40	DS-7 65-75				
		Crop:	N/G	N/G	N/G				
		Client:	Umwelt	Umwelt	Umwelt	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter	**Method reference**	**K2353/25**	**K2353/26**	**K2353/27**	**Indicative guidelines - refer to Notes 6 and 8**			
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	381	..	..	*1150*	*750*	*375*	*175*
	Soluble Magnesium (mg/kg)		96	..	..	*160*	*105*	*60*	*25*
	Soluble Potassium (mg/kg)		320	..	..	*113*	*75*	*60*	*50*
	Soluble Phosphorus (mg/kg)		1.3	..	..	*15*	*12*	*10*	*5.0*
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	11	..	..	*45 note 8*	*30 note 8*	*24 note 8*	*20 note 8*
		**Rayment & Lyons 2011 - 9B2 (Colwell)	41	..	..	*80*	*50*	*45*	*35*
		**Inhouse S3A (Bray 2)	22	..	..	*90 note 8*	*60 note 8*	*48 note 8*	*40 note 8*
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	10	..	..	*15*	*13*	*10*	*10*
	Ammonium Nitrogen (mg/kg N)		1.6	..	..	*20*	*18*	*15*	*12*
	Sulfur (mg/kg S)		5.8	..	..	*10.0*	*8.0*	*8.0*	*7.0*
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.93	8.42	8.77	*6.5*	*6.5*	*6.3*	*6.3*
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.136	0.067	0.086	*0.200*	*0.150*	*0.120*	*0.100*
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	3.3	..	..	*> 5.5*	*>4 .5*	*> 3.5*	*> 2.5*
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	3.6	8.5	9.2	*15.6*	*10.8*	*5.0*	*1.9*
	Exchangeable Calcium (kg/ha)		1,603	3,803	4,144	*7000*	*4816*	*2240*	*840*
	Exchangeable Calcium (mg/kg)		716	1,698	1,850	*3125*	*2150*	*1000*	*375*
	Exchangeable Magnesium (cmol+/kg)		1.2	7.3	8.9	*2.4*	*1.7*	*1.2*	*0.60*
	Exchangeable Magnesium (kg/ha)		329	1,986	2,415	*650*	*448*	*325*	*168*
	Exchangeable Magnesium (mg/kg)		147	886	1,078	*290*	*200*	*145*	*75*
	Exchangeable Potassium (cmol+/kg)		1.7	0.61	0.61	*0.60*	*0.50*	*0.40*	*0.30*
	Exchangeable Potassium (kg/ha)		1,465	531	533	*526*	*426*	*336*	*224*
	Exchangeable Potassium (mg/kg)		654	237	238	*235*	*190*	*150*	*100*
	Exchangeable Sodium (cmol+/kg)		0.62	2.1	3.0	*0.3*	*0.26*	*0.22*	*0.11*
	Exchangeable Sodium (kg/ha)		319	1,081	1,531	*155*	*134*	*113*	*57*
	Exchangeable Sodium (mg/kg)		142	482	684	*69*	*60*	*51*	*25*
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.07	0.02	0.02	*0.6*	*0.5*	*0.4*	*0.2*
	Exchangeable Aluminium (kg/ha)		13	4.9	4.6	*121*	*101*	*73*	*30*
	Exchangeable Aluminium (mg/kg)		6.0	2.2	2.1	*54*	*45*	*32*	*14*
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	*0.6*	*0.5*	*0.4*	*0.2*
	Exchangeable Hydrogen (kg/ha)		<1	<1	<1	*13*	*11*	*8*	*3*
	Exchangeable Hydrogen (mg/kg)		<1	<1	<1	*6*	*5*	*4*	*2*
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	7.1	18	22	*20.1*	*14.3*	*7.8*	*3.3*
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	50	46	43	*77.6*	*75.7*	*65.6*	*57.4*
	Magnesium (%)		17	39	41	*11.9*	*11.9*	*15.7*	*18.1*
	Potassium (%)		23	3.3	2.8	*3.0*	*3.5*	*5.2*	*9.1*
	Sodium - ESP (%)		8.7	11	14	*1.5*	*1.8*	*2.9*	*3.3*
	Aluminium (%)		0.93	0.13	0.11	*6.0*	*7.1*	*10.5*	*12.1*
	Hydrogen (%)		0.00	0.00	0.00				
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	3.0	1.2	1.0	*6.5*	*6.4*	*4.2*	*3.2*

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	Sample ID:		DS-7 0-10	DS-7 30-40	DS-7 65-75				
	Crop:		N/G	N/G	N/G				
	Client:		Umwelt	Umwelt	Umwelt	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
			K2353/25	K2353/26	K2353/27	Indicative guidelines - refer to Notes 6 and 8			
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	0.54	..	..	*6.0*	*5.0*	*4.0*	*3.0*
	Manganese (mg/kg)		69	..	..	*25*	*22*	*18*	*15*
	Iron (mg/kg)		129	..	..	*25*	*22*	*18*	*15*
	Copper (mg/kg)		1.1	..	..	*2.4*	*2.0*	*1.6*	*1.2*
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.68	..	..	*2.0*	*1.7*	*1.4*	*1.0*
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	51	..	..	*50*	*45*	*40*	*35*
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	1.9	..	..	*> 3.1*	*> 2.6*	*> 2.0*	*> 1.4*
	Total Nitrogen (%)		0.11	..	..	*> 0.30*	*> 0.25*	*> 0.20*	*> 0.15*
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	17	..	..	*10–12*	*10–12*	*10–12*	*10–12*
	Basic Texture	**Inhouse S65	Clay Loam	..	..	..	..	..	..
	Basic Colour		Brownish	..	..	..	..	..	..
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	87	43	55	..	..	..	..
	Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	3	2	1	*Class 3–8*			
	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	..	..	..	..
	Mottles Munsell Colour		..	..	..	..	..	..	..
	Degree of Mottling (%)		..	..	..	..	..	..	..

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