



Taroborah Coal Project

Appendix 7 – Soil and Land Suitability Assessment





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LIST OF ABBREVIATIONS

%	-	percent
°C	-	Degrees Celsius
CEC	-	Cation Exchange Capacity
cm	-	Centimetres
DEHP	-	Department of Environment and Heritage Protection
DHLGP	-	Department of Housing, Local Government and Planning
DIP	-	Department of Infrastructure and Planning
DME	-	Department of Minerals and Energy
dS / m	-	deciSiemens per metre
EC	-	Electrical Conductivity
EIS	-	Environmental Impact Statement
EPC	-	Exploration Permit for Coal
ESP	-	Exchangeable Sodium Percentage
g	-	gram
GPS	-	Global Positioning System
ha	-	Hectare
hr	-	Hour
K	-	Potassium
kg	-	kilograms
km	-	kilometres
LRAs	-	Land Resource Areas
m	-	metres
mEq / 100g	-	milliequivalents per one hundred grams
mEq	-	milliequivalents
mg/kg	-	milligrams per kilogram

mg	-	milligrams
MLA	-	Mining Lease Application
mm	-	millimetre
NATA	-	National Association of Testing Authorities
P	-	Phosphorus
PAWC	-	Plant Available Water Content
pH	-	Power of Hydrogen
ppm	-	Parts per million
Qa	-	Quaternary alluvium
SCL	-	Strategic Cropping Land
SLSA	-	Soil and Land Suitability Assessment
SMU	-	Soil Management Unit
SPP	-	State Planning Policy
TOR	-	Terms of Reference

EXECUTIVE SUMMARY

Introduction

AustralAsian Resource Consultants Pty Ltd was commissioned by Shenhua International Group Pty Ltd to conduct a Soil and Land Suitability Assessment for the proposed Taraborah Coal Project. This assessment was to determine the environmental values of soil and land resources on the Project Site. An assessment of the occurrence of Strategic Cropping Land on the project area was also made.

Method

Soil resources at the Project site were assessed through the classification, testing and mapping of soils and description of the terrain in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (Department of Minerals and Energy 1995). Soils were described according to the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain 2009) and the *Australian Soil Classification* (Isbell 2002).

Information was presented according to the standards required by the *Planning Guidelines: Identification of Good Quality Agricultural Land* (Department of Housing and Local Government Planning 1993) and the *State Planning Policy 1/92: Development and the Conservation of Agricultural Land* (Department of Housing and Local Government Planning 1992).

Physical and chemical properties of the soil samples were assessed to determine how these could potentially influence erosion potential, storm water run-off quality, agricultural productivity and rehabilitation. The physical and chemical soil properties also helped to determine the Land Suitability of the Project area for cattle grazing and rainfed broadacre cropping.

Baseline Soil and Land Resource Assessment

Three field surveys were undertaken between December 2011 and September 2012 totalling 16 days. During these surveys, primary sampling was conducted at 62 locations within the Taraborah EIS study area. At each location, sample holes were excavated to a maximum depth of 150 centimetres (where possible) and samples were collected at a maximum of six depths throughout the profile. Sample holes were then grouped according to their observed properties and a selection of representative samples of each grouping were sent for further chemical and physical analysis at a National Association of Testing Authorities registered laboratory. A total of 148 samples were sent for further analysis. Laboratory data, field observations and land resource information consisting of published literature (Bureau of Rural Science, 1991; Northcote *et al.* 1960 – 1968; McKenzie *et al.* 2004; Isbell 2002) and land management manuals (Gray and Macnish 1985) were consulted in order to help identify distinct soil management units within the Taraborah Project area.

Based on field and laboratory assessments, eight Soil Management Units were identified within the Taraborah Project area. These were classified as the Orion/Jimbaroo, Adelong, Adelong/College, Rolleston/Glengallan, College/Lascelles, Glengallan, Glen Idol and Jimbaroo Soil Management Units.

The Adelong/College, Rolleston/Glengallan, and College/Lascelles exhibit sodic subsoils with increasing levels of exchangeable sodium within the upper 900 millimetres of the profile. Salinity also increases with depth within these profiles, to levels considered moderate to highly saline by 900-1000 millimetres.



The Orion/Jimbaroo and Jimbaroo soils have low levels of sodium and soluble salts due to the nature of the basaltic parent material from which they have been derived and the fact that these units have high relative relief compared to other soils. The Adelong mapping unit is also low in salts. The Glengallan soil management unit was only described and analysed to 20-30 cm due to the presence of rock at shallow depth. Deeper variants of this soil are present in some site locations. These are duplex soils possessing sodic subsoils.

All soils present on the Project site are moderately to highly deficient in major soil nutrients. As such, it is recommended that topsoil stockpiles be ripped and seeded to maintain soil biota and a viable seed bank. An application of an appropriate fertiliser will also enhance the growing medium.

Topsoil Stripping Depths

Useable soil resources are mainly confined to the surficial horizons and locally in the upper part of the subsurface horizons which contain seed-stock, micro-organisms and nutrients necessary for plant growth. The following list presents the Soil Management Units in terms of the quality of their topsoil resource (from most to least suitable) and outlines their recommended stripping depths:

- Orion/Jimbaroo Soil Management Unit – 60 cm;
- Jimbaroo Soil Management Unit – 20 cm;
- Adelong/College Soil Management Unit – 30 cm;
- Rolleston/Glengallan Soil Management Unit – 10 cm;
- College/Lascelles Soil Management Unit – 30 cm;
- Glengallan Soil Management Unit – 10 cm;
- Glen Idol Soil Management Unit – 30 cm; and
- Adelong Soil Management Unit – 30 cm.

Note that operationally shallow stripping depths of 10 cm may not be achievable and the minimum stripping depth may actually be 20 cm.

The physiochemical properties of the Adelong/College, Rolleston/Glengallan, College/Lascelles, and Glengallan Soil Management Units predispose these soils to dispersion under adverse conditions. In disturbed areas these soils are likely to be prone to local occurrences of sheet, rill and gully erosion due to uncontrolled surface water runoff from hard setting surface soils. Over time this will inevitably lead to exposure of strongly dispersive subsoil layers exacerbating land degradation.

The Orion/Jimbaroo and Jimbaroo soils are vulnerable to erosion due to their relatively high position within the landscape. Additionally, these soils are unstable because they are often left fallow prior to or after cultivation. The Glen Idol soil has no subsoil constraints with the exception of relatively low calcium/magnesium ratios, which suggest that these soils may disperse when wet.

Pre-Mine Land Suitability Assessment

The pre-mining land use suitability of these eight soil types was assessed and in general, most soil types were suitable for grazing purposes. The Orion/Jimbaroo, Adelong, Adelong/College, and College/Lascelles are considered suitable with moderate limitations for Beef Cattle Grazing. The

Rolleston/Glengallan and Glen Idol soils are considered marginally suitable for grazing, whilst the Glengallan is considered unsuitable for grazing having extreme limitations for this land use.

The Orion/Jimbaroo, Adelong/College, and College/Lascelles soils were considered suitable, with moderate limitations, for rainfed broadacre cropping. The Adelong, Rolleston/Glengallan and Glen Idol soils are considered marginally suitable with severe limitations for cropping whilst the Glengallan and Jimbaroo soils are considered unsuitable for cropping with extreme limitations.

Nutrient deficiency and plant available water capacity were the main factors limiting the amount of land on the Project site from supporting rainfed broadacre cropping as a sustainable land use. Some areas were limited to improved pasture production due to other limitations such as soil depth and erosion potential. Small areas can only tolerate light grazing with a reduced carrying capacity. Notwithstanding the classification arrived at in this report, successful cattle grazing will always be more viable during periods of favourable climatic conditions.

Assessment of Good Quality Agricultural Land

The findings of the land use suitability assessment and investigation into the distribution of 'good quality agricultural lands' indicate that the development of the Taraborah Project is considered to impact on, to a greater or lesser extent, resources of land classified as either:

- a. 'Good Quality Agricultural Land' as per the Department of Environment and Resource Management Land Classification System (Department of Environment and Heritage Protection, 2010); or
- b. Land deemed as suitable for a particular agricultural land use as determined in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (Department of Minerals and Energy 1995).

Strategic Cropping Area

A review of the Strategic Cropping Area mapping for the Taraborah Project found one polygon of approximately 2,050 hectares across the Project mapped as Strategic Cropping Area (SCA). Strategic Cropping Area is defined in the *Regional Planning Interests Act 2014* as those areas identified as strategic cropping land (SCL) on the SCL Trigger map, whereby strategic cropping land means land that is, or is likely to be, highly suitable for cropping because of a combination of the land's soil, climate and landscape features. A Strategic Cropping Land Assessment was therefore undertaken to evaluate the validity of the potential Strategic Cropping Area identified in the Trigger Map. During the soil survey of the project area, the information collected included detail necessary to meet the requirements of Strategic Cropping Land Assessment. The Strategic Cropping Land Assessment determined that only part of the SCA polygon met the criteria of Strategic Cropping Land on the Taraborah Site.

Erosion Control and Topsoil Management

Post mine rehabilitation efforts should attempt to return disturbed areas to a condition as close as practicable to their pre-mining land use suitability.

The following actions are recommended to mitigate any potential risk of soil erosion on site and maximise topsoil quality for rehabilitation:

- At any one time, only the minimum area of land required to maintain the safe and efficient operation of the Project should be cleared;
- Land that has been assigned for clearance should be surveyed, marked out and signed off by an appropriate person prior to clearing, in order to ensure no significant areas are inadvertently and unnecessarily disturbed;
- Topsoil stripping should be undertaken only to the depths specified so as to avoid disturbance of potentially erosive surface or subsoil layers;
- Sediment dams or stormwater dams should be installed for all cleared areas and areas of mine or processing infrastructure;
- Runoff from more elevated, undisturbed areas should be directed around disturbed areas and topsoil stockpiles;
- Stockpiles should be ripped and seeded with a quick establishment pasture species to limit erosion and maintain a viable seed bank, if the period of stockpiling is greater than one growing season or six months;
- The spoil emplacement will be rehabilitated progressively to minimise the total disturbed area on the site at any time;
- Rehabilitated spoil emplacement areas will be deep ripped along the contour to maximise rainfall infiltration and minimise runoff;
- Rehabilitated slopes will have contour drains to minimise slope lengths and runoff velocities; and
- Runoff from rehabilitated areas will be collected in both contour and collection drains, then directed to sediment dams and settling ponds in order remove suspended sediment prior to discharge from the site.

1.0 INTRODUCTION

AustralAsian Resource Consultants Pty Ltd was commissioned by Shenhua International Group Pty Ltd to conduct a Soil and Land Suitability Assessment for the proposed Taraborah Coal Project. This assessment was to determine the environmental values of soil and land resources on the Project Site. An assessment of the occurrence of Strategic Cropping Land on the project area was also undertaken.

This report aims to address the Final Terms of Reference (August 2012) for the Environmental Impact Statement (EIS) for the Project.

1.1 SCOPE OF WORKS

In assessing the environmental values of soil and land resources within the Taraborah Project area, the objectives of the Soil and Land Suitability Assessment (SLSA) were to:

- Collect baseline data for soil types found on the Project site by compiling a land resource inventory. This is achieved through description of the surrounding landscape and soil profile, chemical and physical testing, soil type classification and development of a soils map in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (Department of Minerals and Energy (DME) 1995). Soils were described according to the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain 2009) and the *Australian Soil Classification* (Isbell 2002);
- Present the information according to the standards required by the *Planning Guidelines: Identification of Good Quality Agricultural Land* (Department of Housing and Local Government Planning (DHLGP) 1993) and the *State Planning Policy 1/92: Development and the Conservation of Agricultural Land* (DHLGP 1992);
- Make an appraisal of the depth and quality of the topsoil; including physical and chemical properties of the soil and how these influence erosion potential, storm water run-off quality, agricultural productivity and rehabilitation;
- Determine the Agricultural Land Use Suitability of the Project area in accordance with the requirements of the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME 1995);
- Determine the presence or absence of Strategic Cropping Land in accordance with the requirements of the *Strategic Cropping Land Act 2011*; and
- Provide information on the lateral and vertical distribution of soils suitable for rehabilitation, in order to assist in the development of soil stripping and management guidelines for the proposed disturbance areas.

2.0 PROJECT AND SITE DESCRIPTION

2.1 PROJECT LOCATION AND DESCRIPTION

The Taraborah Project Site is located in the Bowen Basin of central inland Queensland, approximately 22 km west of Emerald (as shown in Figure 1 and Figure 2). The site is situated approximately 290 km west of Rockhampton, and 390 km west of Gladstone. Access to the Project site is via the Capricorn Highway. Current land uses include rainfed broadacre cropping, low intensity cattle grazing, horse and goat grazing and coal exploration.

Whilst the Project Site is wholly covered by Mineral Development Licence (MDL) 467, it is comprised of two components separated by the Capricorn Highway and Central West Rail System. The southern section will comprise an open cut pit, coal processing plant, rail loading facility and underground portal. The northern section will only have underground operations and facilities. The area of the Project Site to which this report relates to is shown in Figure 3.



Figure 1 Regional Project Location

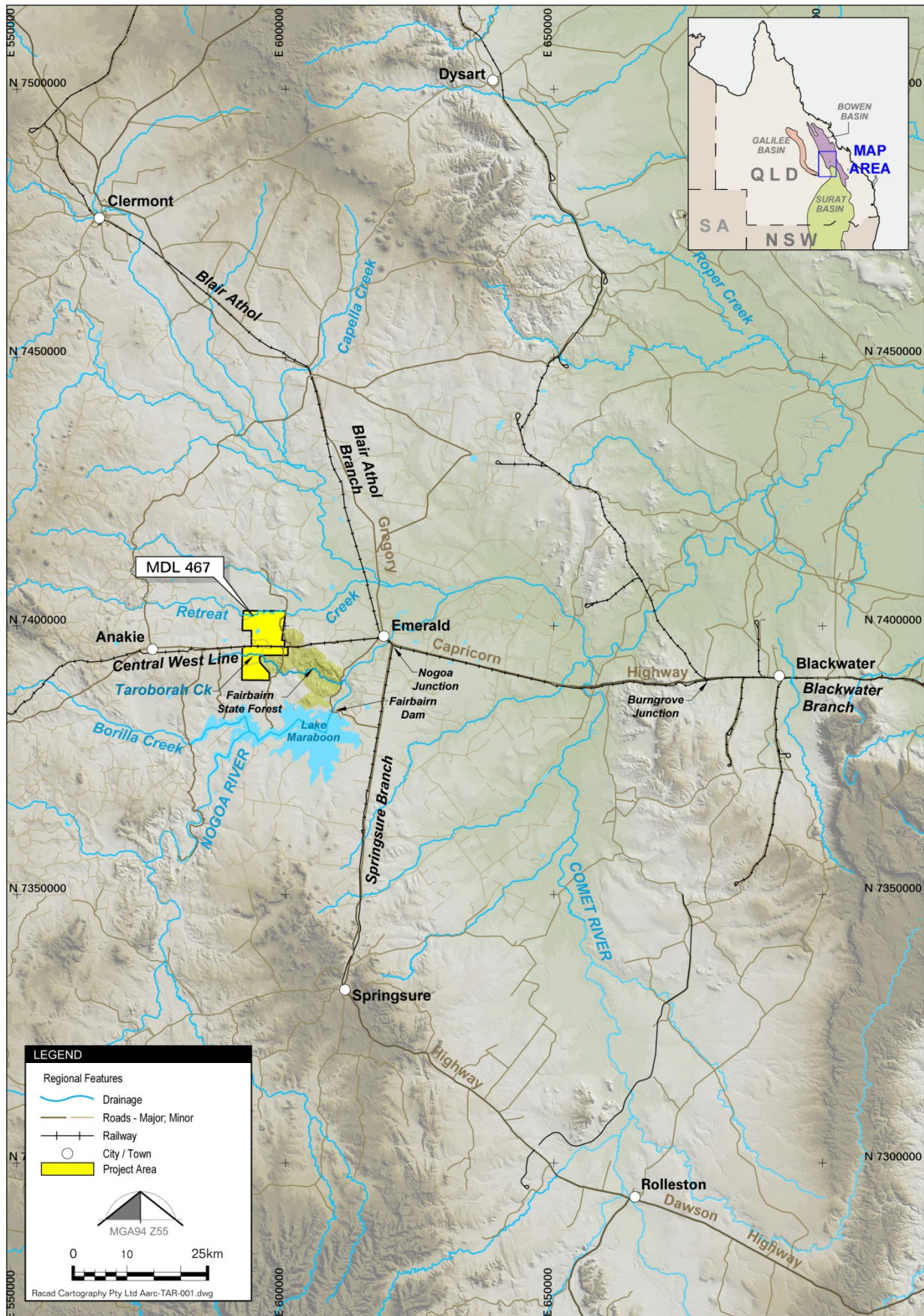


Figure 2 Local Project Location

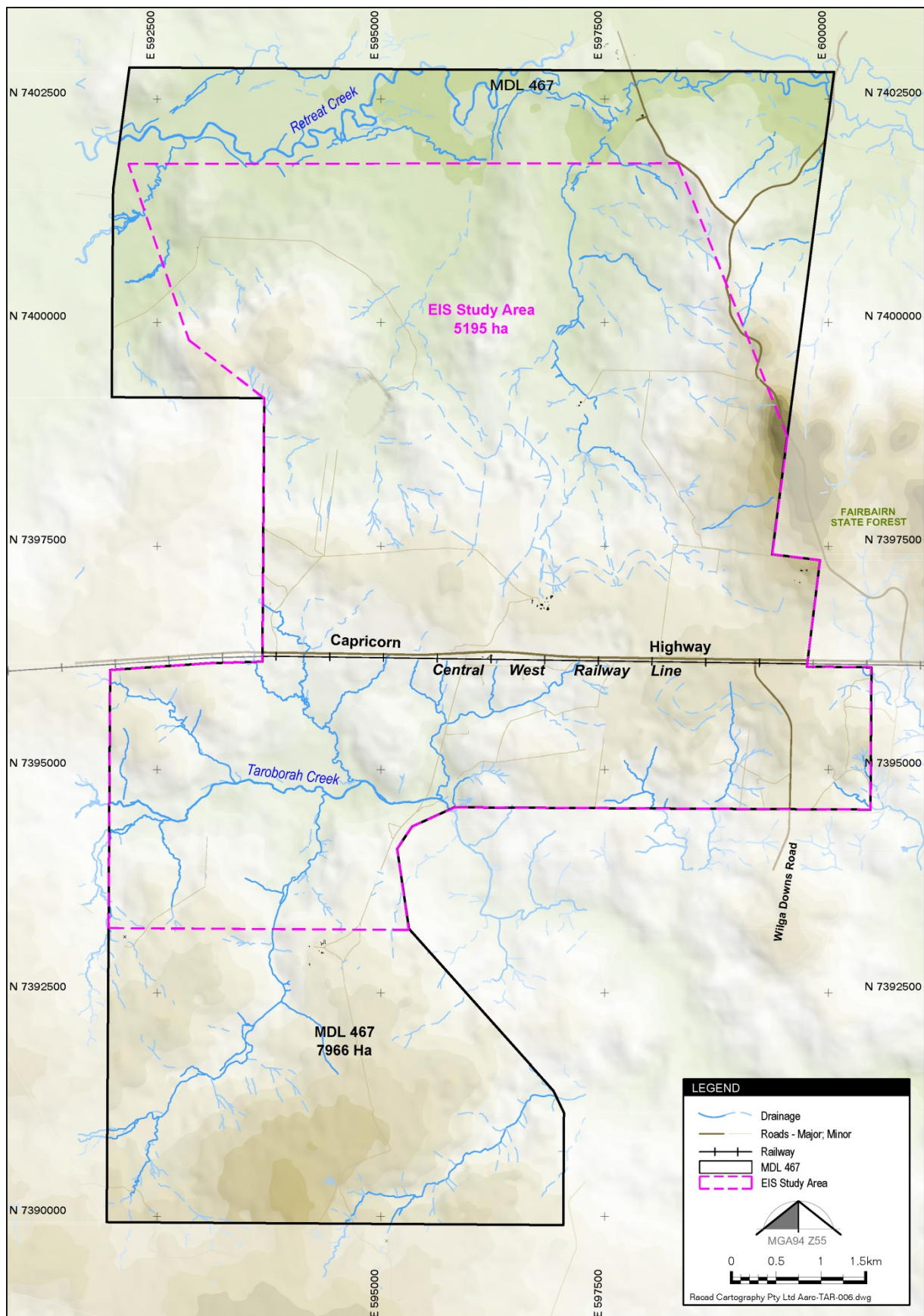


Figure 3 Taraborah Project Site

2.2 LOCAL TOPOGRAPHY, LANDFORMS AND REGIONAL GEOLOGY

The Anakie Inlier sheet at a scale of 1:100,000 indicate that the geology of the area is predominantly Tertiary Basalt and younger Tertiary and Quaternary Alluvial materials overlying Permian Sandstones, which are exposed below the Tertiary weathered zone. The older alluvium occupies areas that are no longer influenced by fluvial geomorphology; however, the younger Quaternary Alluvium is influenced by recent surface hydrological events. Each unit can be described as follows:

- Quaternary Alluvium (Qa) – Alluvium typically consisting of unconsolidated gravel, sand, silt and clay. The alluvial characteristics will be specific to active creeks and wetlands within the study area and to the nature of the weathered material making up the alluvium;
- Tertiary Basalt consisting of olivine and other mafic minerals laid down in the Tertiary period that has since weathered and eroded over large areas leaving residual basalt capped hills and plateaus as well as significant quantities of basaltic alluvium draining these basalt landscapes;
- Tertiary/Quaternary colluvium and alluvium being of older age and made up of soil, sand and gravels dominated by weathered basaltic material; and
- Aldebaran sandstone, lower to upper Permian in age, terrestrial deposits laid down as fluvial and deltaic sands and coal measures.

Figure 4 illustrates the geological distribution across the Project site at a scale of 1:100,000.

The topography of the area is relatively flat being made up of gently undulating alluvial plains and undulating plains and rises made up primarily of basalt and sandstone parent materials. The study area is drained by Retreat Creek to the north and by Taraborah Creek to the south. Retreat Creek is associated with local wetlands draining into the lower braid of Retreat Creek where the local relief is favourable to the ponding of water. These wetlands are ephemeral and dry out when climatic conditions are not favourable. Taraborah Creek to the south drains the south-western and southern portions of the study area below the Capricorn Highway. Several dams within the study area harvest some of the overland flow draining the higher areas and intercept this water before it flows into the larger creeks to the north and south of the study area. The undulating basaltic “Downs” country which has superior soil physical and chemical characteristics is utilised for rainfed broadacre cropping.

The alignment of Retreat and Taraborah Creeks is shown in Figure 5.

The Project Site has an average elevation of approximately 240 metres (m) Australian Height Datum (AHD). The topography on the site reflects much of the surrounding region which has similar geologies and soil types. The general area including the township of Emerald is referred to as the Central Highlands.

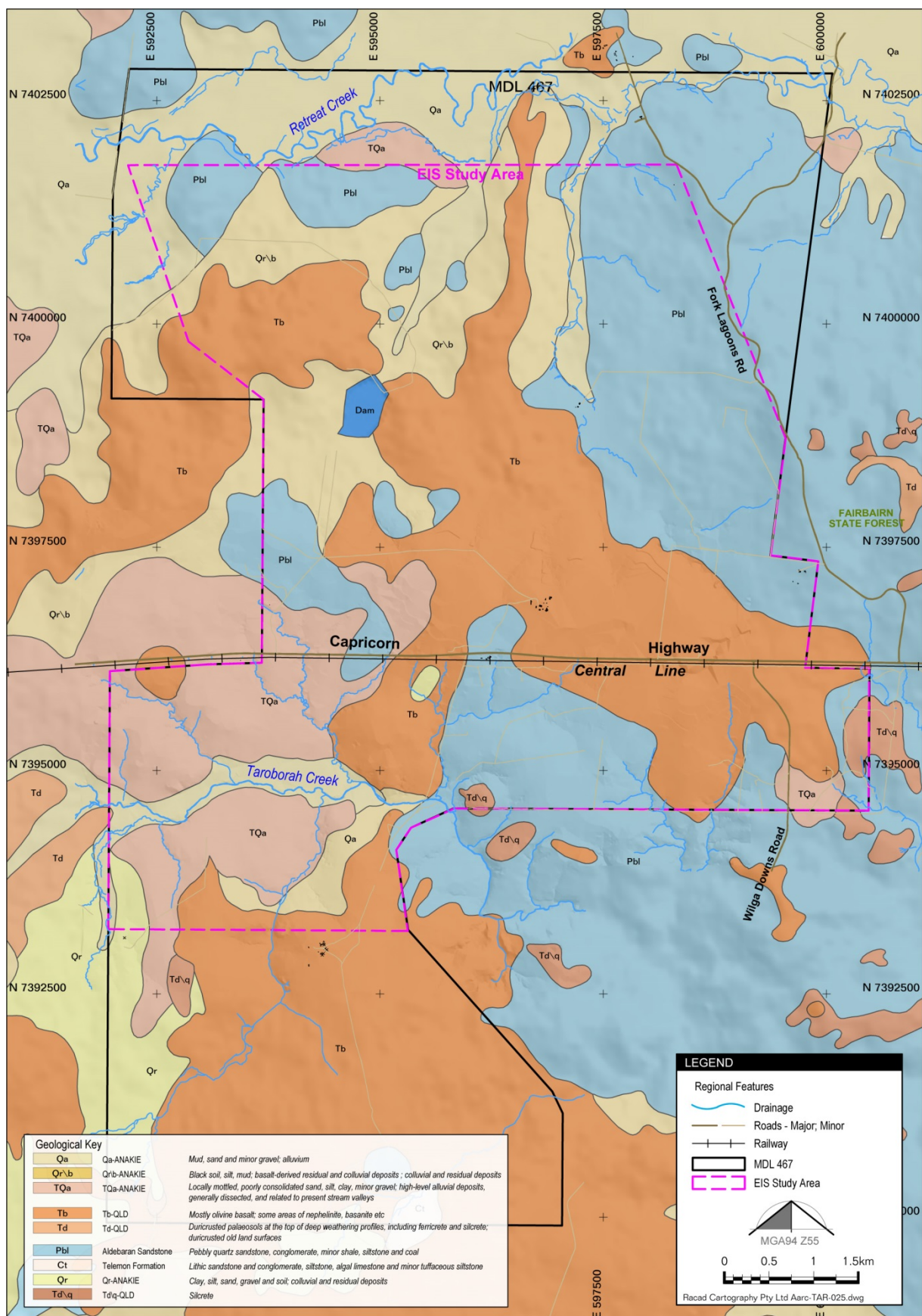


Figure 4 Regional geology surrounding the Taroborah Project

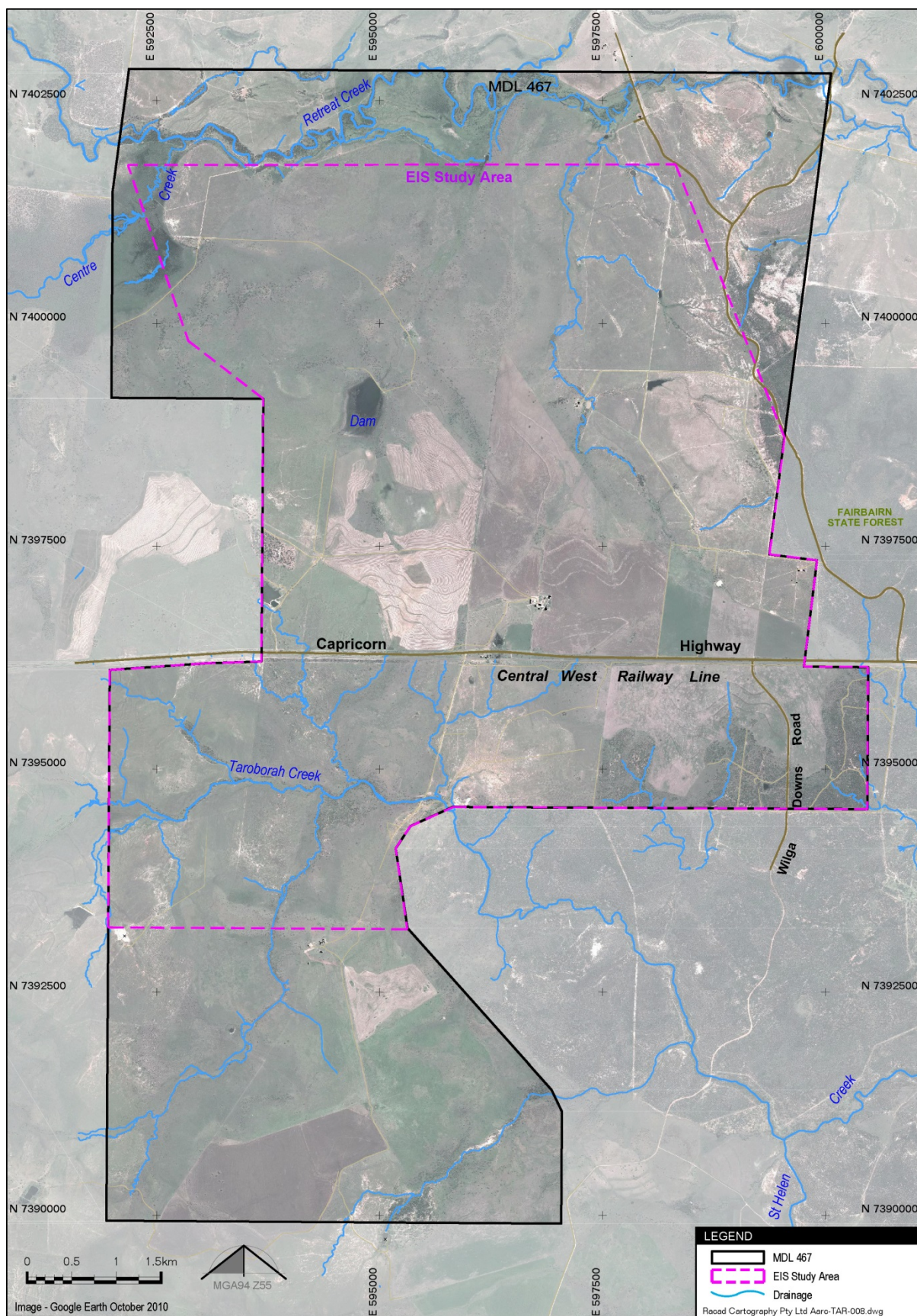


Figure 5 Watercourses Associated with the Project Site

2.3 REGIONAL CLIMATE

Information from the Bureau of Meteorology (www.bom.gov.au) indicates that the average annual rainfall for the region (based on data for the Emerald Airport weather station) is approximately 566.4 millimetres (mm). Rainfall is typically seasonal, with the dry season occurring predominantly from April to September (with an average of 25.1 mm per month) and the wet season peaking between December and February (with an average of 88.4 mm per month).

The coldest period of the year occurs in July, with an average minimum temperature of 8.8 degrees Celsius (°C), and an average maximum of 23.2°C. The warmest month of the year is January, with an average minimum temperature of 22.2°C, and an average maximum of 34.3°C. Moderate winds between 13.7 to 16.3 km per hour (hr) from the east and south-east are predominant in the region. Mean annual rainfall and temperature ranges are shown in Figure 6.

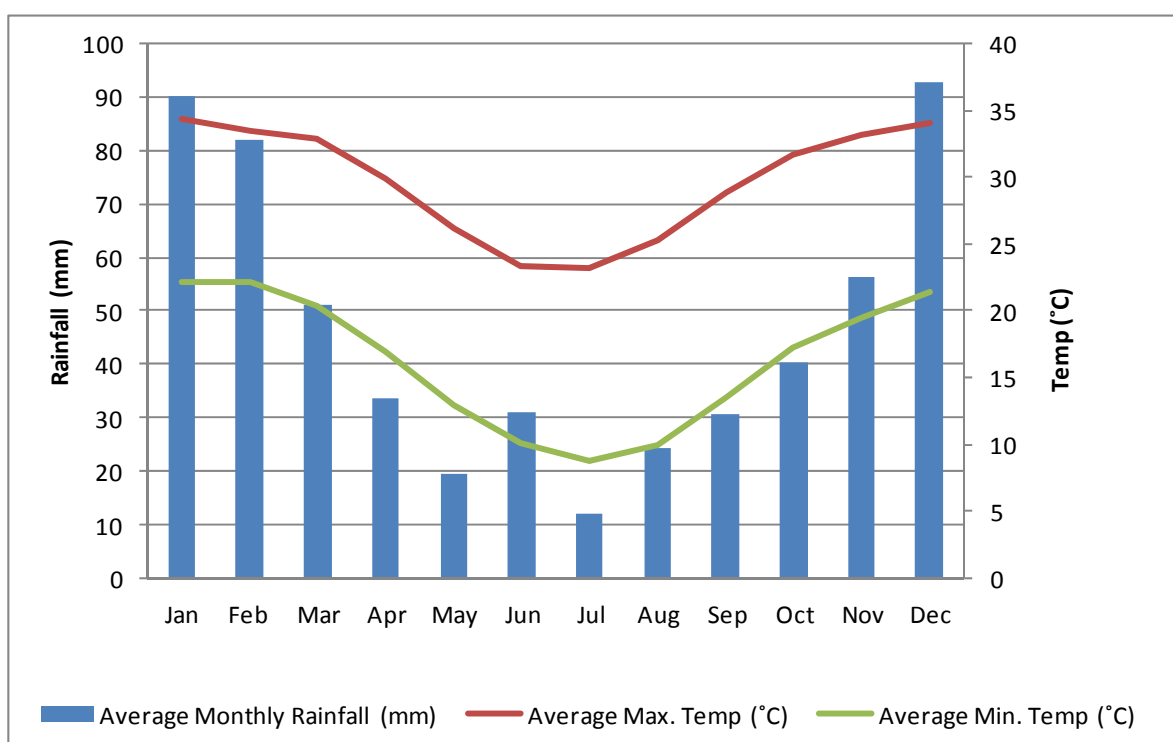


Figure 6 Climograph for Emerald Airport Weather Station (1981 – 2012)

2.4 CURRENT LAND USE AND CONDITION

The dominant current land use within the project area is low to medium intensity cattle grazing enterprises on native and improved pastures. Rainfed, broadacre cropping for cereal production is also a land use within the area. Other less prominent land uses include; regional transport on the Capricorn Highway and Central West Rail System, local transport on unsealed roads, medium intensity goat grazing, residential properties and coal exploration.

3.0 METHODOLOGY

3.1 LITERATURE REVIEW

An initial understanding of the distribution of soils within the region of the Project was gained through the conduct of a literature review. A review of available literature established a limited body of works from which to draw information. These documents also assisted with the classification of soils and land suitability following the field assessment.

Understanding and Managing Soils in the Central Highlands (Thwaites & Maher, 1993) provides a collation of land resource data, mapping of the distribution of Land Resource Areas (LRAs) and describes soils found within the Central Highlands Region of Queensland. LRAs mapped in this publication are at a scale of 1:500,000 and while they provide an indication of the soils types present, they do not map soils at a scale appropriate for this SLSA.

The *Digital Atlas of Australian Soils* (Bureau of Rural Science, 1991) provided a broadscale map of Australia which was originally compiled in the late 1960s. Mapped units in the Atlas are soil landscapes, usually comprising of a number of soil types, but are mapped at a scale of 1:2,000,000. These units are indicative of the soils on site, but are mapped at too broad a scale to accurately assess the distribution of soil types and management units within the Taraborah Project.

The CSIRO publication "*Australian Soils and Landscapes*" (McKenzie et. al. 2004) was also consulted. This document was useful as it provided an illustrated compendium of soils Australia wide but also examples of soils that would be present in the region of the project.

3.2 FIELD STUDY

Field sampling across the Taraborah Project was undertaken during the following periods:

- 12th of December – 17th of December 2011;
- 16th of April 2012 – 22nd of April 2012; and
- 6th of September – 9th of September 2012.

These surveys consisted of primary sampling and secondary visual assessments. Primary sampling involved the extraction of soil samples at a predetermined intensity along a sampling grid. Secondary visual assessments were conducted continuously across the study area while traversing the primary sample grid. Where visual assessments indicated a change in soils conditions outside of the pre-selected sampling grid, an additional primary sample was collected.

Sampling strategies and survey plans were developed in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (herein referred to as the *Technical Guidelines*) (DME 1995) and the *Guidelines for Surveying Soil and Land Resources* (McKenzie et al 2008) (herein referred to as the *Blue Book*).

The survey effort involved the undertaking of detailed profile descriptions with profiles sampled at 62 locations within the 5195 ha study area (see Figure 7 for details). The location of each site was recorded using a Global Positioning System (GPS) with an accuracy of +/- 10m. This intensity of test pits is within the recommended range in accordance with the *Blue Book* for mapping at a high

intensity of 1:25 000. Mapping observations were taken in the field at regular intervals by the soil scientist undertaking the primary sampling program while traversing from sample site to sample site. Although not always formally annotated, these observations served to confirm mapping boundaries, soil-type distributions and areas subject to cultivation. These observations contributed to completing the 1:25 000 scale requirements. This results in an approximate area of 25 ha or less per observation.

Soil cores were excavated to a maximum depth of 1500 mm where possible, using a mechanised vehicle-mounted auger or hand-held soil auger. Soil samples were typically collected at standard depths (National Committee on Soil and Terrain, 2009) throughout the profile; those being 0–100 mm, 200–300 mm, 500–600 mm, 800–900 mm, 1100–1200 mm and 1400–1500 mm. Care was taken to ensure samples were accurately taken from each depth and that samples did not span horizons.

Sampling at regular intervals allowed for quantitative comparisons between chemical and physical parameters following analysis and best meets the data requirements for determining the pre-mining land use suitability in accordance with the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques (DME, 1995).

Each sample was sealed in a clean plastic zip-lock bag, and the bags labelled with the sample site number, date and depth of sampling. At the completion of the field survey, sites were grouped together into similar soil types based on field observation notes, soil physical characteristics and the topographical and vegetation characteristics of the survey site. This methodology, coupled with a site map outlining soil sampling locations, was used to select several representative samples of each soil type for further analysis of their chemical and physical properties. The selected samples were then packaged for transportation to a National Association of Testing Authorities (NATA) registered laboratory for chemical and physical analysis. A total of 148 samples were selected for further laboratory analysis. Appendix A identifies each sampling location and those which were sent for laboratory analysis. Appendix B details the field descriptions and photos of the soil profile at each sampling location.

Following laboratory analysis, soil groupings previously determined by field observation notes, soil physical characteristics, regional geology, topographical and vegetation characteristics of the survey site were compared with the physiochemical results of the laboratory analysis. Soil Management Units were then allocated from “Understanding and Managing Soils in the Central Highlands” (Thwaites & Maher, 1993) based on all available information.

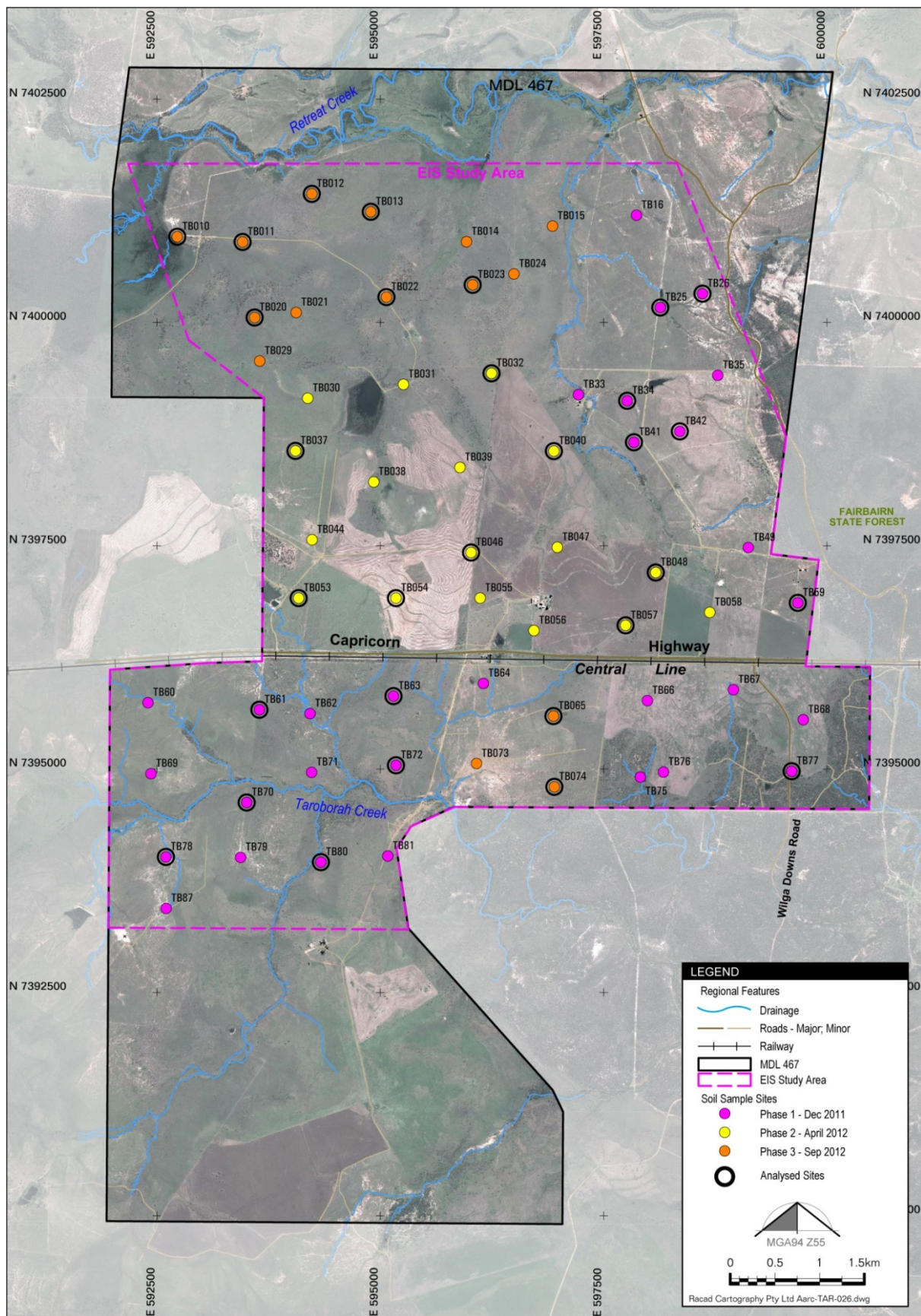


Figure 7 Primary Sampling Locations (Soil Pits) within the Study Area

3.3 SOIL ANALYSIS

A representative selection of 29 survey holes were laboratory tested for the following parameters:

- pH (water);
- Major Elements (Potassium, Nitrate Nitrogen, Phosphorus – Colwell extraction);
- Secondary Elements (Calcium, Magnesium, Sulphur, Aluminium);
- Trace Elements (Boron, Copper, Iron, Manganese, Zinc);
- Organic Carbon;
- Sodium, Chloride;
- Electrical Conductivity; and
- Exchangeable Cations (Aluminium, Calcium, Magnesium, Potassium, Sodium).

Soil analysis also included calculation of the following parameters:

- Cation Exchange Capacity (CEC);
- Calcium / Magnesium Ratio;
- Exchangeable Sodium Percentage (ESP); and
- Dispersion Index.

The soil analysis was conducted by the NATA registered SGS Australia Pty Ltd, which is accredited for analysis of all of the listed parameters. Laboratory analysis reports for all samples analysed are provided in Appendix C. A description of the significance of each parameter and typical values is included in Appendix D.

3.4 ACID SULFATE SOILS ASSESSMENT

State Planning Policy 2/02 – Planning and Managing Development Involving Acid Sulphate Soils (Department of Infrastructure and Planning (DIP) 2002) sets out the State's interests concerning development involving acid sulphate soils in low-lying coastal areas. The policy applies only to certain types of development assessments in a strict list of local government areas as outlined in Annex 1 of the policy. Given that the Project falls outside of these areas, an assessment of the risk of Acid Sulphate Soils is neither relevant nor required.

3.5 SOIL CLASSIFICATION

Soil classification was undertaken using the methodology specified in *The Australian Soil Classification* (Isbell 2002). Based on the characteristics of the soil profile, this classification methodology lists 14 orders of soils. Refer to Appendix E for these soil orders and a brief description of each order.

4.0 RESULTS

4.1 DESCRIPTION OF SOIL MANAGEMENT UNITS

Based on field and laboratory assessments, a total of 9 soil units were confirmed within the MDL, however only 8 are within the disturbance footprint of the Project. The distribution of these Soil Management Units (SMUs) has been mapped at a scale of 1:25,000 in Figure 8. A description of the dominant soil type identified in each management unit is included in the following sections. Appendix F provides a summary of the typical chemical characteristics for each soil management unit. Table 1 quantifies the coverage of each soil management unit within the Project site.

Table 1 Coverage of Each Soil Management Unit

Soil Management Unit	Surface Area (Within EIS Assessment Area)	Approximate Disturbance Area		Percentage of Total Disturbance Area*
	Hectares	Hectares		%
		Underground Activities	Above Ground Activities	
Orion/Jimbaroo	1831	1010.7	173.3	46.11
Adelong	55.04	54.9	0	2.14
Adelong/College	1028.1	390.5	100.8	19.13
Rolleston/Glengallan	1245.8	531.8	178.9	27.68
College/Lascelles	488	0	0.2	0.01
Glengallan	357.6	79.1	15.0	3.66
Glen Idol	153.6	4.3	0	0.17
Jimbaroo	39.55	0	28.4	1.11
Pickardy	30.74	0	0	0.00
		2071.3	496.6	
Total	5229.43	2567.9		100

*Percentage rounded to two decimal places

The following descriptions are a combination of data collected in the field and information taken from *Understanding and Managing Soils in the Central Highlands* (Thwaites & Maher, 1993). Chemical data is assessed using *Interpreting Soil Test Results* (Hazelton & Murphy, 2007) and *Salinity Management Handbook* (SALCON, 1997).

Several SMUs are made up of two different soil types. These are soil associations with a dominant soil and sub-dominant soil contained within mapped polygons. Variability within these SMUs was such that a single soil type could not represent a single polygon. These associations typically contain 70% of the dominant soil type and 30% of the sub-dominant soil type.

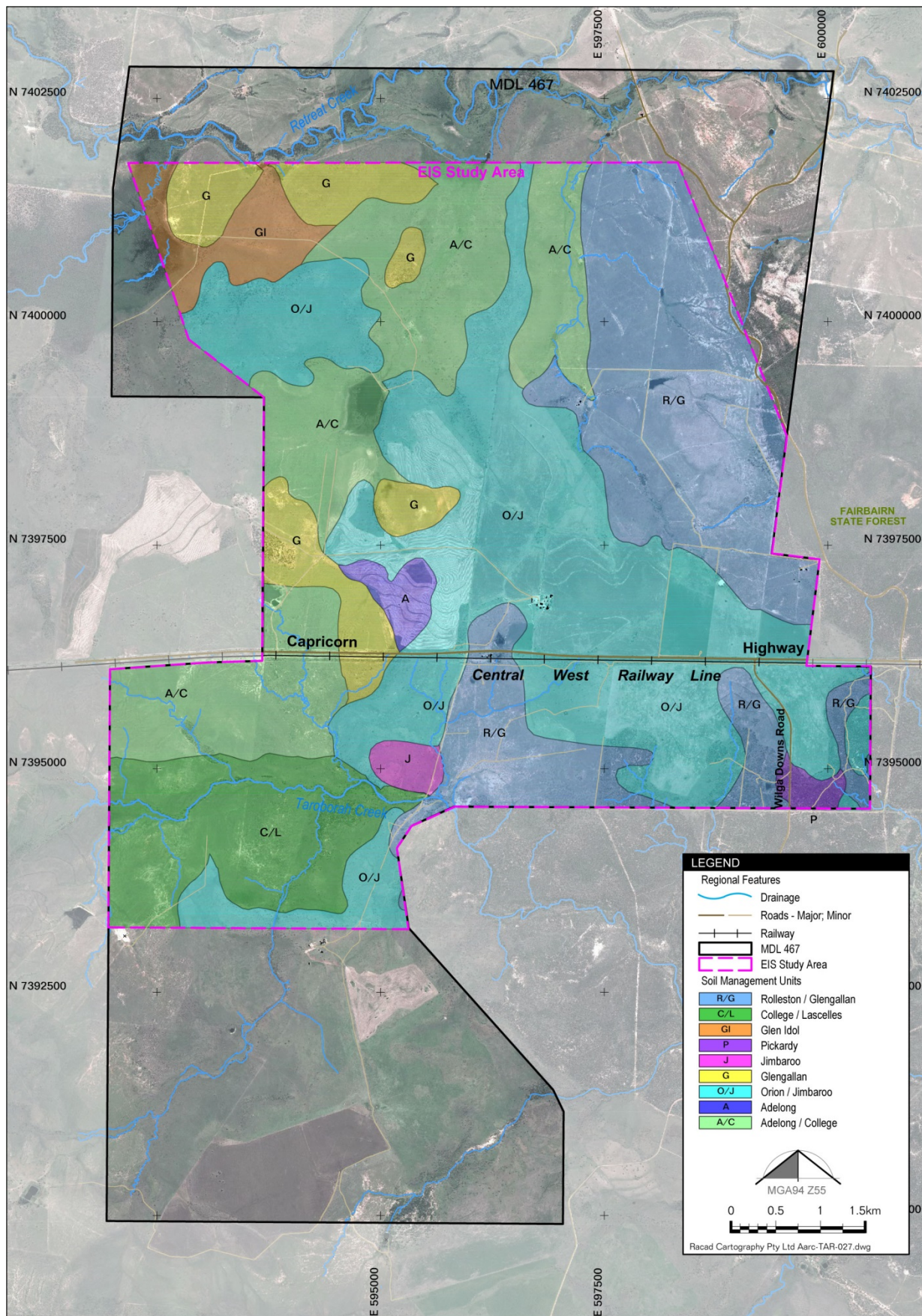


Figure 8 Distribution of Soil Management Units within the Project site

4.1.1 Orion/Jimbaroo Soil Management Unit

Australian Soil Classification: Black/Brown Vertosols

Topography and Landform Attributes: Undulating Plains and Rises on Basalt.

Geology Unit: Tertiary Basalt.

Photographic Reference: Photo Plate 1

Native Vegetation: Open grasslands of bluegrass, Mitchell grass, black speargrass and wiregrass with scattered mountain coolabah, bloodwood, silver leaved ironbark and wattles.

Physical Attributes: The Orion/Jimbaroo SMU is an association of deep and shallow black or brown, self-mulching and cracking medium to heavy clay soils. These soils possess strong lenticular structure and may have some carbonate nodules at depth. The heavy clay nature of the soil makes it difficult to work when wet. Effective rooting depth and hence plant available water capacity (PAWC) is governed by the depth of soil to parent material. Soils formed in areas of higher relief and steeper slopes are generally shallower than their counterparts on flatter terrain. These soils are imperfectly drained with a low to moderate soil permeability. These soils are used extensively for agriculture.

Chemical Analyses: The pH profile of the Orion/Jimbaroo SMU is generally alkaline throughout with the subsoil trending between a pH of 8-9. CEC is relatively high due to the presence of 2:1 clay types such as montmorillonite. These clays present a higher amount of charge which increases the soils ability to retain cations such as calcium and magnesium. Hence, these soils are often high in these nutrients. However, their relative proportions are not always favourable as high amounts of sodium or magnesium with respect to calcium can affect the integrity of the soil's structure. When at high levels these cations can cause the soils to slake or disperse. EC and ESP are typically low in these soils and have not accumulated within the profile. The chemistry of the basaltic parent material and the relatively high relief that these soils occupy has prevented any significant accumulation of sodium or chloride in the soil profile.

These soils are usually low in Nitrate Nitrogen 1-8 milligrams per kilogram (mg/kg), Phosphorus (1-10 mg/kg); with moderate levels of Potassium (38-420 mg/kg). Organic Carbon levels were very low at all sites varying between 0.30% and 5.80% with the mean skewed towards the low end of the range. Micro-nutrient levels at most sites are not deficient with the exception of zinc. Zinc is deficient at most sites ranging from 0.3-3.0mg/kg. Levels greater than 0.8 mg/kg are considered to be above low levels. Availability of zinc levels to plants is affected by soil pH.



Photo Plate 1 Orion/Jimbaroo SMU

4.1.2 Rolleston/Glengallan Soil Management Unit

Australian Soil Classification: Brown/Grey Sodosols, Vertosols

Topography and Landform Attributes: Typically found on undulating plains of low relief, level and lower sloping areas of undulating plains. Can include areas of normal gilgai with less than 0.4 m vertical.

Geology Unit: Permian Alderbaran sandstone below the tertiary weathered zone.

Photographic Reference: Photo Plate 2

Native Vegetation: Brigalow and Dawson Gum Scrub with areas of gidgee and blackwood. Some brigalow scrub with emerging eucalypts.

Physical Attributes: The Rolleston/Glengallan Soil Management Unit is an association of grey/brown cracking and non-cracking soils with minor areas of grey and brown duplex soils. The grey clays have developed from finer material associated with the Alderbaran sandstones whilst texture contrast soils which possess sandy loam topsoils over medium to heavy clay subsoils have developed from coarser sedimentary parent material. The grey clays and texture contrast soils have low to moderate levels of salts and are sodic to strongly sodic at depth. The grey clays possess melon holes that are less than 40 centimetres (cm) deep, however, they remain wet for extended periods. These soils are poorly drained and have slow infiltration and permeability. The effective rooting depth is a function of the sodium bulge at 50 cm. These soils are moderately dispersive below 0.5 m. The texture contrast soils have severe soil physical properties such as hardsetting, structure-less surface horizons, and very low infiltration and drainage. Effective rooting depth is less than 20 cm due to the soil being strongly sodic below this depth. This sodicity predisposes the subsoil to erosion due to its highly dispersive behaviour. The texture contrast soils are strongly sodic at depth and possess low PAWC. Most water infiltration ceases within the contact zone of the subsoil. Upon hitting the impermeable subsoil water tends to move laterally in the landscape. This hydrological process leads to the formation of bleached horizons which sit directly above the subsoil.

Chemical Analyses: The pH of the grey clays can be neutral to alkaline in the surface horizon, becoming acidic with depth (pH<6.0). The Glengallan texture contrast soils are extremely alkaline at depth often exceeding a pH of 9.0. Macro nutrients are at low concentrations at most sites. Nitrate ranges between 1-19 mg/kg; Phosphorus from 1-16 mg/kg and Potassium (14-150 mg/kg). The upper range values are due to moderate to high levels of N, P & K at one or two sites. Micro nutrient levels are generally low, particularly Cu, Zn and B. Organic carbon levels are low at all sites. Ca/Mg ratios are also low with values rarely exceeding 2%. ESP levels are considered moderately to highly sodic with ESP values exceeding 15% at depth. EC levels range from low to moderate with the exception of site 74 which has >1000 mg/kg of chloride at 50-60 cm depth.



Photo Plate 2 Rolleston/Glengallan SMU

4.1.3 Glen Idol Soil Management Unit

Australian Soil Classification: Red Chromosol

Topography and Landform Attributes: Undulating plains of low local relief with most slopes below 1%.

Geology Unit: Quaternary soil, silt, mud, basalt derived residual and colluvial deposits.

Photographic Reference: Photo Plate 1

Native Vegetation: Brigalow scrub with emergent Eucalypts.

Physical Attributes: Red brown, loamy sand over a redder brown sandy clay. Below 70 cm a grey clay is present often with strong red and yellow mottles. Weak basalt rock fragments are encountered below 120 cm. There is a noticeable texture increase beyond 120 cm with reddish coarse sandy clay present.

Chemical Analyses: These soils are low in soluble salts and are non-sodic. These soils are extremely low in levels of nitrate nitrogen, phosphorus and potassium whilst also being deficient in some trace elements. These soils are magnesian with high levels of magnesium relative to calcium. pH is generally slightly acid to mildly alkaline. The presence of mottles in the subsoil indicates that soil wetness issues may be a problem.



Photo Plate 3 Glen Idol SMU

4.1.4 College/Lascelles Soil Management Unit

Australian Soil Classification: Grey/Brown Vertosols and Dermosols

Topography and Landform Attributes: Elevated levees, terraces and relict alluvial plains. Undulating plains of low relief with slopes <1%.

Geology Unit: Black soil, silt, mud, basalt derived residual and colluvial deposits. Poorly consolidated sand, silt, clay, minor gravel, high level alluvial deposits, generally dissected and related to present stream valleys.

Photographic Reference: Photo Plate 4

Native Vegetation: Poplar box, Narrow leaved Iron Bark, silver leaved ironbark, small areas of shrubby woodlands of brigalow and Dawson Gum.

Physical Attributes: The College/Lascelles soil association is made up of coarse self-mulching or crusting, grey and brown cracking and non-cracking clays on alluvial plains and levees with minor areas of hard setting, yellow-brown sandy duplex soils with hard impervious clay subsoils.

Chemical Analyses: pH levels tend to be alkaline to acidic at one site location within this SMU. The remainder of sites exhibit a strongly alkaline trend throughout their profiles. The College/Lascelles association possesses soils that have low N, P & K levels. Trace element levels are generally low with the expression of deficiencies of Zinc and Boron. Soils range from being sodic to strongly sodic at depth. EC values indicate that there are moderate to high levels of soluble salts within the profiles of this SMU. This is confirmed by high levels of chloride exceeding 1000 mg/kg at depth at most site locations. Ca/Mg ratios are generally low with magnesium being at high levels relative to calcium.



Photo Plate 4 College/Lascelles SMU

4.1.5 Adelong Soil Management Unit

Australian Soil Classification: Brown/Grey Vertosols

Topography and Landform Attributes: Wide, level, alluvial plains of major drainage lines. Low lying clay plains and inter-channel areas are prone to flooding. Characterised by low local relief and slopes below 1%.

Geology Unit: Qr\l Anakie. Black soil, silt, mud, basalt derived residual and colluvial deposits, colluvial and residual deposits.

Photographic Reference: Photo Plate 5

Native Vegetation: Dense brigalow scrub with coolabah and yellowwood and associated wilga and belah.

Physical Attributes: Grey uniform heavy cracking clay. Black, brownish-black to grey-black at the surface grading to greyish yellow brown at depth. Soil depth is typically greater than 1500 mm and it is very hard when dry. These soils have a self-mulching to weak crusting surface and are difficult to work when wet. These soils have superior soil physical characteristics.

Chemical Analyses: Adelong soils have alkaline pH throughout their profiles often exceeding 8.5. The Adelong SMU has low levels of nitrate, moderate levels of phosphorus, and moderate levels of K. Trace elements such as B, Zn and Cu are at low levels within the soil profile. Levels of Calcium and Magnesium are in adequate supply, however, levels of magnesium relative to calcium is high. Soils dominated by magnesium tend to disperse when wet and have unfavourable soil structures. ESP levels are low (below 8% in the subsoil) indicating that sodium is unlikely to cause structural degradation in these soils. EC indicates that subsoils have moderate to high levels of salt. This is confirmed by chloride levels in excess of 600 mg/kg in subsoil material. Sodium and chloride are the dominant salts within the soil profile. CEC is high for the Adelong SMU as the dominant clay type is a 2:1 lattice clay called montmorillonite which has greater surface charge giving the soil a greater capacity to adsorb nutrients. Organic carbon levels are generally below the optimum levels.



Photo Plate 5 Adelong SMU

4.1.6 Adelong/College Soil Management Unit

Australian Soil Classification: Dark, Grey or Brown Vertosols or Dermosols

Topography and Landform Attributes: Wide, level, alluvial plains of major drainage lines. Low lying clay plains and inter-channel areas are prone to flooding. Characterised by low local relief and slopes below 1%. Elevated levees, terraces and relict alluvial plains often in small, localised occurrences.

Geology Unit: Qr\ b Anakie. Black soil, silt, mud, basalt derived residual and colluvial deposits, colluvial and residual deposits.

Photographic Reference: Photo Plate 6

Native Vegetation: Shrubby woodlands of Brigalow, Silver-leaved Ironbark Sandalwood and Dawson Gum. Dense brigalow scrub with coolabah and yellowwood.

Physical Attributes: The Adelong/College SMU is comprised of two soil types differentiated on the basis of soil colour and the condition of the surface soil material. The College soil type has a potentially crusting and sealing surface which can affect seedling establishment and cultivation. These soils are difficult to work when wet. The College soils have restricted permeability and poor drainage with restricted rooting depths a result of high sodium levels. Both soils have heavy clay textures and high cation exchange capacities due to the presence of 2:1 lattice clays such as montmorillonite. Both soils have strong blocky or lenticular structure.

Chemical Analyses: The Adelong/College SMU contains soils with moderate to high salinity at depth. These soils also have low to moderate levels of sodium in their lower profiles which affects their PAWC and plant rooting depths. pH levels are strongly alkaline with some analysed sites having pH values in excess of 9.0. The exception to this is site 37 which has an acid soil reaction trend at depth with values less than pH 6.0. Macro-nutrient levels are generally low with Nitrate nitrogen levels at 1 mg/kg at several sites. Phosphorus levels are also around 1 mg/kg with Potassium ranging from 132-232 mg/kg. Boron is at low levels at some sites whilst Iron and Manganese tend to have moderate to high concentrations at the majority of sites. EC indicates that there are moderate to high levels of salts in the soil solution. This is confirmed by the presence of high levels of chloride at depth at the majority of sites. Chloride levels exceed 1000 mg/kg in the subsoil at some locations. Ca/Mg ratios are low to moderate with most sampled location having ratios of between 1-2%. ESP levels are at moderate levels at each site with sodicity only becoming a constraint below 60 cm. ESP ranges from 1.8% in surface soil to 15.9% in the subsoil at site 13. Organic carbon is present only at low levels.



Photo Plate 6 Adelong/College SMU

4.1.7 Glengallan Soil Management Unit

Australian Soil Classification: Brown Sodosols

Topography and Landform Attributes: Undulating plains of low relief with most slopes below 1%.

Geology Unit: Permian Alderbaran sandstone below the tertiary weathered zone.

Photographic Reference: Photo Plate 7

Native Vegetation: Brigalow scrub with emergent eucalypts

Physical Attributes: The Land Management Manual for the Central Highlands presents the Glengallan soil as the most likely fit for the soils encountered on these Permian sandstones. The Glengallan SMU has a shallow, loamy sand to sandy loam surface lying above decomposing sandstone parent material occasionally with mottled grey clay subsoils. These soils have hardsetting surface horizons with massive structures with some coarse fragments found within the profile. Due to the nature of the parent material these soils have low nutrient levels including deficiencies of Copper, Zinc and Boron, low levels of soluble salts and low to moderate Ca/Mg ratios. At two of the three logged sites subsoil material was not encountered in the field due to the presence of parent material close to the surface. Where subsoil was encountered, soil analyses showed that subsoil was moderately to highly sodic. These soils possess low PAWC due to shallow soil depths and low clay levels.

Chemical Analyses: Soil analytical information suggests that within the subsoils of the Glengallan SMU there are moderate to high levels of sodium, low levels of soluble salts and low Ca/Mg ratios. Due to high sodium levels these soils are likely to have dispersive subsoils. These soils have very poor permeabilities and drainages, most likely due to high sodium levels in the subsoil. Mottled grey clays present at some sites are a good indicator of low permeability and poor drainage.



Photo Plate 7 Glengallan SMU

Two additional soil types or SMUs have been mapped within the study area but are of minor significance. The Pickardy SMU has been absorbed by the Orion/Jimbaroo SMU for the purposes of the Soil and Land Suitability Assessment having similar physical and chemical properties to the Orion soil type. Essentially the Pickardy is a red variant of this over-arching unit but has superior permeability and drainage. A Jimbaroo SMU has been mapped and is basically a shallow phase of the Orion/Jimbaroo SMU. This soil has been included in the SLSA.

4.1.8 Jimbaroo Soil Management Unit

Australian Soil Classification: Black Vertosols/Dermosols

Topography and Landform Attributes: Ridgelines and crests of gently undulating open downs.

Geology Unit: Tertiary Basalt.

Native Vegetation: Open woodlands of mountain coolabah, silver leaved ironbark or bloodwood. Ground cover of bluegrass mitchell grass, black spear grass and wiregrass.

Physical Attributes: These soils are shallow cracking and non-cracking clays on undulating open downs formed on basalt. These soils have self-mulching surfaces and are non-sodic and non-saline with moderately alkaline pH. Abundant surface cobbles are present being part of a basalt flow. These soils are a shallow phase of the Orion soil type.

Chemical Analyses: These soils are low in N and P and some trace elements. Soil chemistry is relatively inert with low levels of sodium, and chloride and moderate pH.

4.1.9 Pickardy Soil Management Unit

Australian Soil Classification: Red Vertosol/Dermosol

Topography and Landform Attributes: Level to undulating plains.

Geology Unit: Tertiary Basalt.

Native Vegetation: Fairly dense scrub consisting of brigalow, yellowwood and associated softwood species or gidgee, mostly cleared for cultivation.

Physical Attributes: Similar physical characteristics to Orion/Jimbaroo SMU. These soils essentially are a red variant of the Orion soil type.

Chemical Analyses: Similar soil chemical characteristics to the Orion soil type. These soils are mapped, as a separate entity (polygon) but can essentially be treated the same as the Orion/Jimbaroo SMU.

5.0 TOPSOIL MANAGEMENT ACTIONS

5.1 TOPSOIL SUITABILITY

Useable soil resources are mainly confined to the surficial horizons and locally in the upper part of the subsurface horizons which contain seed-stock, micro-organisms and nutrients necessary for plant growth. Soil microbial activity, organic matter content and other parameters affecting soil fertility, tend to decrease with depth.

The following list presents the Soil Management Units in terms of the quality of their topsoil resource (from most to least suitable) with consideration to the soil physical and chemical properties and the extent of occurrence within the project area:

- Orion/Jimbaroo Soil Management Unit 50-60 cm;
- Jimbaroo Soil Management Unit 20 cm;
- Adelong Soil Management Unit 30 cm;
- Adelong/College Soil Management Unit 30 cm;
- Rolleston/Glengallan Soil Management Unit 1 10 cm;
- College/Lascelles Soil Management Unit 30 cm;
- Glen Idol Soil Management Unit 30 cm; and
- Glengallan Soil Management Unit 1 10 cm.

Note that operationally shallow stripping depths of 10 cm may not be achievable and the minimum stripping depth may actually be 20 cm.

5.2 STRIPPING AND REUSE

5.2.1 Planning

It is recommended that detailed topdressing material resource assessments be carried out progressively over the life of the mine in advance of mining in new areas. These assessments will involve review of existing soils data and additional soil sampling and testing, where necessary. The assessments will enable detailed volume calculations and preparation of stripping plans prior to clearing. The stripping plans will also include designated respreading areas or stockpile locations.

Minor variability of topsoil characteristics occur within the soil types of each of the land units. Consequently, it is recommended that monitoring of soil type variability be undertaken during the ongoing operational phases of the project to ensure that the maximum quantity and quality of useable topsoil resources is recovered.

5.2.2 Stripping

5.2.2.1 Recommended Stripping Depths

Prior to the commencement of the stripping of topsoil, areas will be cleared of vegetation. Section 5.1 ranks the soils in terms of their topsoil suitability. As such, the following list provides an indication of the absolute maximum depth of topsoil removal within each Soil Management Unit that will be stripped for development of the open-cut mine and MIA. Comments are also given as to the limitations which inhibit stripping further into the soil profile:

- **Orion/Jimbaroo Soil Management Unit** - **600 mm**
This soil type presents no chemical limitations to stripping. Stripping of soil in this SMU is dependent on location. Soil within this management unit has variable depth to parent rock and should be treated on a site specific basis.
- **Adelong/College Soil Management Unit** - **300 mm**
Stripping to depths below 300 mm is not recommended due to the increased risk of soil dispersion caused by sodic subsoil material. pH is also strongly alkaline below 300 mm. Chloride levels also become limiting below this depth.
- **Rolleston/Glengallan Soil Management Unit** **100 mm**
Below 100 mm the soil becomes moderately saline and moderately sodic with increases in these parameters with depth.
- **Glengallan Soil Management Unit** - **100 mm**
Stripping topsoil from this SMU may expose decomposing or hard rock. Two sites were logged within these management units with both encountering rock at 100 mm. Other areas may have deeper soils but may expose shallow subsoils not competent enough to be left exposed between stripping operations and rehabilitation.
- **Jimbaroo Soil Management Unit** - **200 mm**
This unit on average has a soil depth of 30 cm to parent material. Hence, any stripping below 20 cm may expose weathered rock and make it difficult to rehabilitate this area after the end of mine life.

5.2.2.2 Volume of Available Topsoil

The volume of topsoil generated from the recommended stripping depths across the project site's disturbance footprint that is available for re-use in post-mining rehabilitation activities is calculated as 1,771,620 m³ (Table 2). Allowing for a 10% handling loss, approximately 1,594,460 m³ of suitable topdressing is available within the disturbance area.

Table 2 Approximate Volumes of Topsoil Available for Rehabilitation

Soil Management Unit	Approximate Surface Area to be Disturbed	Stripping Depth	Approximate Volume of Topsoil Available for Rehabilitation
	ha	m	m³
Orion/Jimbaroo	171.7	0.6	1,030,200
Adelong/College	103.8	0.3	311,400
Rolleston/Glengallan	172.5	0.2 *	345,500
College/Lascelles	0.14	0.3	420
Glengallan	18.5	0.2 *	37,000
Jimbaroo	23.8	0.2	47,600
Total	490.4	-	1,771,620

* note that the recommended thickness is too thin for practical soil stripping and therefore, a thickness of 0.2 m has been used for estimating volumes.

5.2.3 Stockpiling

Topsoil material stockpiles will be located in areas which are away from drainage lines. Drainage from higher areas will be diverted around stockpiles to prevent erosion. Sediment controls should be installed downstream of the stockpiles to collect any sediment, as necessary.

The topsoil stockpiles should be placed away from drainage areas, roads, machinery, transport corridors, and stock grazing areas. The stockpiles may need to be ripped and seeded with a quick establishment pasture, to limit erosion, and maintain a viable seed bank if the period of stockpiling is greater than one growing season or six months. Stockpiles will be clearly sign-posted for easy identification and to avoid any inadvertent losses. Establishment of weeds on the stockpiles will also be monitored and controlled.

5.3 EROSION CONTROL

5.3.1 Current Erosion Status

Field surveys have found that localised areas, primarily within the Glengallan and Lascelles Soil Management Units, exhibit moderate to severe sheet and gully erosion. These areas mostly occur intermittently throughout the minor drainage lines which originate from the upper slopes.

Soils within the Glengallan and College/Lascelles Soil Management Units have instances of sodic soil layers within close proximity to the surface. Accordingly, in cleared areas these soils are likely to be prone to locally severe occurrences of sheet, rill and gully erosion due to uncontrolled surface water runoff from the hard setting surface soils. Over time this will inevitably lead to exposure of the more strongly dispersive subsoil layers which will exacerbate the effects and severity of the gully erosion.

The Orion and Jimbaroo Soil Management Units are vulnerable to sheet, rill or gully erosion because of their relative elevation compared to lower positions in the landscape. Although not possessing any adverse chemical indicators of dispersion, medium to high runoff occurs on these soils which can lead to erosion. These soils are also prone to erosion because they are cultivated for grain production and therefore have less basal area coverage to hold soil peds together. Local examples of soil erosion on these basaltic soils can be seen south of the Capricorn Highway where gully erosion is feeding good quality topsoil from exposed cultivated areas in the north into grazing paddocks dominated by sandy texture contrast soils. This material is thus lost from the system and is not economical to recover. Glen Idol soils are relatively porous with their red colour indicating that they possess favourable permeability and drainage. However, subsoil layers exhibit mottling which indicates that the soil profile remains wet for significant periods of time or is affected by rising and falling groundwater levels.

5.3.3 Erosion Management

Management options for the mitigation of soil erosion include:

- Only the minimum land required for the safe operation of the Project should be cleared;
- Land to be cleared should be surveyed and marked out prior to clearing and signed off by an appropriate person, to ensure no significant areas are inadvertently disturbed;
- Runoff from more elevated undisturbed areas should be directed around disturbed areas and topsoil stockpiles;
- Stockpiles should be ripped and seeded with a quick establishment pasture species, to limit erosion, and maintain a viable seed bank, if the period of stockpiling is greater than 1 growing season or 6 months;
- The spoil emplacement will be rehabilitated progressively in order to minimise the total disturbed area on the Project site at any time;
- Rehabilitated spoil emplacement areas will be deep ripped along the contour to maximise rainfall infiltration and minimise runoff;
- Rehabilitated slopes will have contour drains, in order to minimise slope lengths and runoff velocities;
- Runoff from rehabilitated areas will be collected in both contour and collection drains, then directed to sediment dams and settling ponds in order remove suspended sediment prior to discharge from the site;
- The disturbed area of the Project should be rehabilitated progressively where possible;
- Mine rehabilitation should aim to return the land to the pre-mining land suitabilities;
- Sediment dams or stormwater dams should be installed for all cleared areas and areas of mine or processing infrastructure; and
- Topsoil should be stripped to the depths nominated in Section 5.2.2.

6.0 LAND SUITABILITY ASSESSMENT

6.1 AIMS OF THIS ASSESSMENT

This assessment aims to evaluate the suitability of the Project area for a variety of land uses prior to mine development. Evaluations were made in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995). The outcomes of the land suitability assessment are also compared with the distribution of land classified as 'good quality agricultural land' in the Land Classification System (DERM 2010).

6.2 CURRENT LAND USE

The dominant land use in the region of the Project and within the boundaries of the MDL is cattle grazing and dryland cropping.

6.3 LAND SUITABILITY CLASSES

Land suitability classes refer to the capacity of the land resources to sustain particular forms of land use such as cattle grazing, broadacre cropping, and conservation. These classes are derived through qualitative and quantitative interpretation of the data collected on the physical, chemical and nutritional characteristics of the soil. This system ranks the land suitability according to a five-class system. The classes are described in the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995) as:

- | | |
|----------------|---|
| Class 1 | Suitable land with <u>negligible</u> limitations which is well suited to a proposed use. |
| Class 2 | Suitable land with <u>minor</u> limitations which is suited to a proposed use but which may require minor changes in management to sustain use. |
| Class 3 | Suitable land with <u>moderate</u> limitations which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use. |
| Class 4 | Marginal land with <u>severe</u> limitations which is marginally suited for a proposed use and would require major inputs to ensure sustainability. These inputs may not be justified by the benefits to be obtained in using the land for a particular purpose and is hence considered presently unsuitable. |
| Class 5 | Unsuitable land with <u>extreme</u> limitations which preclude its sustainable use for the proposed purpose. |

6.4 PRE-MINING LAND SUITABILITY

6.4.1 Beef Cattle Grazing

The limitations that were used to assess land suitability for beef cattle grazing at the Project site are as follows:

- Water availability;
- Nutrient deficiency;
- Soil physical factors;
- Salinity;
- Rockiness;
- Microrelief;
- pH;
- ESP;
- Wetness;
- Topography;
- Water erosion;
- Flooding; and
- Vegetation.

These limitations, as they relate to the suitability for beef cattle grazing, are discussed individually in respect to each of the Soil Management Units in Section 4.1 of this report. These individual limitations are summarised in Section 6.4.1.12 to determine the overall land use suitability. A depth of 60 cm has been assumed for the root zone of pasture species as described in the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995).

6.4.1.1 Water Availability

Plant Available Water Capacity (PAWC) for the Soil Management Units has been estimated in reference to Table 2.3 of the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995) and are presented in Table 3. PAWC cut-off levels for each of the land suitability classes are as follows:

- Class 1:** >125 mm
- Class 2:** 100-125 mm
- Class 3:** 75-100 mm
- Class 4:** 50-75 mm
- Class 5:** <50 mm

These cut-off levels are not based on a particular species of pasture, but on pasture as a general land use.

Table 3 Land Suitability Classes for Beef Cattle Grazing based on PAWC

Soil Management Unit	Limiting Features	PAWC (mm)	Land Suitability Class
Orion/Jimbaroo	Cracking clays, >=90 cm depth to weathered or hard rock (Dense cracking and fine self-mulch)	125-150	1
Adelong	Cracking clays, >=90 cm depth to weathered or hard rock (Dense cracking and fine self-mulch)	125-150	1
Adelong/College	Cracking Clays, alkaline to neutral pH throughout and 60-90 cm depth to Cl>=600 mg/kg	100-125	2
Rolleston/Glengallan	Cracking Clays, alkaline to neutral pH throughout and 60-90 cm depth to ESP> =15%	50-75	4
College/Lascelles	Cracking Clays, alkaline to neutral pH throughout and 60-90 cm depth to ESP> = 15%	100-125	2
Glengallan	Rigid soils, non-sodic, loams and clay loams with <30 cm to parent material	<=50	5
Glen Idol	Rigid soils (non-sodic) 75-125 cm to weathered or hard rock	75-100	3
Jimbaroo	Cracking Clays, alkaline to neutral pH throughout and 20-40 cm depth to weathered or hard rock.	50-75	4

6.4.1.2 Nutrient Deficiency

The nutrient status of each Soil Management Unit identified has been assessed against Table 2.2 of the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995). The land suitability classes identified for each Soil Management Unit are presented in Table 4.

Table 4 Land Suitability Classes for Beef Cattle Grazing based on Nutrient Status

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Other soils with Bicarbonate P (Average root zone) P = 5-10 parts per million (ppm)	3
Adelong	Brigalow soils Average root zone P >10 ppm	1
Adelong/College	Other soils with Bicarbonate P Average root zone P = 5-10 ppm	3
Rolleston/Glengallan	Other soils with Bicarbonate P Average root zone P = 5-10 ppm	3
College/Lascelles	Eucalypt soils Average root zone P >10 ppm	2
Glengallan	Sands and loams at least 75cm deep or overlying rock at shallow depth	4
Glen Idol	Bicarbonate P ≤ 4	4
Jimbaroo	Other soils with Bicarbonate P (Average root zone) P = 5-10 ppm	3

6.4.1.3 Soil Physical Factors

The *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995) for *Land Suitability Assessment Techniques* have been used to assess the physical factors of each Soil Management Unit identified. Results are presented in Table 5.

Table 5 Land Suitability Classes for Beef Cattle Grazing based on Soil Physical Factors

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Cracking clays with a fine self-mulch	2
Adelong	Cracking clays with a fine self-mulch	2
Adelong/College	Cracking clay with coarse peds or crust on the surface	3
Rolleston/Glengallan	Cracking clay with coarse peds or crust on the surface	3
College/Lascelles	Cracking clay with coarse peds or crust on the surface	3

Soil Management Unit	Limiting Features	Land Suitability Class
Glengallan	Rigid soils with a hardsetting surface when dry	2
Glen Idol	Rigid soils with a hardsetting surface when dry	1
Jimbaroo	Cracking clays with a fine self-mulch	2

6.4.1.4 Salinity

The *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995) have been used to determine the land suitability class against salinity parameters. Given salinity can inhibit plant growth; the highest electrical conductivity (EC) recorded is considered the most limiting factor and dictates the rating given to each Soil Management Unit. The results are provided in Table 6.

Table 6 Land Suitability Classes for Beef Cattle Grazing based on Salinity

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Rootzone EC < 0.15 desi Siemens per metre (dS/m)	1
Adelong	Rootzone EC 0.15-0.3 dS/m	2
Adelong/College	Rootzone Cl 300-600 mg/kg	2
Rolleston/Glengallan	Rootzone EC 0.3-0.9 dS/m	3
College/Lascelles	Rootzone EC 0.3-0.9 dS/m	3
Glengallan	Rootzone EC <0.15 dS/m	1
Glen Idol	Rootzone Cl < 300 ppm	1
Jimbaroo	Rootzone EC < 0.15 dS/m	1

6.4.1.5 Rockiness

The land suitability class identified for each Soil Management Unit based on rockiness is presented in Table 7.

Table 7 Land Suitability Classes for Beef Cattle Grazing based on Rockiness

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	<20% coarse surface gravel	1
Adelong	<20% coarse surface gravel	1
Adelong/College	<20% coarse surface gravel	1
Rolleston/Glengallan	<20% coarse surface gravel	1
College/Lascelles	<20% coarse surface gravel	1
Glengallan	<20% coarse surface gravel	1
Glen Idol	<20% coarse surface gravel	1
Jimbaroo	20-50% coarse surface gravel and rock outcrop	2

6.4.1.6 Microrelief

The land suitability class identified for each Soil Management Unit based on microrelief is presented in Table 8.

Table 8 Land Suitability Classes for Beef Cattle Grazing based on Microrelief

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Melonholes cover <20% surface area	1
Adelong	Melonholes cover <20% surface area	1
Adelong/College	Melonholes cover <20% surface area	1
Rolleston/Glengallan	Deep melonholes (>60 cm deep) cover 20-50% of surface area	3
College/Lascelles	Melonholes cover <20% surface area	1
Glengallan	Melonholes cover <20% surface area	1
Glen Idol	Melonholes cover <20% surface area	1
Jimbaroo	Melonholes cover <20% surface area	1

6.4.1.7 pH

The land suitability class identified for each Soil Management Unit based on average rootzone pH is presented in Table 9.

Table 9 Land Suitability Classes for Beef Cattle Grazing based on pH

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	pH 8.0-9.0	3
Adelong	pH 8.0-9.0	3
Adelong/College	pH 8.0-9.0	3
Rolleston/Glengallan	pH 8.0-9.0 and 4.5-5.0	3
College/Lascelles	pH 8.0-9.0 and 4.5-5.0	3
Glengallan	pH 6.6-8.0	2
Glen Idol	pH 6.6-8.0	2
Jimbaroo	pH 6.6-8.0	2

6.4.1.8 Exchangeable Sodium Percent ESP (100 mm)

ESP is employed to determine the erosion potential of soils. The land suitability class identified for each Soil Management Unit based on ESP in the upper 100 mm of soil is presented in Table 10.

Table 10 Land Suitability Classes for Beef Cattle Grazing based on ESP excl. Aluminium

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	ESP <5%	1
Adelong	ESP <5%	1
Adelong/College	ESP <5%	1
Rolleston/Glengallan	ESP <5%	1
College/Lascelles	ESP <5%	1
Glengallan	ESP <5%	1
Glen Idol	ESP <5%	1
Jimbaroo	ESP <5%	1

6.4.1.9 Wetness

The land suitability class identified for each Soil Management Unit based on wetness is presented in Table 11.

Table 11 Land Suitability Classes for Beef Cattle Grazing based on Wetness

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Undulating terrain or elevated plains	1
Adelong	Low-lying level plains	2
Adelong/College	Low-lying level plains	2
Rolleston/Glengallan	Undulating terrain or elevated plains	1
College/Lascelles	Low-lying level plains	2
Glengallan	Low-lying level plains	2
Glen Idol	Shallow seasonal and permanent swamps	3
Jimbaroo	Undulating terrain or elevated plains	1

6.4.1.10 Water Erosion

The land suitability class identified for each Soil Management Unit based on water erosion is presented in Table 12.

Table 12 Land Suitability Classes for Beef Cattle Grazing based on Water Erosion

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Slopes <3% on all other soils	1
Adelong	Slopes <3% on all other soils	1
Adelong/College	Slopes <3% on cracking clays	1
Rolleston/Glengallan	Slopes 1-3% sodic rigid soils or slopes 3-6% on cracking clays	2
College/Lascelles	Slopes 1-3% sodic rigid soils or slopes 3-6% on cracking clays	2
Glengallan	Slopes 3-6% on sodic rigid soils	3
Glen Idol	Slopes <3% on all other soils	1
Jimbaroo	Slopes <3% on all other soils	1

6.4.1.11 Flooding

The land suitability class identified for each Soil Management Unit based on flooding risk is presented in Table 13.

Table 13 Land Suitability Classes for Beef Cattle Grazing based on Flooding

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	No flooding	1
Adelong	Periodic flooding	2
Adelong/College	Periodic flooding	2
Rolleston/Glengallan	No flooding	1
College/Lascelles	Periodic flooding	2
Glengallan	No flooding	1
Glen Idol	Periodic flooding	2
Jimbaroo	No Flooding	1

6.4.1.12 Summary of Land Suitability for Beef Cattle Grazing

The suitability of beef cattle grazing on the Project site is most limited by nutrient deficiencies and soil pH. Low levels of N, P, and K and some trace elements can affect the quality of feed for cattle grazing. Moderate to extreme pH levels affect the availability of nutrients to plants, particularly levels of micro-nutrients. Flooding and erosion are of significance on-site as some portions of the study area become inundated with water in wetter years. Erosion is also a potential threat to areas on-site, particularly steeper areas of cracking clay soils and disturbed areas on texture contrast soils with sodic subsoils. Cattle pads or vehicle tracks can quickly turn into gullies with ongoing soil erosion problems. Once sodic texture contrast soils start to erode due to exposure of sodic material, they are difficult to stop. The limitations affecting land suitability are highlighted in Table 14. Note that some land suitability limitation ratings take priority over others and therefore, the overall suitability rating does not reflect the average of these ratings.

Due to the presence of the aforementioned attributes/limitations on-site, the Orion/Jimbaroo, Adelong, Adelong/College, and the College/Lascelles SMUs are considered to be suitable land areas with moderate limitations to cattle grazing (Class 3). The Rolleston/Glengallan SMU and Glen Idol SMU is considered Class 4 land as it is marginal land with severe limitations, whilst the Glengallan SMU has been classified as Class 5 land which is unsuitable land with extreme limitations to grazing. Although limited in extent, the Jimbaroo SMU is classified as Class 4 land. This is mainly due to its shallow depth to rock (<30 cm). The distribution of these land suitability classes is shown in Table 14.

Notwithstanding the classification derived from this assessment, grazing within the Central Highlands is most often limited by rainfall trends. Grazing as a land use is more suitable and carrying capacities higher in wetter years associated with La Nina events.

Table 14 Land Suitability Limitations for Beef Cattle Grazing

Soil Management Unit	Orion / Jimbaroo	Adelong	Adelong / College	Rolleston / Glengallan	College / Lascelles	Glengallan	Jimbaroo	Glen Idol
PAWC	2	2	3	4	3	5	4	3
Nutrient deficiency	3	1	3	3	2	4	3	4
Soil Physical Factors	2	2	3	3	3	2	2	1
Salinity	1	2	2	3	3	1	1	1
Rockiness	1	1	1	1	1	1	2	1
Microrelief	1	1	1	3	1	1	1	1
pH	3	3	3	3	3	2	2	2
ESP	1	1	1	1	1	1	1	1
Wetness	1	2	2	1	2	2	1	3
Water Erosion	1	1	1	2	2	3	1	1
Flooding	1	2	2	1	2	1	1	2
Overall Suitability Rating	3	3	3	4	3	5	4	4

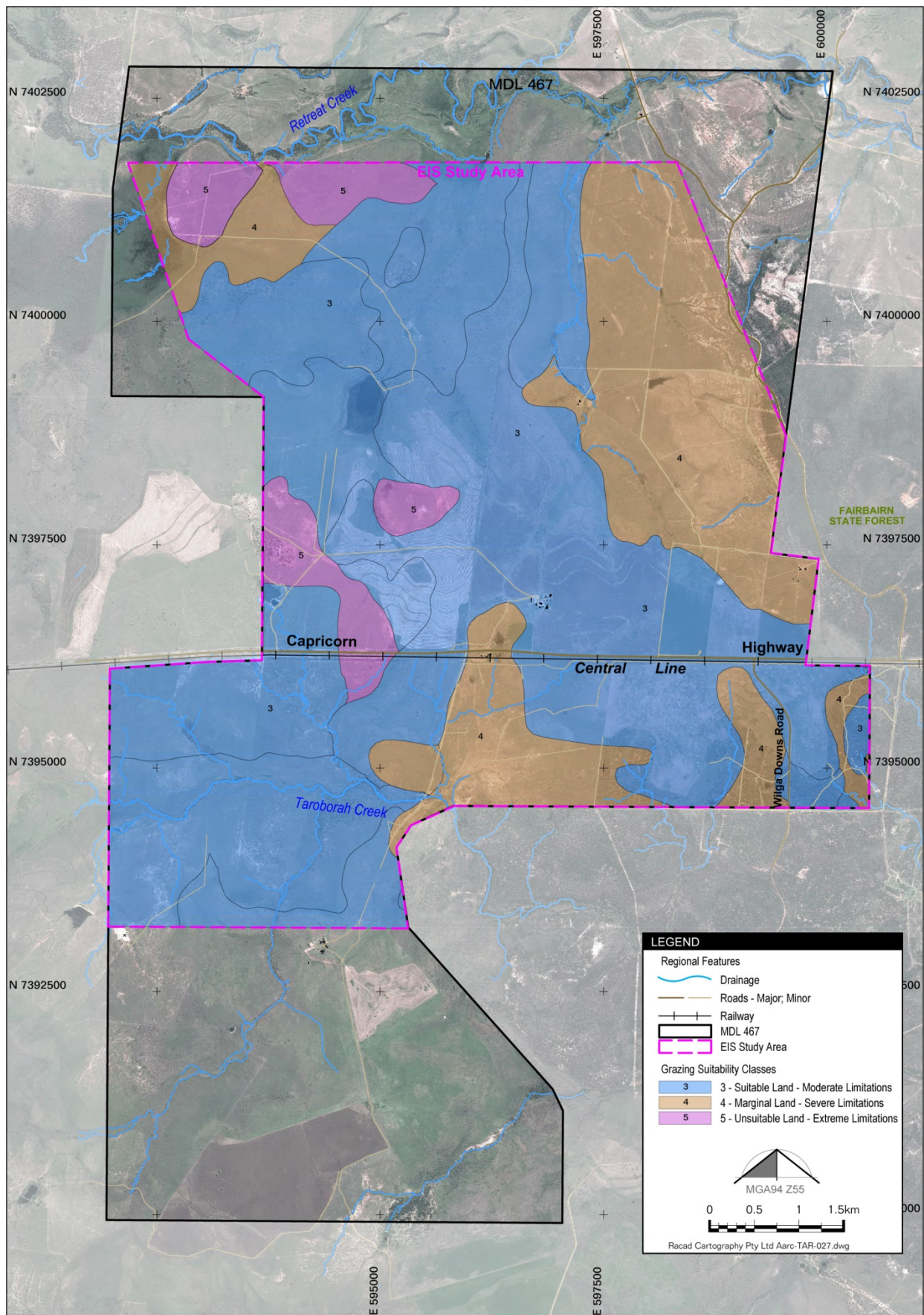


Figure 9 Beef Cattle Grazing Land Use Suitability

6.4.2 Rainfed Broadacre Cropping

Criteria that were employed to assess the land use suitability for rainfed broadacre cropping at the Project site are as follows:

- Water availability;
- Nutrient deficiency;
- Soil physical factors;
- Soil workability;
- Salinity;
- Rockiness;
- Microrelief;
- Wetness;
- Topography;
- Water erosion; and
- Flooding.

These limitations are discussed in Section 6.4.2.12 for each of the Soil Management Units identified and are summarised in Section 4.1. A depth of 1m has been assumed for the root zone of cropping species as described in the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995).

6.4.2.1 Water Availability

PAWC for the soil types of the Taraborah MLA have been estimated with reference to Table 2.3 of the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995) and are presented in Table 15. PAWC cut-off levels for each of the land suitability classes are as follows:

Class 1:	>150 mm
Class 2:	125-150 mm
Class 3:	100-125 mm
Class 4:	75-100 mm
Class 5:	<75 mm

These cut-off levels are not based on a particular cropping species, but on cropping as a general land use.

Table 15 Land Suitability Classes for Rainfed Broadacre Cropping based on PAWC

Soil Management Unit	Limiting Features	PAWC (mm)	Land Suitability Class
Orion/Jimbaroo	Cracking clays, ≥ 90 cm depth to weathered or hard rock (Dense cracking and fine self-mulch)	125-150	2
Adelong	Cracking clays, ≥ 90 cm depth to weathered or hard rock (Dense cracking and fine self-mulch)	125-150	2
Adelong/College	Cracking Clays, alkaline to neutral pH throughout and 60-90 cm depth to $Cl \geq 600$ mg/kg	100-125	3
Rolleston/Glengallan	Cracking Clays, alkaline to neutral pH throughout and 60-90 cm depth to $ESP > = 15\%$ or rigid sodic soils	75-100	4
College/Lascelles	Cracking Clays, alkaline to neutral pH throughout and 60-90 cm depth to $ESP > = 15\%$	100-125	3
Glengallan	Rigid soils, non-sodic, loams and clay loams with < 30 cm to parent material	≤ 50	5
Glen Idol	Rigid soils (non-sodic) 75-125 cm to salt bulge $Cl \geq 900$ mg/kg	75-100	4
Jimbaroo	Cracking Clays, alkaline to neutral pH throughout and 20-40 cm depth to weathered or hard rock	50-75	5

6.4.2.2 Nutrient Deficiency

The nutrient status of each SMU identified has been assessed against Table 2.1 of the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques (DME, 1995)*. The land suitability classes identified for each SMU are presented in Table 16.

Table 16 Land Suitability Classes for Rainfed Broadacre Cropping based on Nutrient Status

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Average root zone P = 5-10 ppm, Exchangeable Potassium (K) > 0.3 milli equivalents (mEq) %	2
Adelong	Average root zone P = 5-10 ppm, Exchangeable Potassium K < 0.3 mEq%	3
Adelong/College	Average root zone P = 5-10 ppm, Exchangeable Potassium (K) > 0.3 mEq %	2
Rolleston/Glengallan	Average root zone P = 5-10 ppm, Exchangeable Potassium (K) < 0.3 mEq %	3
College/Lascelles	Average root zone P > 10 ppm	1

Soil Management Unit	Limiting Features	Land Suitability Class
Glengallan	Average root zone P <10 ppm, and Exchangeable Potassium (K) <0.3 mEq % and exchangeable Ca less than 3 mEq.%	4
Glen Idol	Average root zone P <10 ppm, and Exchangeable Potassium (K) <0.3 mEq % and exchangeable Ca less than 3 mEq.%	4
Jimbaroo	Average root zone P = 5-10 ppm, Exchangeable Potassium (K) >0.3 mEq %	2

6.4.2.3 Soil Physical Factors

The *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995) have been used to assess the physical factors of each SMU identified at the Taraborah MLA. Results are presented in Table 17.

Table 17 Land Suitability Classes for Rainfed Broadacre Cropping based on Physical Factors

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Cracking clays with a fine self-mulch	2
Adelong	Cracking clays with a fine self-mulch	2
Adelong/College	Cracking clay with coarse peds or crust on the surface	3
Rolleston/Glengallan	Cracking clay with coarse peds or crust on the surface	3
College/Lascelles	Cracking clay with coarse peds or crust on the surface	3
Glengallan	Rigid soils with a hardsetting surface when dry	2
Glen Idol	Rigid soils with a loose, soft or firm surface when dry	1
Jimbaroo	Cracking clays with a fine self-mulch	2

6.4.2.4 Soil Workability

The land suitability class for Rainfed broadacre cropping determined for each SMU based on soil workability is presented in Table 18.

Table 18 Land Suitability Classes for Rainfed Broadacre Cropping based on Soil Workability

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Firm cracking clays with fine self-mulch	2
Adelong	Firm cracking clays with fine self-mulch	2
Adelong/College	Firm to stiff cracking clays with a coarse self-mulch	3
Rolleston/Glengallan	Stiff cracking clays with a coarse self-mulch	3
College/Lascelles	Stiff cracking clays with a coarse self-mulch	3
Glengallan	Rigid soils with a hardsetting surface when dry	2
Glen Idol	Rigid soils with a loose, soft or firm surface when dry	1
Jimbaroo	Firm cracking clays with fine self-mulch	2

6.4.2.5 Salinity

The land suitability class identified for each SMU based on salinity is presented in Table 19. Given that salinity can inhibit plant growth; the highest EC recorded is considered the most limiting factor and dictates the rating given to each SMU.

Table 19 Land Suitability Classes for Rainfed Broadacre Cropping based on Salinity

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Rootzone EC < 0.15dS/m	1
Adelong	Rootzone EC 0.15-0.3 dS/m	2
Adelong/College	Rootzone Cl 300-600 mg/kg	2
Rolleston/Glengallan	Rootzone EC 0.3-0.9 dS/m	3
College/Lascelles	Rootzone EC 0.3-0.9 dS/m	3
Glengallan	Rootzone EC <0.15 dS/m	1
Glen Idol	Rootzone EC < 0.15dS/m	1
Jimbaroo	Rootzone EC < 0.15dS/m	1

6.4.2.6 Rockiness

The land suitability class identified for each SMU based on rockiness is presented in Table 20.

Table 20 Land Suitability Classes for Rainfed Broadacre Cropping based on Rockiness

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	<10% coarse surface gravel and rock outcrop	1
Adelong	<10% coarse surface gravel and rock outcrop	1
Adelong/College	<10% coarse surface gravel and rock outcrop	1
Rolleston/Glengallan	<10% coarse surface gravel and rock outcrop	1
College/Lascelles	<10% coarse surface gravel and rock outcrop	1
Glengallan	<10% coarse surface gravel and rock outcrop	1
Glen Idol	<10% coarse surface gravel and rock outcrop	1
Jimbaroo	20-50% surface cobble (6-20 cm diameter) and rock outcrop	3

6.4.2.7 Microrelief

The land suitability class identified for each SMU based on microrelief is presented in Table 21.

Table 21 Land Suitability Classes for Rainfed Broadacre Cropping based on Microrelief

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	No melonholes	1
Adelong	Shallow melon holes cover 20-50% surface area	2
Adelong/College	Shallow melon holes cover 20-50% surface area	2
Rolleston/Glengallan	Melonholes 30-60 cm deep cover 20-50% of surface area	3
College/Lascelles	No melonholes	1
Glengallan	No melonholes	1
Glen Idol	No melonholes	1
Jimbaroo	No melonholes	1

6.4.2.8 Wetness

The land suitability class identified for each SMU based on wetness is presented in Table 22.

Table 22 Land Suitability Classes for Rainfed Broadacre Cropping based on Wetness

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Undulating terrain or elevated plains	1
Adelong	Low lying level plains with melon holes covering <25% of surface area	2
Adelong/College	Low lying level plains with melon holes covering <25% of surface area	2
Rolleston/Glengallan	Low lying level plains with melon holes covering <25% of surface area	2
College/Lascelles	Low lying level plains with melon holes covering <25% of surface area	2
Glengallan	Rigid soils with sodic subsoils within 60 cm of the surface	2
Glen Idol	Non-sodic rigid soils with coarse pale grey and yellow mottles within 75 cm of the surface	2
Jimbaroo	Undulating terrain or elevated plains	1

6.4.2.9 Topography

The land suitability class identified for each SMU based on topography is presented in Table 23.

Table 23 Land Suitability Classes for Rainfed Broadacre Cropping based on Topography

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Occasional deep gullies impede cultivation slightly	2
Adelong	Occasional deep gullies impede cultivation slightly	2
Adelong/College	Occasional deep gullies impede cultivation slightly	2
Rolleston/Glengallan	Occasional deep gullies impede cultivation slightly	2
College/Lascelles	Occasional deep gullies impede cultivation slightly	2
Glengallan	Occasional deep gullies impede cultivation slightly	2
Glen Idol	Occasional deep gullies impede cultivation slightly	2
Jimbaroo	Occasional deep gullies impede cultivation slightly	2

6.4.2.10 Water Erosion

The land suitability class identified for each SMU based on water erosion is presented in Table 24. This criterion takes into consideration slope, surface ESP and soil type.

Table 24 Land Suitability Classes for Rainfed Broadacre Cropping based on Water Erosion

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	Slopes 1-3% on cracking clays without melon holes	3
Adelong	Slopes of 0.5-1% on cracking clays without melon holes	2
Adelong/College	Slopes of 0.5-1% on cracking clays without melon holes	2
Rolleston/Glengallan	Slopes of 1-3% on melon hole clays	2
College/Lascelles	Slopes of 0.5-1% on cracking clays without melon holes	3
Glengallan	Slopes 2-3% on sodic rigid soils	4
Glen Idol	Slopes 2-4% on non-sodic rigid soils	3
Jimbaroo	Slopes 1-3% on cracking clays without melon holes	3

6.4.2.11 Flooding

The land suitability class identified for each SMU based on flooding is presented in Table 25.

Table 25 Land Suitability Classes for Rainfed Broadacre Cropping based on Flooding

Soil Management Unit	Limiting Features	Land Suitability Class
Orion/Jimbaroo	No Flooding	1
Adelong	Occasional Flooding	4
Adelong/College	Infrequent Flooding	3
Rolleston/Glengallan	Rare Flooding	2
College/Lascelles	Infrequent Flooding	3
Glengallan	No Flooding	1
Glen Idol	Infrequent flooding	3
Jimbaroo	No Flooding	1

6.4.2.12 Summary of Land Suitability for Rainfed Broadacre Cropping

The suitability of rainfed broadacre cropping as a land use on the Project site is mostly limited by the PAWC available for crop growth. Shallow soils, soils with subsoil constraints such as salinity and sodicity as well as high pH reduces the water storage potential that plant roots can tap into. Soil fertility is another limitation with most soils possessing low levels of N, P and K. Some soils are also prone to soil erosion either due to their position in the landscape or nature of their soil material. Vertosols can be highly erodible on steeper slopes whilst sodic texture soils can disperse and erode if subsoil is disturbed.

Management Units in the steeper areas (Orion, Jimbaroo, Glengallan, Rolleston) had additional limitations in respect to slope and consequently erosion. Management areas on alluvial plains and slopes in areas of lower relief are at risk of flooding (Adelong, College / Lascelles and Glen Idol). These limitations are summarised in Table 26.

Overall, the Orion/Jimbaroo, Adelong/College, Rolleston/Glengallan, College/Lascelles, SMU were considered suitable land with moderate limitations (Class 3) for Rainfed Broadacre Cropping. The Adelong SMU and Glen Idol SMU were considered marginal land with severe limitations (Class 4), whilst the Glengallan SMU was considered unsuitable land with extreme limitations (Class 5). The Jimbaroo SMU was also classified as Class 5 land due to shallow soil depth (<30 cm). The distribution of these land suitability classes is shown in Figure 10.

Notwithstanding this assessment, cropping in the Central Highlands would be severely limited by rainfall. Soils that possess subsoil constraints cannot fully take advantage of this rainfall due to limited plant rooting depths associated with these constraints.

Table 26 Land Suitability Limitations for Rainfed Broadacre Cropping

Soil Management Unit	Orion / Jimbaroo	Adelong	Adelong / College	Rolleston / Glengallan	College / Lascelles	Glengallan	Jimbaroo	Glen Idol
PAWC	2	2	3	4	3	5	5	4
Nutrients Levels	2	3	2	3	1	4	2	4
Soil Physical Condition	2	2	3	3	3	2	2	1
Soil Workability	2	2	3	3	3	2	2	1
Salinity	1	2	2	3	3	1	1	1
Rockiness	1	1	1	1	1	1	3	1
Micro-relief	1	2	2	3	1	1	1	1
Wetness	1	2	2	2	2	2	1	2
Topography	2	2	2	2	2	2	2	2
Erosion	3	2	2	2	3	4	3	3
Flooding	1	4	3	2	3	1	1	3
Overall Suitability Rating	3	4	3	4	3	5	5	4

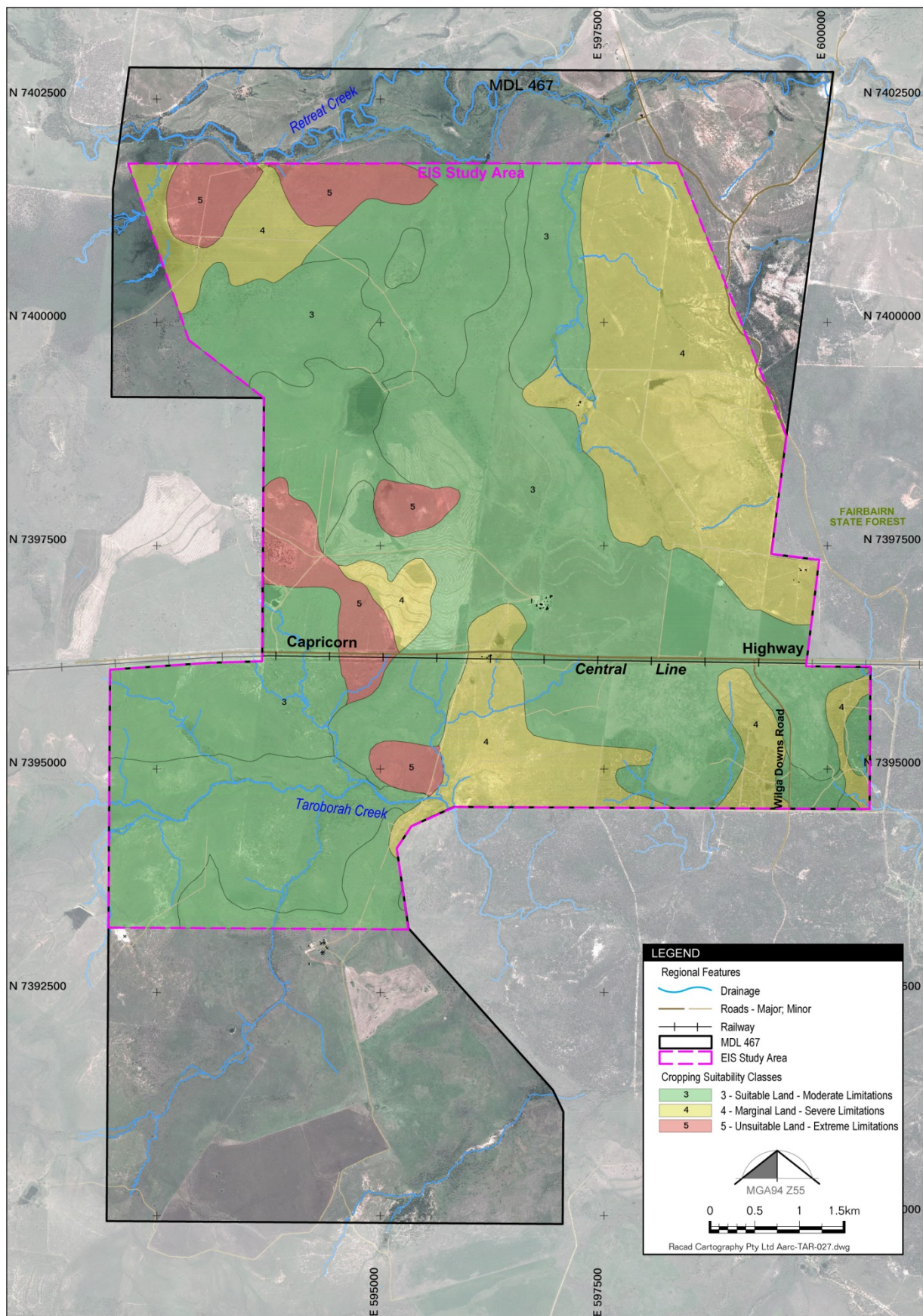


Figure 10 Rainfed Broadacre Cropping Land Use Suitability

6.5 GOOD QUALITY AGRICULTURAL LAND

The local distribution of land classified as 'Good Quality Agricultural Land' in the Land Classification System (DERM 2010) is shown in accordance with the *Planning Guideline – The Identification of Good Quality Agricultural Land* (herein referred to as the *Planning Guideline*) (DHLGP 1993). The GQAL mapping has been developed from the DHLGP guidelines. The classification of good quality agricultural land provides an indication of the quality of the land resource to maintain a sustainable level of productivity for a given land use (DHLGP 1993).

The *Planning Guideline* (DHLGP 1993) defines agricultural land quality as follows.

Class A CROP LAND

Land suitable for current and potential crops

Limitations to production range from none up to moderate levels.

All crop land is considered to be good quality agricultural land.

Class B LIMITED CROP LAND

Land marginal for current and potential crops; and suitable for pastures

Land which is marginal or unsuitable for most current and potential crops due to severe limitations. Further engineering and/or agronomic improvements may be required before land would be considered suitable for cropping.

Land marginal for particular crops of local significance is considered to be good quality agricultural land.

Class C PASTURE LAND

Land suitable only for improved or native pastures

Limitations preclude continuous cultivation for crop production but some areas may tolerate a short period of ground disturbance for pasture establishment.

In areas where pastoral industries are the major primary industry, land suitable for improved or high quality native pastures may be considered to be good quality agricultural land.

Class D NON-AGRICULTURAL LAND

Land not suitable for agricultural uses

This may be undisturbed land with significant habitat, conservation and/or catchment values. Severe limitations preclude any interference with land or biological resources for the production of agricultural goods.

6.5.1.1 Findings

DERM (2010) has previously mapped the distribution of land classified as good quality agricultural land in the region of the Project (Figure 11) at scales of between 1:100 000 and 1: 500 000. Within the Central Highlands Regional Council Local Government Area, lands classified as Class A, Class B and Class C1 are all considered to be 'good quality agricultural land' (Agricultural Land Class Overlay, Emerald Shire Planning Scheme, 2006). Class C2 and C3 are classified as other classes by the same scheme. Class C2 supports beef cattle production on native grasses only whilst, Class C3 is only suitable for light grazing.

Under the DERM mapping scheme, a large portion of the Project site has been assigned as Class A – “limitations to crop production which range from none to moderate levels”. In comparison to the findings of the Land Suitability Assessment (Section 6.0), this classification of the land as Class A may not be a holistic representation of value of the land as an agricultural resource. An accepted correlation between Broadacre Cropping Land Suitability Ranking and Agricultural Land Class is presented in Table 27. Subsequently, Table 28 compares the Land Suitability and Agricultural Land Quality classifications derived during this study against GQAL mapping provided by DERM 2010 for soils of the Project site.

It should be noted that the DERM 2010 mapping of GQAL represents the Department of Environment and Resource Management (DERM) assessment of GQAL from the best available land resource information and expert opinion within the Central-West Region. The dataset contains land resource information at varying scales (1:1,000,000 to 1:25,000) and it should be noted that the accuracy of the mapping is only as good as the scale at which it was captured.


Based on the conclusions drawn in this Land Suitability Assessment, development of the Project is considered likely to have an impact on areas identified as GQAL. Preliminary mapping of infrastructure proposed for the coal mine operation shows that some GQAL will be disturbed (Figure 12). South of the Capricorn Highway, the open-cut pit, spoil dumps and mine infrastructure area are likely to disturb Class A land, whilst Class A and C1 land north of the highway may be at risk of slumping due to proposed underground mining activities.

Table 27 Correlation between Broadacre Cropping Land Suitability Ranking and Agricultural Land Class

SLSA Ranking	Description	Agricultural Land Class
1	Suitable land w/ negligible limitation	A
2	Suitable land w/ minor limitations	A
3	Suitable land w/ moderate limitations	A
4	Marginally suitable land for cropping	B or C
5	Unsuitable land for cropping	C or D

Table 28 Land Suitability and Agricultural Land Quality Comparison

Soil Management Unit	Important Limitations	Agricultural Suitability (according to DME 1995)		GQAL Class (This Study)	GQAL Class (DERM 2010)
		Beef Cattle Grazing	Broadacre Cropping		
Orion/Jimbaroo*	Nutrient deficiency and PAWC deficiencies.	3	3	A	A/B
Adelong	Nutrient deficiency Erosion potential	3	4	C1	A
Adelong/College*	PAWC deficiencies, nutrient deficiency and Erosion potential.	3	3	A	B
Rolleston/Glengallan*	Nutrient deficiency and PAWC	4	4	C2	C1/C2/C3
College/Lascelles*	PAWC deficiencies, nutrient deficiency, erosion	3	3	A	A
Glengallan	PAWC and Nutrient Deficiencies, soil depth, erosion	5	5	C3	C2
Glen Idol	PAWC and Nutrient deficiencies	4	4	C2	A
Jimbaroo	Nutrient deficiencies, PAWC, soil depth	4	5	C2	B

 Denotes classification considered to by GQAL under the *Emerald Shire Planning Scheme* (2006).

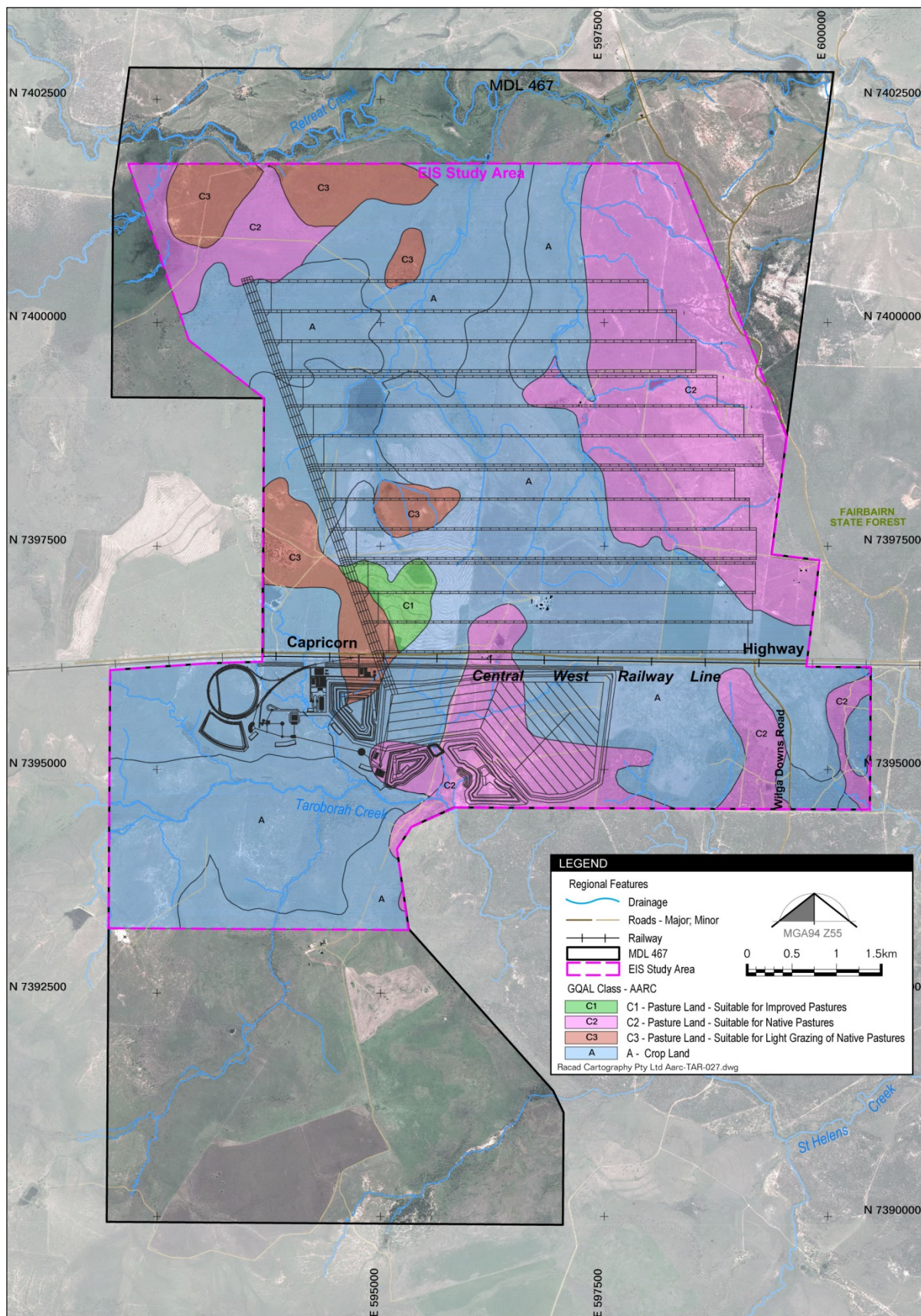


Figure 12 Classification of Good Quality Agricultural Land Derived from this Land Suitability Assessment

7.0 STRATEGIC CROPPING AREA ASSESSMENT

7.1 METHODOLOGY

The *Regional Planning Interests Act 2014* (RPI Act 2014) aims to protect agricultural land resources that are deemed important to Queensland. It is designed to ensure that planning and development assessment under local government planning schemes includes appropriate consideration of strategic cropping land (SCL). The RPI Act came into effect on 3 June 2014, and replaced the Strategic Cropping Land Act 2011 that commenced on 30 January 2012. As this Soil and Land Suitability Assessment was undertaken while the SCL Act 2011 was in force, the following discussion relates to the SCL assessment methodology used under that Act.

State Planning Policy 1/12: Protection of Queensland's strategic cropping land (SPP 1/12) was part of the overall legislative and planning framework, established under the Strategic Cropping Land Act 2011, to protect SCL from developments that lead to permanent impacts or diminished productivity. SPP 1/12 operated in tandem with SPP 1/92: Development and the Conservation of Agricultural Land, which applied to a broader range of agricultural lands. These SPPs have been incorporated into the RPI Act 2014.

The Act requires developments on areas deemed to have potential Strategic Cropping Land (SCL) to undertake a review of the relevant mapping. If a developer wishes to refine the extent of SCL, or validate that the land is not SCL, an assessment is required. This may be in the form of an assessment against the zonal criteria, or, if located in a management area, an assessment of cropping history. The Project site is located within the management area of the Western Cropping Zone.

Figure 13 shows the areas of the Project site mapped as potential SCL on the 2012 SCL Trigger Map, overlain with the soil management units and the disturbance footprint of the mine.

An assessment of the SMUs against the zonal criteria was undertaken, with a summary of results provided in Table 29. This indicated that four SMUs did not meet the zonal criteria for SCL. An assessment of cropping history, however, prevented most of the area of these SMUs from being declared non-SCL as the validation must be conducted on a management unit (i.e. single property or group of properties if managed by a single entity) basis rather than strictly a zonal criteria basis within a management unit. The area of the Project site validated as SCL following the assessment is illustrated in Figure 14. Table 30 indicates the areas of disturbance from both above and below ground mining activities for each SMU and validated SCA.

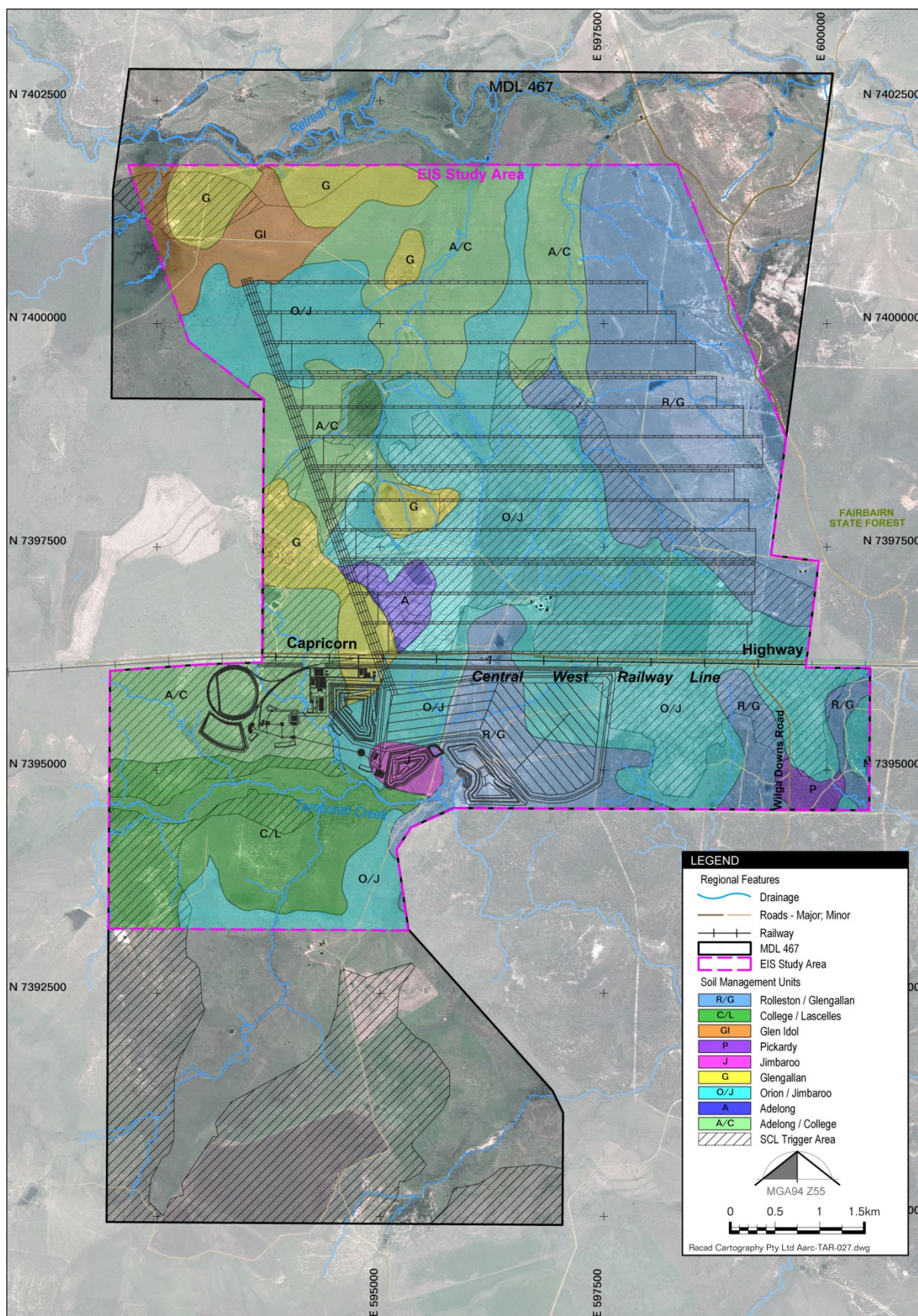


Figure 13 Strategic Cropping Area Mapping with SMUs and Mine Infrastructure

Table 29 Soil Management Units with SCL Status

	Orion/Jimbaroo				Rolleston/Glengallan			Adelong/College			College/Lascelles				Glengallan		Adelong	Glen Idol	
Criteria	TB40	TB48	TB58	TB57	TB59	TB33	TB41	TB37	TB60	TB61	TB70	TB78	TB80	TB69	TB12	TB44	TB54	TB10	TB11
Slope	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not SCL	Not SCL	Yes	Yes	Yes	Yes	Yes	Yes
Rockiness	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
Gilgai Microrelief	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
Soil Depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			Not SCL	Yes	Yes	Yes	Yes	Yes
Soil Wetness	Yes	Yes	Yes	Yes	Yes	Not SCL	Yes	Yes	Yes	Yes	Yes				Yes	Yes	Yes	Not SCL	Not SCL
Soil pH	Yes	Yes	Yes	Yes	Not SCL		Not SCL	Yes	Yes	Yes	Yes				Yes	Yes	Yes		
Salinity	Yes	Yes	Yes	Yes				Yes	Yes	Yes	Not SCL				Yes	Yes	Yes		
Soil Water Storage	Yes	Yes	Yes	Yes				Yes	Yes	Yes					Not SCL	Not SCL	Yes		
Minimum Area	Yes	Yes	Yes	Yes				Yes	Yes	Yes							Yes		
Outcome	SCL	SCL	SCL	SCL				SCL	SCL	SCL							SCL		

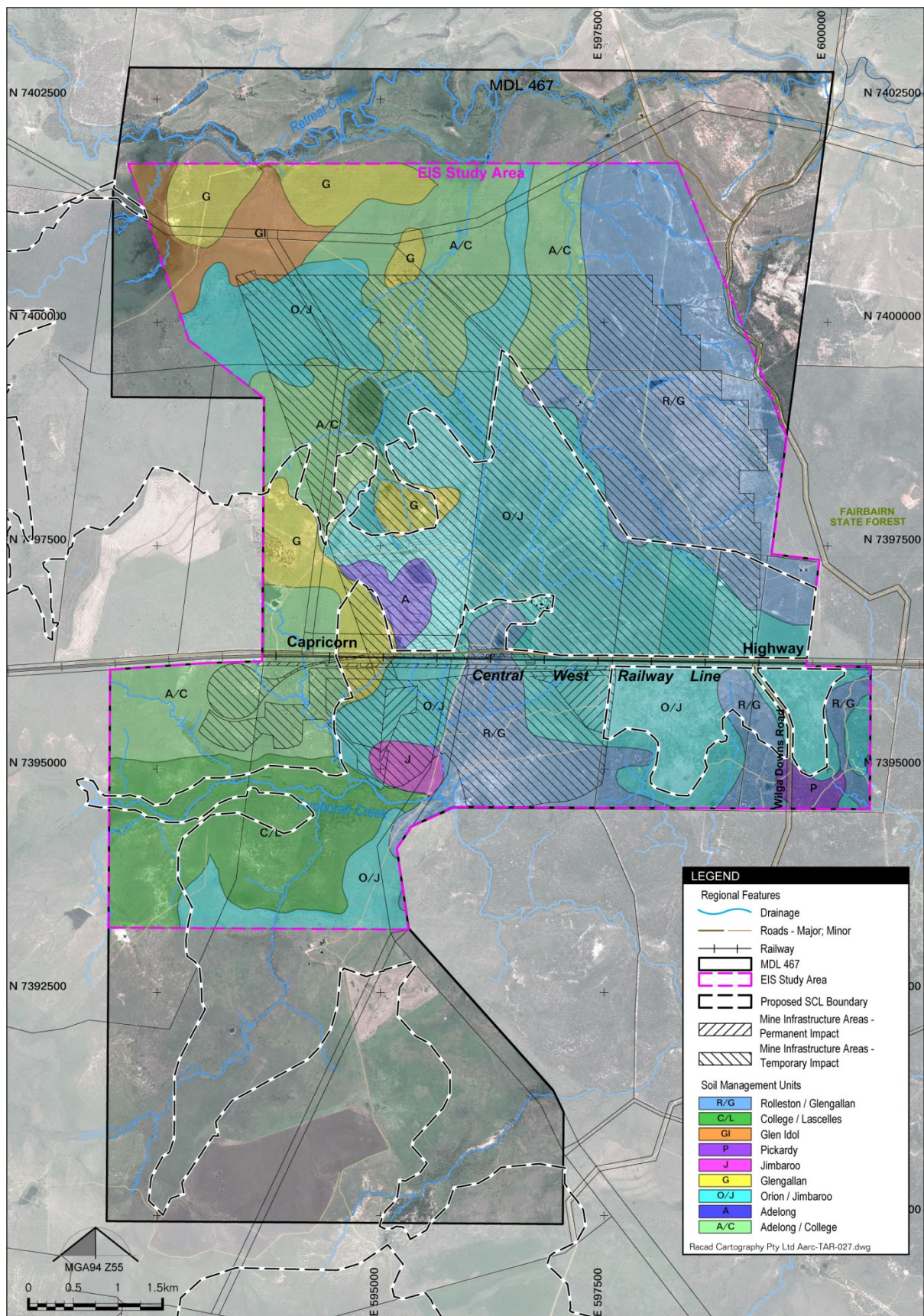


Figure 14 SCA Mapping after Assessment

Table 30 Extent of Soil Mapping Units and SCA Disturbed by Site Activities

Disturbance from Underground Mining (ha)		
SMU	SMU Area	Strategic Cropping Area
Orion/Jimbaroo	1010.7	691.6
Adelong	54.9	54.0
Adelong/College	390.5	28.2
Rolleston/Glengallan	531.8	441.8
Glengallan	79.1	14.1
Glen Idol	4.3	0
Total	2071.3	829.7
Disturbance from Surface Activities (ha)		
SMU	SMU Area	Strategic Cropping Area
Orion/Jimbaroo	173.3	5.3
Adelong/College	100.8	99.7
Rolleston/Glengallan	178.9	0
College/Lascelles	0.2	0
Glengallan	15.0	0.7
Jimbaroo	28.4	0
Total	496.6	105.7

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 SOIL MANAGEMENT UNITS

Field and laboratory analysis identified eight SMUs within the Project area. Soils have been described as the following:

The **Orion/Jimbaroo SMU** consists of a black/brown medium to heavy clay with self-mulching and cracking characteristics. The soil is generally alkaline at the surface increasing with depth. These soils are non-sodic and non-saline. Soil chemistry indicates low to moderate levels of major soil nutrients at the surface and a relatively good physical stability. Landscapes of the Orion/Jimbaroo SMU consist of undulating plains and rises on basalt. Soil depth can be a major limitation for broadacre cropping.

The **Adelong SMU** consists of a greyish brown to brownish grey heavy clay with self-mulching and cracking surface material. These soils are alkaline to acid in the subsoil, however soils surveyed in this assessment were moderately to highly alkaline with depth. These soils are moderate to highly saline and sodic with very low nitrate and phosphorus levels with moderate levels of potassium. These soils are difficult to work when wet but have high PAWC. These soils are found on wide, level alluvial plains of major drainage lines and low lying clay plains and inter-channel areas which are prone to flooding.

The **Adelong/College SMU** consists of a greyish brown heavy clay with self-mulching or sealing surface horizons which may or may not crack. pH is moderately alkaline in the surface becoming extremely alkaline with depth. These associations can be both sodic and saline particularly at depth. These soils are generally low in Nitrate and Phosphorus with moderate levels of potassium. These soils can have poor physical characteristics including the crusting and sealing surface. These soils have a narrow moisture range for successful cultivation with restricted rooting depths caused by the previously mentioned subsoil constraints. These constraints reduce the amount of moisture which the soil profile can hold leading to a low PAWC. These soils occupy elevated levees, terraces and relict alluvial plains often in small, localised occurrences. The remainder of the association is made up of the Adelong soil type already outlined.

The **Rolleston/Glengallan SMU** consists of cracking grey and brown heavy clays with a crusting or cracking surface interspersed with yellow-brown duplex soils consisting of medium to heavy clays overlain by brown loamy sands or sandy loams with hardsetting surfaces. pH is generally alkaline but can become acidic at depth. Both soil types are sodic and saline with low levels of Nitrate and Phosphorus and moderate levels of potassium. The Rolleston soils possess large gilgai that can remain full of water for lengthy periods of time due to slow permeability and drainage. PAWC are moderate to high. Conversely, the Glengallan soil has low permeability and drainage has a very low PAWC and has a hardsetting structureless surface and is highly vulnerable to erosion. Due to a strongly sodic subsoil these soils have a very low PAWC. These soils occupy plains of low relief with slopes less than 1% whilst the Rolleston soils occupy lower sloping areas of undulating plains within the landscape where this association is found.

The **College/Lascelles SMU** consists of self-mulching or crusting grey and brown cracking and non-cracking heavy clay soils interspersed with hardsetting, yellow-brown, duplex soils with hard impervious subsoils. Lascelles soils occupy undulating plains of low relief. These soils are alkaline throughout although there are examples where the subsoil becomes strongly acid with depth. These soils are sodic and saline with depth and have very low levels of nitrate, phosphorus with medium levels of potassium. Some trace elements may be deficient also. These soils have low PAWC due to shallow rooting depths caused by sodium and moderate to high soluble salt levels. These soils are

particularly vulnerable to erosion especially if the subsoil is exposed. These soils occupy undulating plains of low relief and elevated levees, terraces and relict alluvial plains.

The **Glengallan SMU** comprises soils developed on Permian Sandstones of the Aldebaran Formation. The Glengallan SMU has a shallow, loamy sand to sandy loam surface lying above decomposing sandstone parent material. Occasionally deeper profiles are present above the parent material. These layers consist of mottled, grey clay, sodic subsoils. These soils have hardsetting surface horizons with massive structures with some coarse fragments found within the profile. Due to the nature of the parent material these soils have low nutrient levels and are non-saline. Low PAWC is a feature of these soils as shallow soils cannot hold a sufficient volume of water. These soils occupy undulating plains and rises of low relief. These soils may have poor permeability and drainage associated with mottled subsoils present at some locations.

The **Glen Idol SMU** consists of a red-brown, loose, loamy sand surface over a brown to reddish brown sandy clay. At 70 cm grey clay is present with prominent orange and red mottles overlying a horizon with weak basalt rock fragments. Texture increases with depth as the soil grades back into a coarse sandy clay with grit. .

The **Jimbaroo SMU** consists of a shallow phase of the Orion/Jimbaroo SMU. Soils are derived from basaltic parent material and occupy higher landscape positions on basalt flows. These soils have significant quantities of surface cobbles and are relatively shallow soils with approximately 30 cm to parent material. These soils are limited by nutrient deficiencies, shallow soil profiles and low PAWC due to shallowness of the profile. These soils are considered suitable for native pasture production.

8.2 PRE-MINING LAND USE SUITABILITY

The pre-mining land use suitability of rainfed broadacre cropping and beef cattle grazing is mostly limited by nutrient deficiency and low PAWC. Several of the management units were also limited by their susceptibility to erosion and shallow soil depth.

The Orion/Jimbaroo, Adelong, Adelong/College, and College/Lascelles SMUs are considered suitable with moderate limitations (Class 3) for Beef Cattle Grazing. The Rolleston/Glengallan, Jimbaroo and Glen Idol SMUs are considered to be marginally suitable with severe limitations (Class 4) whilst the Glengallan SMU is considered unsuitable with extreme limitations (Class 5) and can only sustain light grazing.

The Orion/Jimbaroo, Adelong/College, and College/Lascelles SMUs are considered suitable with moderate limitations (Class 3) for Rainfed Broadacre Cropping. The Adelong, Glen Idol and Rolleston/Glengallan SMUs are considered to be marginally suitable with severe limitations (Class 4) whilst the Glengallan and Jimbaroo SMUs are considered unsuitable with extreme limitations (Class 5). The specific classes and key limitations of each soil type are outlined in Table 31.

Table 31 Land Suitability and Good Quality Agricultural Land Classes

Soil Management Unit	Important Limitations	Agricultural Suitability (according to DME 1995)		Good Quality Agricultural Land Class
		Beef Cattle Grazing	Broadacre Cropping	
Orion/Jimbaroo*	Nutrient deficiency and PAWC deficiencies.	3	3	A
Adelong	Nutrient deficiency Erosion potential	3	4	C1
Adelong/College*	PAWC deficiencies, nutrient deficiency and Erosion potential.	3	3	A
Rolleston/Glengallan*	Nutrient deficiency and PAWC	4	4	C2
College/Lascelles*	PAWC deficiencies, nutrient deficiency, erosion	3	3	A
Glengallan	PAWC and Nutrient Deficiencies, soil depth, erosion	5	5	C3
Glen Idol	PAWC and Nutrient deficiencies	4	4	C2
Jimbaroo	Nutrient deficiencies, PAWC, soil depth	4	5	C2

Development of the Taraborah Project is considered to impact, to a greater or lesser degree, on land classified as either:

- 'Good Quality Agricultural Land' in the DERM Land Classification System (DERM 2010); or,
- Land deemed as suitable for a particular agricultural land use as determined in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME, 1995).

Post mine rehabilitation efforts should attempt to return disturbed areas to as close as practicable to their pre-mining land use suitability, as listed in Table 31.

8.3 STRATEGIC CROPPING AREA

A review of the Strategic Cropping Area mapping for the Taraborah Project found approximately 2050 hectares across the Project mapped as SCA (potential strategic cropping land). Based on the results of the soil survey and land suitability assessment, there was sufficient evidence to suggest that the SCA mapping was inaccurate. An SCA Assessment was undertaken to evaluate the validity of the potential SCA identified in the SCL Trigger Map.

The SCA Assessment determined that part of the mapped area of potential SCL did not meet the criteria of Strategic Cropping Land. As of June 2014, the remaining amount of potential SCL mapped within the study area after both zonal and cropping history assessments is 1,766 hectares.

8.4 TOPSOIL STRIPPING

Useable soil resources are mainly confined to the surficial horizons and locally in the upper part of the subsurface horizons which contain seed-stock, micro-organisms and nutrients necessary for plant growth. The quality of topsoil resource and recommended stripping depths for the identified SMUs (from most to least suitable) are listed below:

- | | |
|---|--------|
| • Orion/Jimbaroo Soil Management Unit | 60 cm; |
| • Jimbaroo Soil Management Unit | 20 cm; |
| • Adelong/College Soil Management Unit | 30 cm; |
| • Rolleston/Glengallan Soil Management Unit | 10 cm; |
| • College/Lascelles Soil Management Unit | 30 cm; |
| • Glengallan Soil Management Unit | 10 cm; |
| • Glen Idol Soil Management Unit | 30 cm; |
| • Adelong Soil Management Unit | 30 cm. |

It is recommended that detailed topdressing material resource assessments be carried out progressively over the life of the mine in advance of surface clearing in new areas. Note that operationally shallow stripping depths of 10 cm may not be achievable and the minimum stripping depth may actually be 20 cm.

It is also recommended that topsoil stockpiles should be placed away from drainage areas, roads, machinery, transport corridors, and stock grazing areas. If the period of stockpiling is greater than 1 growing season or 6 months, the stockpiles may need to be ripped and seeded to limit erosion, and maintain a viable seed bank.

8.5 EROSION MANAGEMENT

The physiochemical properties of the Glengallan, Rolleston/Glengallan and College/Lascelles SMUs predispose them to dispersion under adverse conditions. In disturbed areas these soils are likely to be prone to locally severe occurrences of sheet, rill and gully erosion due to uncontrolled surface-water runoff from the hard setting surface soils. Over time this will inevitably lead to exposure of the more strongly dispersive subsoil layers which will exacerbate the effects and severity of the gully erosion.

The following key strategies are recommended in order to reduce the likelihood of erosion:

- Only the minimum land required for the safe operation of the Project should be cleared;
- Land to be cleared should be surveyed and marked out prior to clearing and signed off by an appropriate person, to ensure no significant areas are inadvertently disturbed;
- Runoff from more elevated undisturbed areas should be directed around disturbed areas and topsoil stockpiles;



- Stockpiles should be ripped and seeded with a quick establishment pasture species, to limit erosion, and maintain a viable seed bank, if the period of stockpiling is greater than 1 growing season or 6 months;
- The overburden emplacement will be rehabilitated progressively in order to minimise the total disturbed area on the Project site at any time;
- Rehabilitated overburden emplacement areas will be deep ripped along the contour to maximise rainfall infiltration and minimise runoff;
- Rehabilitated slopes will have contour drains, in order to minimise slope lengths and runoff velocities;
- Runoff from rehabilitated areas will be collected in both contour and collection drains, then directed to sediment dams and settling ponds in order remove suspended sediment prior to discharge from the site;
- The disturbed area of the Project should be rehabilitated progressively where possible;
- Mine rehabilitation should aim to return the land to the pre-mining land suitabilities;
- Sediment dams or stormwater dams should be installed for all cleared areas and areas of mine or processing infrastructure; and
- Topsoil should be stripped to the depths nominated in Section 8.4.

9.0 REFERENCES

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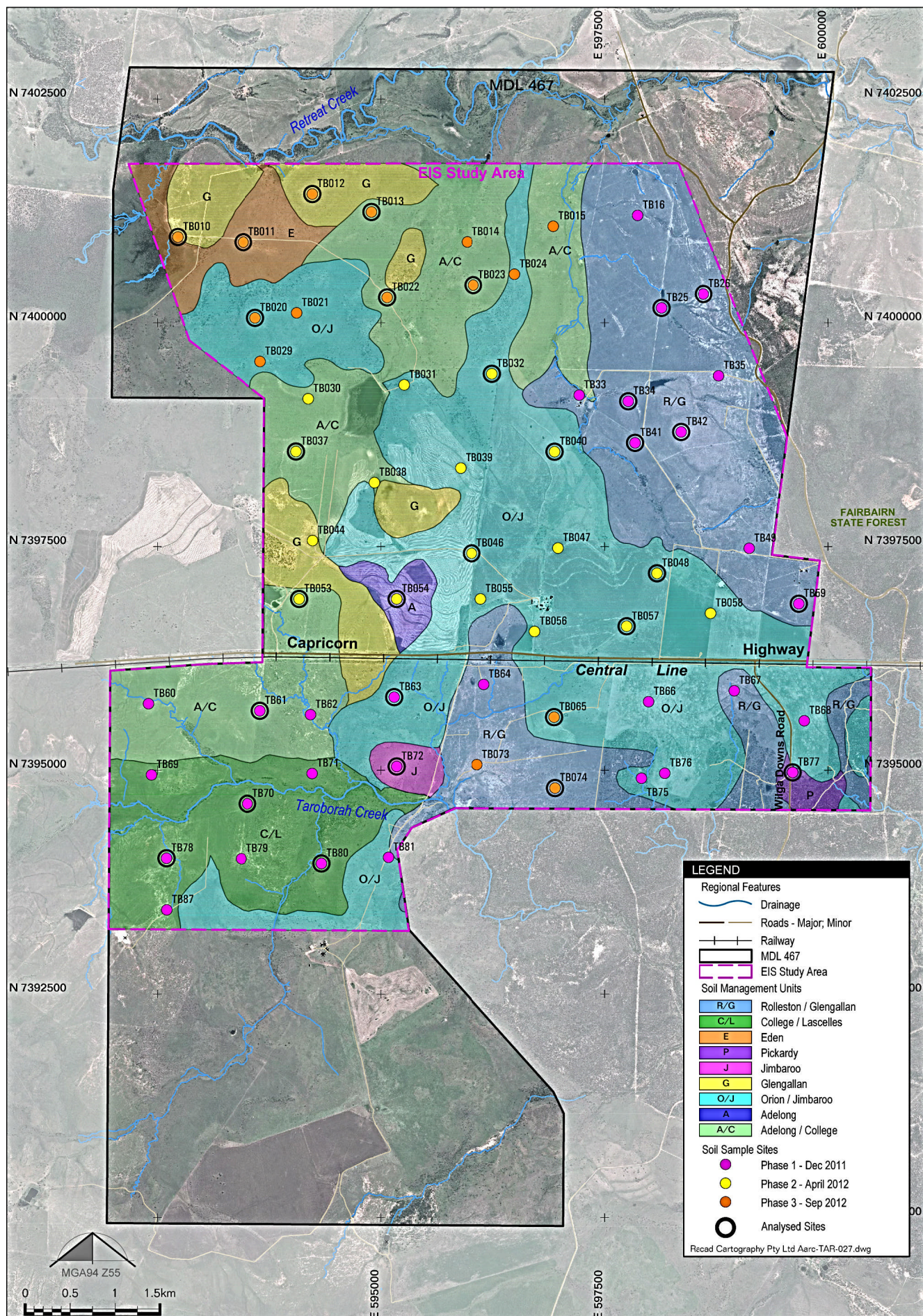
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Appendix A: Identification of Soil Sampling Locations and Laboratory Analysis Sites



Appendix B: Field Profile Descriptions

Site Description Sheet



Client:	Shenhua Group				
Date:	14/12/11	Site:	016		
Location:	Taroborah Coal Project	Map Reference:	E 597867	N 7401198	
Micro Relief:		Run-off:	2		
Permeability:	3	Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	H		
Landform	Slope (%):	1%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-20		D.brown grey		ZS					
A2	20-50		Brown/grey		ZS					
B21	60-120		L.brown/grey	M21DO	MHC					
2A1	120-150		Brown Grey	M12DO M11D8	LC					

Notes: Small hill or old alluvial plain, B21 may be a sodic hard pan. No erosion on landform, but much subsidence into the gully.

Vegetation	Cleared poplar box regrowth
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Site Description Sheet



Client:	Shenhua Group				
Date:	14/12/11	Site:	025		
Location:	Taroborah Coal Project	Map Reference:	E 598131	N 7400166	
Micro Relief:		Run-off:			
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	H		
Landform	Slope (%):		Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-30		Grey Brown		Zs					
A2	30-6-		Brownish Grey		ZS					
B21	60-90		Grey Brown	M31DR N21DG	MC			2KCI		
B22	90-150		Reddish Brown	M33PR M23PG	HC			2KS2		

Notes: 20 m from gully, but still a lower slope. Gully erosion nearby, B horizon sodic?

Vegetation	Cleared, cypress pine, ghost gum
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Site Description Sheet



Client:	Shenhuo Group				
Date:	14/12/11	Site:	026		
Location:	Taroborah Coal Project	Map Reference:	E 598604	N 7400320	
Micro Relief:		Run-off:	3		
Permeability:	3	Erosion:	S A 1 G A 1 1		
Drainage:		S C Fragments:	24 S SA S		
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	H		
Landform	Slope (%):	4% MOH	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		D Brown Grey		ZL					
B2	10-50		D.Grey	M22DR	CLS					
C1	50-120		Yellow Mottled White		Mottled Siltstone					
C2	120-150		White		Bleached Siltstone					

Notes:

Vegetation	Cleared, Ironbark, Angophora/Forest Red?? Acacia regrowth
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Site Description Sheet



Client:	Shenhua Group				
Date:	01/12/11		Site:	030	
Location:	Taroborah Coal Project		Map Reference:	E 594188	N 7399151
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):	5%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Brown cracking surface, firm. Dark brown clay to 40cm; brown MC below 40cm, stiff till 140cm grey clay pan? White flecks at 50cm; very few. Stiff Clay; grey clay pan @140-150cm orange mottles. Photos 100 2172 to 100 2184

Vegetation	
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Site Description Sheet



Client:	Shenhuo Group				
Date:	18/04/11		Site:	031	
Location:	Taroborah Coal Project		Map Reference:	E 595860	N 7399305
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: 0-70 black clay, big surface fragments (50% @ >100mm) self-mulch cracking clay. 70-100cm silty loam (ground up rock?) (hit rock early, possibly just ground it up). Rock fragments (60% @ 20-30mm). Photos 100-2200 to 100-2209.

Vegetation	
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Site Description Sheet



Client:	Shenhua Group				
Date:	18/04/12		Site:	032	
Location:	Taroborah Coal Project		Map Reference:	E 596243	N 7399430
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Firm clay surface; previously cultivated (pers comm.) dark brown. 0-90 dark brown heavy clay. 90-100 AZ. 100- MC brown, gravelly, >60cm fragments <10mm (sandstone?) This soil would extend West of sample site; now visible limitations to cropping/cultivation. Photos 100-2210 to 100-2221.

Vegetation	
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Site Description Sheet



Client:	Shenhua Group			
Date:	01/12/11	Site:	033	
Location:	Taroborah Coal Project	Map Reference:	E 597216	N 7399191
Micro Relief:		Run-off:	2	
Permeability:	3	Erosion:		
Drainage:		S C Fragments:		
Substrate:		Rock Outcrops:		
Site Disturbance:		Surface Condition:	L	
Landform	Slope (%):	3%	Morphological Type:	
	Relief:		Landform Element:	HSL
	Elevation:		Landform Pattern Type:	Hill

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		L Brown		ZFS					
A12	10-60		Brown Grey		LFS					
B21	60-100		Brown		HC					
C1	100-130				River rounded pebbles and HC					
C2	130-150				White siltstone and orange sandstone					

Notes: Mixing at 60cm

Vegetation	Partially cleared, ironbark, poplar box, ghost gum.
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Site Description Sheet



Client:	Shenhuo Group			
Date:	14/12/11	Site:	034	
Location:	Taroborah Coal Project	Map Reference:	E 897762	N 7399122
Micro Relief:		Run-off:	2	
Permeability:	2	Erosion:		
Drainage:		S C Fragments:		
Substrate:		Rock Outcrops:		
Site Disturbance:		Surface Condition:	L	
Landform	Slope (%):	2%	Morphological Type:	
	Relief:		Landform Element:	HSL
	Elevation:		Landform Pattern Type:	Hill

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A11	0-20		D Grey		SL					
A12	20-40		D Blacky Grey		SCL					
A2	40-50		Light Brown		SCL					
B21	50-100		L Yellowy Brown	M31PO M22DG	HC					
B22/B3	100-110		Pale Grey		HC					
C1	110-150		Yellowy White		Decom sandstone/ med stone					

Notes:

Vegetation	Cleared
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Site Description Sheet



Client:	Shenhua Group				
Date:	14/12/11	Site:	035		
Location:	Taroborah Coal Project	Map Reference:	E 598775	N 7399407	
Micro Relief:		Run-off:	3		
Permeability:	2	Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	H		
Landform	Slope (%):	5%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-30		D.browny Grey		LS					
A3	30-50		D. Grey		SCL					
B21	50-70		Grey		MC					
C1	70-110		Yellow White		Decom Sandstone					
C2	110-150		Orangey Yellow		Decom Sandstone					

Notes: The A3 horizon (30-50) may be a mixture of the A1 + B21.

Vegetation	Cleared, cypress pine.
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Site Description Sheet



Client:	Shenhuo Group				
Date:	18/04/12	Site:	037		
Location:	Taroborah Coal Project	Map Reference:	E 594050	N 7398560	
Micro Relief:		Run-off:			
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:			
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Thick grass covering, very firm surface, regular large cracking, brown with red mottles/accumulations throughout profile (medium to fine size). More prominent below 40cm and then at 90cm but visible in surface sample (recent mechanical mixing). Brown MC 0-40cm; 40-90cm M/HC brown, 90-150 HC brown. Noticeably more clay at 90cm. Photos 100-2156 to 2171.

Vegetation	Non remnant grassland
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Site Description Sheet



Client:	Shenhua Group				
Date:	18/04/12		Site:	038	
Location:	Taroborah Coal Project		Map Reference:	E 594925	N 7398212
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):	1%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Between cultivated areas. Cracking surface (self mulch?) (Heavily grassed). 0-130 black grey HC. 130-150 br M/HC

Vegetation	
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Site Description Sheet



Client:	Shenhua Group				
Date:	17/04/12		Site:	040	
Location:	Taroborah Coal Project		Map Reference:	E 596437	N 7398559
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):		Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: 0-140 black C. Vertisol, self-mulch, moist throughout profile. (photos 100-2072 to 100 2082).

Vegetation	
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Site Description Sheet



Client:	Shenhua Group				
Date:	14/12/11		Site:	041	
Location:	Taroborah Coal Project		Map Reference:	E 597837	N 7398656
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:	S	
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-20		D browny Grey		LS					
A3	20-40		Browny Grey		FSCL					
B21	40-100		Yellowy Brown		MC			2KC1 2KC2		
B22	100-150		Browny Yellow		HC			1KC1		

Notes:

Vegetation	Cleared
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Site Description Sheet



Client:	Shenhua Group				
Date:	14/12/11	Site:	042		
Location:	Taroborah Coal Project	Map Reference:	E 598351	N 7398778	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	H		
Landform	Slope (%):	3%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-20		Grey brown		LS					
A12	20-40		Yellowy brown		LS					
A13	50-60		Brownish Yellow		LS					
B21	60-100		Brownish Yellow	M31PO	CS					
B22	100-140		Yellow Grey	M2110	CS					
B23/C1	140-150		Yellowish white		ZS					

Notes: Sandy soil, hard to tell if bottom is decom. sandstone.

Site Description Sheet



Client:	Shenhua Group				
Date:	18/04/12		Site:	044	
Location:	Taroborah Coal Project		Map Reference:	E 594236	N 7397566
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Br FSCL 0-20cm, BR SCL 30-60cm, BR LC 60-100, Light Br 100-140, some grey clay (HC) with orange mottles (possibly continuing deeper). Photos 100-2118-100-2131.

Vegetation	
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Site Description Sheet



Client:	Shenhua Group			
Date:	18/04/12	Site:	046	
Location:	Taroborah Coal Project	Map Reference:	E 596015	N 7397424
Micro Relief:		Run-off:		
Permeability:		Erosion:		
Drainage:		S C Fragments:		
Substrate:		Rock Outcrops:		
Site Disturbance:		Surface Condition:		
Landform	Slope (%):	1%	Morphological Type:	
	Relief:		Landform Element:	
	Elevation:		Landform Pattern Type:	

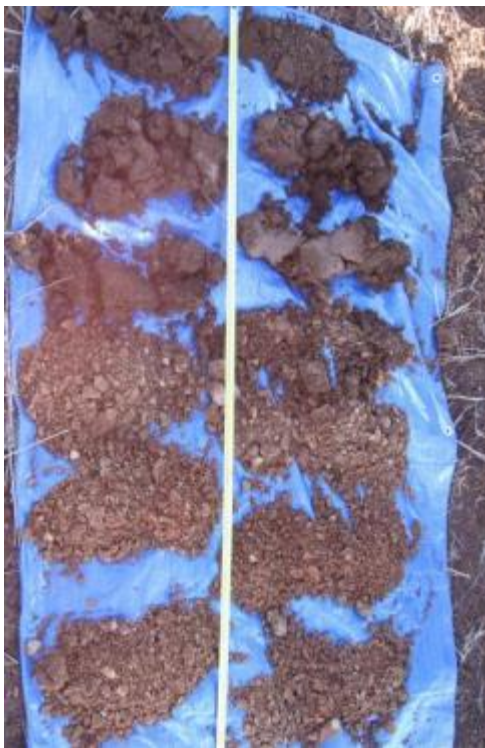
Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Self mulching surface. Black/grey clay (HC) filled, no rock fragments 0-60, 60-70 AZ. Under cultivation/crop. 70cm brown M/HC rock fragments and gravel 50% at <30mm. Rock @ 120cm by 130cm >90% rock fragments. Photos 100-2098 to 100-2108

Vegetation	
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Site Description Sheet



Client:	Shenhua Group				
Date:	17/04/12	Site:	047		
Location:	Taroborah Coal Project	Map Reference:	E 596980	N 7397481	
Micro Relief:		Run-off:			
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:			
Landform	Slope (%):		Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Cultivated, self-mulching surface, vertisol. 0-60cm A1 Black HC, 60-70cm B1 Black/brown HC gravel, 80% @ <30mm, 70-150cm B Brown H/MC gravel siltstone (grey?) 80% @ < 50mm. Photos 100-2056 to 100-2071

Vegetation	Cleared/cultivated
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Site Description Sheet



Client:	Shenhua Group				
Date:	17/04/12		Site:	048	
Location:	Taroborah Coal Project		Map Reference:	E 598081	N 7397199
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):	2	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Cultivated plain, self mulch surface; <10% rock fragments/pebbles <30mm dia. Black HC 0=80cm upper; Distinct BR and texture change @ 80cm gravel <20mm 50% sandstone. Texture change again @ 140cm; rock fragments <40mm 50%. Photos 100-2044 to 100-2057.

Vegetation	
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Site Description Sheet



Client:	Shenhua Group				
Date:	01/12/11	Site:	049		
Location:	Taroborah Coal Project	Map Reference:	E 599117	N 7397478	
Micro Relief:		Run-off:	2		
Permeability:	3	Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	H		
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A11	0-20		Greyey brown		ZFS	23 A SA M				
A12	20-50		D greyey brown		ZFS	43 A SA M 4 A SA M				
B21/B3	50-60		D greyey brown	M33PG M23DO	ZMC	13 A SA M				
C1	60-100		Mottled yellowy white		Weathered siltstone					
C2	100-150		Off white		Siltstone					

Notes: Sandstone coarse fragments are blood red B3 mottles may be mixed in siltstone.

Vegetation	Cleared, poplar box, acacia regrowth, ironbark is around.
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Site Description Sheet



Client:	Shenhua Group				
Date:	18/04/12		Site:	053	
Location:	Taroborah Coal Project		Map Reference:	E 594086	N 7396912
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Very firm surface, some large cracks. 0-30cm A, BR Silty loam, dark brown. 30-40 A2 Silty CL, 40-80cm B2 LC, 80-140 C, gravel MC/rock fragments 70% @ <15mm, 140-150cm C2, HC red/yellow mottles, lighter brown. Photos 100-2133 to 100-2141.

Vegetation	Non remanent grassland
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Site Description Sheet



Client:	Shenhua Group				
Date:	18/04/12		Site:	055	
Location:	Taroborah Coal Project		Map Reference:	E 896117	N 7396912
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):	1%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Cultivated alluvial plain. Self mulching surface. No surface fragments. HC, black/darker br, 0-110; 110 onwards HC, brown calcareous flecks, gravelly 30% small @ <20mm, texture change. Photos 100-2083 to 100-2097.

Vegetation	
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Site Description Sheet



Client:	Shenhua Group				
Date:	17/04/12	Site:	056		
Location:	Taroborah Coal Project	Map Reference:	E 596719	N 739549	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:			
Drainage:	4	S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	L/M		
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:	ALPL	
	Elevation:		Landform Pattern Type:	Plain	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
Cultivated	0-120				HC					
	120-B				MC	42				

Notes: Cultivated land to depth 120cm. A Mod to H clay tilled; blacked, surface cracking, strong peds. Self-mulching vertosol, B gravelly MC; yellow BR. Photos 100-2006 to 100-2015.

Vegetation	Cleared
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Site Description Sheet



Client:	Shenhua Group				
Date:	17/04/12	Site:	057		
Location:	Taroborah Coal Project	Map Reference:	E 597744	N 7396606	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:			
Drainage:	4	S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:			
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:	ALPL	
	Elevation:		Landform Pattern Type:	Plain	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
	0		Black		HC					
	140		Slight Brown		HC					

Notes: Cultivated land to depth of 120cm, self mulching. Same as TB056 throughout 0-140cm, Black HC. 140-180cm HC but brown. Photos 100-2018 to 100-2032.

Vegetation	
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Site Description Sheet



Client:	Shenhua Group				
Date:	17/04/12	Site:	058		
Location:	Taroborah Coal Project	Map Reference:	E 598686	N 7396752	
Micro Relief:		Run-off:			
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:			
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Cleared, not cultivated. Should be same as TB056. Self mulch surface, no fragments. Upper Black HC. Vertisol @ 130cm BRHC Gravel <15% oresebt <30%. Slight change @ 100cm more pedal than massive (moisture change?). Photos 100-2034 to 100-2043

Vegetation	Cleared
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Site Description Sheet



Client:	Shenhua Group				
Date:	01/12/11	Site:	059		
Location:	Taroborah Coal Project	Map Reference:	E 599672	N 7396860	
Micro Relief:		Run-off:	3		
Permeability:	3	Erosion:			
Drainage:	3	S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	SL		
Landform	Slope (%):	3%	Morphological Type:		
	Relief:		Landform Element:	HILM	
	Elevation:		Landform Pattern Type:	HSLM	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		Greyed Brown		LFS					
B21/A12	10-50		Reddy Brown	M11FY	FSCL	32 S SA S				
B22/B21	40-80		L. Brown		FSLC	31 S QZ S		2 K S 3		
B23/B22	80-100		L. Brown		HCH	21 S QA S		2 K S 1		
C	100-150		Pale Yellow		Weathered siltstone					

Notes:

Vegetation	Partially cleared poplar box, bullock, long fingered Grevillia
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11		Site:	060	
Location:	Taroborah Coal Project		Map Reference:	E 592399	N 7395741
Micro Relief:			Run-off:	3	
Permeability:	2		Erosion:	G/S	
Drainage:			S C Fragments:	2 1 A MU N	
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:	G	
Landform	Slope (%):	3%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	HILL	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		Red Brown		LC	32 S SA S				
B21	10-20		D Red Brown		MC	22 S SA S				
B22	20-50		Greyed Brown		HC	12 A SA S				
B23/C1	50		Pale Grey	M22FO M32PG	HC or wet mudstone					

Notes:

Vegetation	Cleared
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Site Description Sheet



Client:	Shenhua Group				
Date:	13/12/11		Site:	061	
Location:	Taroborah Coal Project		Map Reference:	E 593647	N 7395663
Micro Relief:			Run-off:	2	
Permeability:	2		Erosion:		
Drainage:	3		S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:	S	
Landform	Slope (%):	3%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-20		D. Grey		LC					
B21	20-70		Black Grey		MC	1		1 KC 1		
B22	70-110		Black Grey		MHS	1		2 KC 1		
B23	110-150		D. Grey		HC	2		3 KC 1		

Notes: Classic grey Brigalow clay

Vegetation	Regrowth, Brigalow, prickly acacia, serra
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Site Description Sheet



Client:	Shenhua Group				
Date:	01/12/11	Site:	062		
Location:	Taroborah Coal Project	Map Reference:	E 594212	N 7395619	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	S		
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-50		D. Brown		FSLC					
B21	50-100		Brown		LCM					
B22	100-150		L. Brown		MC	M 1 1 FD M 1 1 FO		1 KN 1		

Notes: Soil surface wet – may crack?

Vegetation	Regrowth – false sandalwood? ODD Brigalow and poplar box regrowth
------------	---

Site Description Sheet



Client:	Shenhua Group				
Date:	01/12/11		Site:	063	
Location:	Taroborah Coal Project		Map Reference:	E 595147	N 7395815
Micro Relief:			Run-off:	3	
Permeability:	2		Erosion:		
Drainage:	3		S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:	S	
Landform	Slope (%):	5%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	LOW	

Horizon	Depth (m)	Boundary	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-40			LMC	12 A SA S				
B21	40-90			MHC	14 A SA S		2 KN 1		
B22	90-150		M 21 DB	HC	14 A SA S				

Notes: Soil is wet, but there were some minor cracks. Appears to be on boundary west 50m (may be Brigalow soil that was recently cleared < 5 years).

Vegetation	Cleared – not Brigalow, Brigalow's cousin
------------	---

Site Description Sheet



Client:	Shenhua Group				
Date:	13/12/11	Site:	064		
Location:	Taroborah Coal Project	Map Reference:	E 596153	N 7395958	
Micro Relief:		Run-off:	3		
Permeability:	3	Erosion:			
Drainage:		S C Fragments:	3 3 RP QZ		
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	S		
Landform	Slope (%):	4%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-20		D Brown		CLFS	42 S QZ S				
B21	20-50		D Brown Yellow	M31DD	MC	11 SP SA M		1 K S 2		
B22	50-70		Yellowy Brown	M31DD M11DP	MC					
B23	70-100		L brown Yellow	M31DP	MC					
C					Yellow sandstone					

Notes: Midslope – above creek, gully to east 100m

Vegetation	Cleared, probably poplar box, false sandalwood.
------------	---

Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11	Site:	066		
Location:	Taroborah Coal Project	Map Reference:	E 597988	N 7395769	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	G		
Landform	Slope (%):	1%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	HCR	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		D Grey Brown		LMC					
B21	10-40		V Dark Grey		MHC					
B22	40-60		V Dark Grey		HC					
	60-100		Yellowy Brown	M 31 PO	HC	3 2 S IS M		2 KN I 2 KS		
	100-150		L Brown	M 11 DO	MC	3 2 S IS M		2 KN 1 2 KS		

Notes: Possible gilgai, Carbonate covered rocks below 60 cm. Slicker sides 20-60.

Vegetation	Cleared
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11	Site:	067		
Location:	Taroborah Coal Project	Map Reference:	E 598951	N 7395888	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	G		
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:	HSLM	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		V Dark Grey		LC					
B21	10-40		D Grey		LMC					
B22	40-60		D Grey		MHC					
C?	60-100		Pale Brown		HC	33 A IP 3 AP		3 K S I		
C?	100-150		Pale Yellowy Brown		HC	33 A IS 3 AP		3 K S I		

Notes: Possible gilgai? – Tall grass. The white coarse fragments appear to be ironstone? Or red sandstone covered in carbonate.

Vegetation	Cleared, similar veg to 77?
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11	Site:	068		
Location:	Taroborah Coal Project	Map Reference:	E 599733	N 7395551	
Micro Relief:		Run-off:			
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	G		
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:	HSLH	
	Elevation:		Landform Pattern Type:	HILL	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		D Grey Brown		LC					
B21	10-30		Grey Brown		LMC					
B22	30-60		Grey Brown		HC					
C1	60-150		Pale Brown		Rocky mudstone					

Notes: Distinct cracking of a wet soil. Possibly gilgai – tall grass?? Slickensides @30-60

Vegetation	Cleared, similar veg to 77?
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11	Site:	069		
Location:	Taroborah Coal Project	Map Reference:	E 592435	N 7394946	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	H (G)		
Landform	Slope (%):	3%	Morphological Type:		
	Relief:		Landform Element:	HSLU	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-20		Dark Brown		FSLC					
B21	20-30		Brown	M I I P Y	FSMC					
B22	30-50		Yellowy Brown	M 3 3 P B	FSHC					
C1	50-90		Yellowy Brown		Decom mudstone	10 MU				
C2	90-120		Yellowy Brown		Wet decom mudstone			2 K S 2		
C3	120-150		Pale Yellow		Decom mudstone					

Notes: Hard setting with very minor surface cracking. This profile seems mixed up between 90-120? Investigate.

Vegetation	Cleared
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11	Site:	070		
Location:	Taroborah Coal Project	Map Reference:	E 593505	N 7394624	
Micro Relief:		Run-off:	1		
Permeability:	2	Erosion:			
Drainage:		S C Fragments:	2 2 S MU M		
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	G (H)		
Landform	Slope (%):	>1%	Morphological Type:		
	Relief:		Landform Element:	PLA	
	Elevation:		Landform Pattern Type:	ALPP	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-30		VD Grey		MC					
B21	30-100		VD Grey		HC					
B22	100-120		D. Grey	M 2 1 F O	HC	1 2 S MU M		1 K S 1		
B23	120-150		Brownish Grey	M 1 1 FO	HC	1 2 S MU M		2 M L 1 1 K S 1		

Notes: Melon holed flood plain- soil is very wet and pooling. Buried soil underneath.

Vegetation	Cleared, regrowth Brigalow, false sandalwood, poplar box?
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11	Site:	072		
Location:	Taroborah Coal Project	Map Reference:	E 595174	N 7395040	
Micro Relief:		Run-off:	2		
Permeability:	3	Erosion:			
Drainage:	3	S C Fragments:	4 4 A 3A S		
Substrate:		Rock Outcrops:	3 BA		
Site Disturbance:		Surface Condition:	S(C)		
Landform	Slope (%):	1%	Morphological Type:		
	Relief:		Landform Element:	TOR	
	Elevation:		Landform Pattern Type:	LOW	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-22		D Brown		Cl	4 3 S BA S 3 4 S BA S				
C	22				Basalt					

Notes: Basalt plateau on a basalt ridge. Skeletal soils over or amongst basalt.

Vegetation	Some bloodwood, yellow gum (Forest Red), silver leaved ironbark
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11		Site:	075	
Location:	Taroborah Coal Project		Map Reference:	E 597909	N 7394909
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:	H-G	
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
0-10			L Brown		LMC	1 2 S SA S				
10-20			D Browny Grey		HC	1 2 S SA S				
20-50			V Dark Grey		HC	1 2 S SA S		1 K S 1		
50-100			L Yellowy Brown		HC			1 K N 2		
100-150			L Browny Yellow		HC			2 K S 1		

Notes: Soil colour. Maybe lower in landscape, hard to tell due to heavy timber, moderate cattle trampling of site.

Vegetation	Brigalow, poplar box, false sandalwood, Wilga, unknown gum
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11	Site:	076		
Location:	Taroborah Coal Project	Map Reference:	E 598170	N 7394965	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:	G A 1 1		
Drainage:		S C Fragments:	1 4 S SA M		
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	G		
Landform	Slope (%):	3%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	HILL	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		D Grey		LMC	1 1 A SA W				
B21	10-60		D Grey		MHC	1 1 A SA W				
B22	60-100		D Grey		HC	1 1 A SA W				
C1	100-150		Pale Yellow		Rocky mudstone					

Notes:

Vegetation	Cleared
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Site Description Sheet



Client:	Shenhua Group				
Date:	14/12/11	Site:	077		
Location:	Taraborah Coal Project	Map Reference:	E 599603	N 7394975	
Micro Relief:		Run-off:	1		
Permeability:	2	Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	G F		
Landform	Slope (%):	>1%	Morphological Type:		
	Relief:		Landform Element:	HCRU	
	Elevation:		Landform Pattern Type:	HSL	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		D Red		LC					
B21	10-60		Browny Red		MHC					
B22	60-110		D Red		HC					
B23	110-150		Very Red		HC					

Notes: Signs of stickensides at 90cm.

Vegetation	Remnant, Blackbutt, Brigalow, Wilga, Sandalwood
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11	Site:	078		
Location:	Taroborah Coal Project	Map Reference:	E 592599	N 7394015	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:	G A 1 1		
Drainage:		S C Fragments:	2 2 S SA S		
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	G		
Landform	Slope (%):	4%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		L Brown		LC	1 2 S SA S				
B21	20-40		D Brown		MC	1 2 S SA S				
B22	40-100		D Brown		HC	1 2 S SA S				
B23	100-130		L Brown		HC Feels MC but wet					
B24	130-150		Yellowy Brown		HC			2 K C 1		

Notes:

Vegetation	Cleared
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11	Site:	079		
Location:	Taroborah Coal Project	Map Reference:	E 593435	N 7394010	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:			
Drainage:		S C Fragments:	2 3 S AZ/MU/SA M		
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	H		
Landform	Slope (%):	1%	Morphological Type:		
	Relief:		Landform Element:	HCRM	
	Elevation:		Landform Pattern Type:	HSL	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		D Grey		ZCL	1 2 SP SA S				
B2	10-20		D Grey		LC	1 2 SP SA S				
B22	20-50		Yellowy Grey	M 3 2 P o M 2 1 D G	HC					
B3/C1?	50-150		Greyey Yellow	M 2 2 D O M 1 1 DP	ZHC? Or mottled mudstone					

Notes: Hard setting surface with no signs of cracking

Vegetation	Cleared, regrowth of Brigalow, poplar box, false sandalwood, Wilga
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Site Description Sheet



Client:	Shenhua Group				
Date:	15/12/11	Site:	080		
Location:	Taroborah Coal Project	Map Reference:	E 594336	N 7393956	
Micro Relief:		Run-off:	3		
Permeability:	2	Erosion:	S A 1/2		
Drainage:		S C Fragments:	3 2 S MU W		
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	G		
Landform	Slope (%):	5%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		Browny D Grey		MC					
B2	10-80		D Grey		HC	2 2 A MU W				
B3	90-100		D Grey		HC	5 s A MU W				
C	100-150		Mottled Yellow	M O M G	Decom Mudstone					

Notes: Possible sheet erosion of a light A horizon?

Vegetation	Cleared, gum topped box? Stringybark, bloodwood
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Site Description Sheet



Client:	Shenhua Group				
Date:	13/12/11	Site:	081		
Location:	Taroborah Coal Project	Map Reference:	E 595082	N 7394026	
Micro Relief:		Run-off:	2		
Permeability:	2	Erosion:			
Drainage:	3	S C Fragments:	1 3 R BA S		
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	G (S)		
Landform	Slope (%):	2%	Morphological Type:		
	Relief:		Landform Element:	HSLM	
	Elevation:		Landform Pattern Type:	Hill	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-20		Greyey Brown		LC					
B21	20-60		D Browny Grey		HC	1 1 A - S		1 K C 1		
B22	60-100		D Browny Grey		VHC	1 1 A - S		2 K C 1		
C	100-150		Yellowy Brown		Decom Sandstone/ mud					

Notes: May be slickensides present.

Vegetation	Ironbark, Blackbutt
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Site Description Sheet



Client:	Shenhuo Group				
Date:	15/12/11		Site:	082	
Location:	Taroborah Coal Project		Map Reference:	E 592603	N 7393439
Micro Relief:			Run-off:	3	
Permeability:	1		Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:	H (C)	
Landform	Slope (%):	5%	Morphological Type:		
	Relief:		Landform Element:	HSL	
	Elevation:		Landform Pattern Type:	HSL	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
	0-10		Greyey Brown		FSL					
	10-20		VD Grey		FSZL					
	20-50		Grey		FSZL					
	50-70		D Grey		FSCL					
	70-100		Pale Grey		FSCL					
	100-150		White		Mudstone					

Notes:

Vegetation	Blackbutt, Sandalwood
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Site Description Sheet



Client:	Shenhua Group				
Date:	18/04/12	Site:	010		
Location:	Taroborah Coal Project	Map Reference:	E 5927256	N 7400958	
Micro Relief:		Run-off:			
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:			
Landform	Slope (%):		Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Adjacent (uphill) of swamp. Loose, silty loam surface. Likely dispersive. 0-20cm silty loam, brown 20-40cm clayey loam, brown, 40-50cm grey clay layer (medium clay), 50-60cm brown clay loam, 60-70cm transition or auger mixing? 70cm-140cm grey silty clay (orange mottles) possible a pan. Photos 100-2222 to 100-2236.

Vegetation	Non-remnant grassland, bloodwood, ghost gum
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Site Description Sheet



Client:	Shenhua Group			
Date:	06/09/12	Site:	65	
Location:	Taroborah Coal Project	Map Reference:	E 2596936	N 7395592
Micro Relief:	Normal	Run-off:	2	
Permeability:		Erosion:	Gully/Stream bank 3	
Drainage:		S C Fragments:	4	
Substrate:	Moderate Basalt	Rock Outcrops:	2	
Site Disturbance:	Extensive clearing	Surface Condition:	Cracking/self-mulching	
Landform	Slope (%):	1-2%	Morphological Type:	Flat
	Relief:	Bad lands	Landform Element:	DDE
	Elevation:	235	Landform Pattern Type:	RIS

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10	D	7.5YR32		MC		M P 5-10		D3 3	5 – 7.0
B2	10 +		7.5YR32		HC		M L 10-20		D3 3	30 – 7.0
										60 – 7.0
										8.0
										8.5

Notes: Crack Width 10-20 Stickiness – Moderately, Pans – uncemented.

Vegetation	Isolated clumps, 1.01-2.0 Height, Mitchell grass, prickly acacia, small melon holes <density required for SCL
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Site Description Sheet



Client:	Shenhua Group				
Date:	06/09/12	Site:	TB74		
Location:	Taroborah Coal Project	Map Reference:	E 0596946	N 7394800	
Micro Relief:	Normal	Run-off:	2		
Permeability:		Erosion:			
Drainage:		S C Fragments:	0		
Substrate:	Moderate Andesite	Rock Outcrops:			
Site Disturbance:	Complete clearing, not cultivate	Surface Condition:	Hard Setting		
Landform	Slope (%):	1-2%	Morphological Type:	Flat	
	Relief:	GUP	Landform Element:	PLA	
	Elevation:	247m	Landform Pattern Type:	PLA	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	10-40		10YR42		SL	P 5-10	V		4	5 -6.5
B21	40-80		5YR31		MHC	L 5-10	M		3	30 – 7.5
B22			15Y41		MHC		M	10-20 Soft 2-6	3	60 – 8.5
										90 -8.5

Notes: Moderately sticky to slightly sticky, pans uncemented

Vegetation	Rhodes Grass, big melon holes, sparse coverage, non-dense enough to rule out SCL. Non cracking grey clay
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Site Description Sheet



Client:	Shenhua Group			
Date:	--09/12	Site:	TB 73	
Location:	Taroborah Coal Project	Map Reference:	E 0596076	N 7395060
Micro Relief:		Run-off:	4	
Permeability:		Erosion:	Moderate sheet	
Drainage:		S C Fragments:	3	
Substrate:	Strong sandstone highly siliceous	Rock Outcrops:	2	
Site Disturbance:	Complete clearing, not cultivated	Surface Condition:	Hard setting	
Landform	Slope (%):	4%	Morphological Type:	Upper slope
	Relief:	Undulating rises	Landform Element:	HSL
	Elevation:	232m	Landform Pattern Type:	RIS

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	10	5	7.5YR337 7.5YR 54		SL	2 SA	V		4	

Notes: Slightly sticky

Vegetation	Grass
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Site Description Sheet



Client:	Shenhuo Group				
Date:	06/09/12	Site:	TB 29		
Location:	Taroborah Coal Project	Map Reference:	E 0593648	N 7399567	
Micro Relief:		Run-off:	2		
Permeability:		Erosion:			
Drainage:		S C Fragments:	2		
Substrate:	Moderate basalt	Rock Outcrops:	3		
Site Disturbance:		Surface Condition:	Cracking/self-mulching		
Landform	Slope (%):	4%	Morphological Type:	Mid Slope	
	Relief:	Undulating rises	Landform Element:	HSL	
	Elevation:	246m	Landform Pattern Type:	RIS	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	10-110	C	10YR22				M P 5-10		D4	5 - 7.5
B2	110+	C	10YR22				M SAB 10-20		T5	30 -7.5
B3			10YR62				V		T4	60 – 7.5
										90 – 7.5

Notes: Slightly sticky

Vegetation	Native and improved pastures
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Site Description Sheet



Client:	Shenhua Group				
Date:	07/09/12		Site:	TB20	
Location:	Taroborah Coal Project		Map Reference:	E 0593592	N 7400053
Micro Relief:			Run-off:	2	
Permeability:			Erosion:		
Drainage:			S C Fragments:	3	
Substrate:	Strong basalt		Rock Outcrops:	2	
Site Disturbance:			Surface Condition:	Cracking/self-mulching	
Landform	Slope (%):	4%	Morphological Type:	Upper slope	
	Relief:	Undulating low hills	Landform Element:	HSL	
	Elevation:	237M	Landform Pattern Type:	LOW	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A	10-35		7.5YR32		MC		M P 5-10		T	5 – 7.5
B	35+		7.5YR32		HC		M L 10-20		T	30 – 7.5
C										

Notes: Rock at 35cm. Slightly sticky

Vegetation	Isolated clumps, 5.01-10 high, SLIB, SG, Bloodwood, NP&IP
------------	---

Site Description Sheet



Client:	Shenhua Group				
Date:	07/09/12	Site:	TB21		
Location:	Taroborah Coal Project	Map Reference:	E 0594057	N 7400111	
Micro Relief:	Normal	Run-off:	2		
Permeability:		Erosion:			
Drainage:		S C Fragments:	3		
Substrate:	Moderate Basalt	Rock Outcrops:	2		
Site Disturbance:	Complete clearing, not cultivated	Surface Condition:	Cracking/self-mulching		
Landform	Slope (%):	2	Morphological Type:	Upper slope	
	Relief:	Undulating low hills	Landform Element:	HSL	
	Elevation:	245m	Landform Pattern Type:	LOW	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	10-60		7.5YR2.5/2		MHC		S P 20-50		T3	5 – 7.8
B2	60-70		10YR2/2		MHC		M L 20-50		T3	30 – 7.8
B3	70 +		10YR52		LMC		V			60 – 7.8

Notes: Isolated clumps, 5.01-10 high. Crack width 10-30. Slightly sticky.

Vegetation	Bloodwood NP&IP
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Site Description Sheet



Client:	Shenhua Group			
Date:	07/09/12	Site:	TB22	
Location:	Taroborah Coal Project	Map Reference:	E 0595067	N 7400282
Micro Relief:	Normal	Run-off:	1	
Permeability:		Erosion:		
Drainage:		S C Fragments:		
Substrate:	Moderate basalt	Rock Outcrops:		
Site Disturbance:	Extensive clearing	Surface Condition:	Cracking/self-mulching	
Landform	Slope (%):	3%	Morphological Type:	Lower slope
	Relief:	Undulating low hills	Landform Element:	HSL
	Elevation:	215 m	Landform Pattern Type:	LOW

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A	15-145	D	10YR22		MHC		M P 5-10		T4	5 – 7.5
B	145 +		1-YR22		HC		S L 10-20		T4	30 - 8
										60 – 7.5
										90 – 7.5
										120 – 8.0

Notes: Crack width 5-10, moderately sticky. Cracking clay, self mulch, deep

Vegetation	Isolated clumps 5.01-10 high, Brigalow, gum and apple box N&I pastures.
------------	---

Site Description Sheet



Client:	Shenhua Group				
Date:	07/09/12	Site:	TB12		
Location:	Taroborah Coal Project	Map Reference:	E 0594233	N 7401438	
Micro Relief:		Run-off:	3		
Permeability:		Erosion:	Sheet, minor		
Drainage:		S C Fragments:			
Substrate:	Moderate sedimentary	Rock Outcrops:			
Site Disturbance:	Extensive clearing	Surface Condition:	Hard setting		
Landform	Slope (%):	2%	Morphological Type:	Simple slope	
	Relief:	G undulating rises	Landform Element:	HSL	
	Elevation:	220 m	Landform Pattern Type:	RIS	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	30		10YR43		LS		M		D2	5 – 6.5
C									D	30 – 6.5

Notes: non-sticky. Soil derived from sed. Material, harder country.

Vegetation	Isolated clumps, 2.01-5.0 high SLIB N&IM pasture
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Site Description Sheet



Client:	Shenhua Group				
Date:	07/09/12	Site:	TB14		
Location:	Taroborah Coal Project	Map Reference:	E 0595695	N 7400902	
Micro Relief:	Normal	Run-off:	1		
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:	Moderate basalt	Rock Outcrops:			
Site Disturbance:	Complete clearing, not cultivated	Surface Condition:	Cracking/self-mulching		
Landform	Slope (%):		Morphological Type:	Lower slope	
	Relief:	G undulating rises	Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	10-100	D	10YR22		MC		M P 10-20		D3	5 – 7.0
B21	100-150	C	10YR22		MHC		M L 10-20		T3	30 – 7.8
B22	150+		10YR43		HC		W AB 5-10		T3	60 -7.0
										90 – 8.0
										120 -8.0

Notes: , Alluvial Basalt material. Crack width 20-50, pores present. Slightly sticky.

Vegetation	Emergent 1.01-2.0 high, native and improved pasture, Acacia spp. Regrowth
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Site Description Sheet



Client:	Shenhua Group				
Date:	07/09/12	Site:	TB23		
Location:	Taroborah Coal Project	Map Reference:	E 0596033	N 7400419	
Micro Relief:	Normal	Run-off:	1		
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:	Moderate basalt	Rock Outcrops:			
Site Disturbance:	Complete clearing, not cultivated	Surface Condition:	Cracking/self-mulching		
Landform	Slope (%):		Morphological Type:	Lower slope	
	Relief:	G undulating rises	Landform Element:	HSL	
	Elevation:	212 m	Landform Pattern Type:	RIS	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	15-150	C	10YR32		MHC		M P 10-20		D4	5 – 7.0
B2	150+		10Yr22		HC		S L 10-20		T3	30 – 7.8
										60 – 7.8
										90 – 7.8
										120 – 7.8

Notes: Lots of small gilgai. Crack width 20-50, pores present, slightly sticky.

Vegetation	Emergent 0.26-0.5 high, native and improved pastures.
------------	---

Site Description Sheet



Client:	Shenhuo Group				
Date:	07/09/12	Site:	TB24		
Location:	Taroborah Coal Project	Map Reference:	E 0596495	N 7400541	
Micro Relief:	Normal	Run-off:	2		
Permeability:		Erosion:			
Drainage:		S C Fragments:	4		
Substrate:	Strong basalt	Rock Outcrops:	4		
Site Disturbance:	Extensive clearing	Surface Condition:	Cracking/self-mulching		
Landform	Slope (%):	2%	Morphological Type:	Crest	
	Relief:	Undulating rises	Landform Element:	HCR	
	Elevation:	230 m	Landform Pattern Type:	RIS	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	10-50	C	10YR22		MC	2 SR 60-200 BI	M P 10-20		4	
B2	50+	S	10YR22		MHC	2 SR 60-200 BI	M P 10-20		3	
C										

Notes: Too many rocks, not SCL. Crack width 20-50, pores present. Slightly sticky. Vertosol, black.

Vegetation	Isolated clumps 2.01-5.0 high, native and improved pastures.
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Site Description Sheet



Client:	Shenhua Group				
Date:	07/09/12	Site:	TB15		
Location:	Taroborah Coal Project	Map Reference:	E 0596927	N 7401077	
Micro Relief:	Normal	Run-off:	1		
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:	Moderate basalt	Rock Outcrops:			
Site Disturbance:	Complete clearing, not cultivated	Surface Condition:	Cracking/self-mulching		
Landform	Slope (%):	3%	Morphological Type:	Lower slope	
	Relief:	Undulating rises	Landform Element:	HSL	
	Elevation:	211 m	Landform Pattern Type:	RIS	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	10-110		10YR33		MC		M SAB 20-50		D	5 -7.5
B21	110-150		10YR33		MHC		M SAB 10-20		T	30 – 7.5
B22	150+		10YR34		MHC		W AB 20-50		T	60 - 8.5
										90 - 8.5
										120 – 8.5

Notes: Mixture of basalt and sediments. Crack width 20-50. Pores present in A1. A1 moderately sticky, B21 & B22 slightly sticky. Paler A1 horizon.

Vegetation	Emergent 0.05-0.25 high, acacia, native and improved pasture.
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Site Description Sheet



Client:	Shenhua Group				
Date:	07/09/12	Site:	TB13		
Location:	Taroborah Coal Project	Map Reference:	E 0594893	N 7401237	
Micro Relief:	Normal	Run-off:	1		
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:	Moderate basalt	Rock Outcrops:			
Site Disturbance:	Complete clearing, not cultivated	Surface Condition:	Cracking/self-mulching		
Landform	Slope (%):	1-2%	Morphological Type:	Flat	
	Relief:	Level plain	Landform Element:	PLA	
	Elevation:	217 m	Landform Pattern Type:	PLA	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A	10YR22	D			MHC		M P 10-20		D5	5 - 8
B21	10YR22	D			MHC		M SAB 10-20	10-20 calcareous soft 2-6	T4	30 - 8
B22	10YR42				HC		M L 10-20		T4	60 - 8
										90 - 8
										120 - 8

Notes: SCL, melon holes, lots of small ones. Crack width 10-20, pores present. Slightly sticky. CaCo3 in B21.

Vegetation	
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Site Description Sheet



Client:	Shenhua Group				
Date:	19/04/12		Site:	TB039	
Location:	Taroborah Coal Project		Map Reference:	E 595891	N 7398375
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):		Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Cultivated, currently under fodder crop. Very dark brown, cracking clay, self mulching. Surface coarse fragment 2% @ <20mm (sandstone). 0-70cm HC very dark brown/black, 70cm brown sandy clay (>40% coarse fragments mostly <5mm; 10% fragments @ 20mm) Free draining subsurface layer. Photos 100-2185 to 100-2199.

Vegetation	
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Site Description Sheet



Client:	Shenhua Group				
Date:	18/04/12	Site:	TB054		
Location:	Taroborah Coal Project	Map Reference:	E 595176	N 739611	
Micro Relief:		Run-off:			
Permeability:		Erosion:			
Drainage:		S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:			
Landform	Slope (%):		Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: Cleared, cultivated, self mulching, grey HC 0-80cm. 80cm > 50% rock/gravel fragments @ <50mm, grey HC.
Photos 100-2109 to 100-2117.

Vegetation	
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Site Description Sheet



Client:	Shenhua Group				
Date:	13/12/12	Site:	TB071		
Location:	Taroborah Coal Project	Map Reference:	E 594231	N 739496	
Micro Relief:	M M B 0.2 5	Run-off:	1		
Permeability:	1	Erosion:			
Drainage:	2	S C Fragments:			
Substrate:		Rock Outcrops:			
Site Disturbance:		Surface Condition:	C		
Landform	Slope (%):		Morphological Type:		
	Relief:		Landform Element:	VLF	
	Elevation:		Landform Pattern Type:	ALP	

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH
A1	0-10		D brown to black		ZLC					
B21	10-50		D brown		HC					
B22	50-100		Brown		VHC			2KN2		
2A1	100-130		Brown		ZKS					
2B21	130-150		L Brown		KHC					

Notes: Melon holed flood plain – soil is very wet and pooling. Buried soil underneath

Vegetation	Bean tree & Poplar box community.
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Site Description Sheet



Client:	Shenhuo Group				
Date:	18/04/12		Site:	TB011	
Location:	Taroborah Coal Project		Map Reference:	E 593460	N 7400899
Micro Relief:			Run-off:		
Permeability:			Erosion:		
Drainage:			S C Fragments:		
Substrate:			Rock Outcrops:		
Site Disturbance:			Surface Condition:		
Landform	Slope (%):	1%	Morphological Type:		
	Relief:		Landform Element:		
	Elevation:		Landform Pattern Type:		

Soil Description

Horizon	Depth (m)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH

Notes: 0-35 red brown, loamy sand, 35-70, redder brown, sandy clay, 70-100 grey clay with strong red/yellow mottles, 110-120 brown clay weak rock fragments (sandstone), noticeable texture increase, 120-150 reddish brown coarse sandy clay (gritty clay). 100-2237 to 100-2249.

Vegetation	
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Appendix C: SGS Australia Pty Ltd – Report of Analysis



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Report of Analysis

TW12-00646

Client:

AUSTRALASIAN RESOURCE CONSULTANTS
SUITE 5B
1 SWANN ROAD
TARINGA QLD 4068

Order Number:

Report Date: 07-March-2012
Received Date: 19-January-2012

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Analysis	Unit	TW12-00646.001 TB34 0-10 Soil	TW12-00646.002 TB34 20-30 Soil	TW12-00646.003 TB34 40-50 Soil	TW12-00646.004 TB34 50-60 Soil
Sulphate	mg/kg	<1	<1	<1	1
ACIDITY					
pH - Water	pH units	5.51	5.94	5.84	7.03
pH - CaCl2	pH units	4.90	5.27	5.16	6.41
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	19	8	3	2
Nitrogen	mg/kg	2560	1940	1100	1220
Total Kjeldahl Nitrogen	mg/kg	2540	1930	1100	1220
Phosphorus - Colwell extr	mg/kg	16	2	2	<1
Potassium	mg/kg	40	16	11	29
SECONDARY ELEMENTS					
Calcium Carbonate	%	1	3	3	2
Sulphur - KCl	mg/kg	5.2	3.9	2.9	6.6
Calcium	mg/kg	813	1300	598	986
Magnesium	mg/kg	164	131	85	474
Aluminium	mg/kg	2	1	1	<1
TRACE ELEMENTS					
Copper	mg/kg	0.2	0.3	0.3	0.6
Zinc	mg/kg	0.3	0.2	0.2	0.7
Manganese	mg/kg	12	13	3.1	<1
Iron	mg/kg	120	110	77	26
Boron	mg/kg	<0.2	<0.2	<0.2	<0.2
ORGANIC MATTER					
Organic Carbon	%	1.8	2.0	0.6	0.4
SALINITY					
Electrical Conductivity	dS/m	0.04	0.03	0.01	0.03
Chloride	mg/kg	4	9	4	9
Sodium	mg/kg	12	24	20	43
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	5.59	7.72	3.81	9.14
Exchangeable Sodium	meq/100g	0.05	0.11	0.09	0.19
Exchangeable Sodium Percent	%	1.0	1.4	2.3	2.1
Exchangeable Potassium	meq/100g	0.10	0.04	0.03	0.07
Exchangeable Potassium Percent	%	1.8	0.5	0.7	0.8
Exchangeable Calcium	meq/100g	4.07	6.48	2.99	4.93
Exchangeable Calcium Percent	%	72.7	84.0	78.4	53.9

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Report of Analysis

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TW12-00646

Analysis	Unit	TW12-00646.001 TB34 0-10 Soil	TW12-00646.002 TB34 20-30 Soil	TW12-00646.003 TB34 40-50 Soil	TW12-00646.004 TB34 50-60 Soil
Exchangeable Magnesium	meq/100g	1.37	1.09	0.70	3.95
Exchangeable Magnesium Percent	%	24.5	14.1	18.5	43.2
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		2.97	5.94	4.24	1.25
OTHER					
Colour		4/1 7.5YR	4/1 7.5YR	6/2 7.5YR	6/3 10YR
Soil Texture		CS	CS	CS	SC

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TW12-00646

Analysis	Unit	TW12-00646.005 TB34 80-90 Soil	TW12-00646.006 TB34 100-110 Soil	TW12-00646.007 TB34 110-120 Soil	TW12-00646.008 TB41 0-10 Soil
Sulphate	mg/kg	<1	2	2	<1
ACIDITY					
pH - Water	pH units	7.34	7.95	7.86	5.03
pH - CaCl2	pH units	6.70	7.04	6.97	4.53
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	2	2	2	5
Nitrogen	mg/kg	1260	1900	<1000	1420
Total Kjeldahl Nitrogen	mg/kg	1260	1900	<1000	1410
Phosphorus - Colwell extr	mg/kg	<1	<1	<1	2
Potassium	mg/kg	39	41	17	22
SECONDARY ELEMENTS					
Calcium Carbonate	%	2	2	2	3
Sulphur - KCl	mg/kg	6.0	9.4	9.2	1.6
Calcium	mg/kg	932	649	242	241
Magnesium	mg/kg	592	1080	638	110
Aluminium	mg/kg	<1	<1	<1	15
TRACE ELEMENTS					
Copper	mg/kg	0.6	0.5	0.4	0.5
Zinc	mg/kg	0.4	0.5	0.5	0.2
Manganese	mg/kg	<1	<1	<1	6.7
Iron	mg/kg	23	19	10	57
Boron	mg/kg	0.2	0.2	<0.2	<0.2
ORGANIC MATTER					
Organic Carbon	%	0.4	0.4	<0.3	0.6
SALINITY					
Electrical Conductivity	dS/m	0.03	0.07	0.06	0.01
Chloride	mg/kg	14	32	42	3
Sodium	mg/kg	59	182	143	14
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	9.95	13.1	7.19	2.42
Exchangeable Sodium	meq/100g	0.26	0.79	0.62	0.06
Exchangeable Sodium Percent	%	2.6	6.0	8.6	2.6
Exchangeable Potassium	meq/100g	0.10	0.11	0.04	0.06
Exchangeable Potassium Percent	%	1.0	0.8	0.6	2.4
Exchangeable Calcium	meq/100g	4.66	3.25	1.21	1.21
Exchangeable Calcium Percent	%	46.8	24.8	16.8	50.0
Exchangeable Magnesium	meq/100g	4.93	8.97	5.32	0.92
Exchangeable Magnesium Percent	%	49.6	68.4	73.9	38.0
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	0.17
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	7.1
Calcium/Magnesium Ratio		0.94	0.36	0.23	1.31
OTHER					
Colour		6/4 10YR	8/2 10YR	8/2 10YR	5/4 10YR

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Report of Analysis

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TW12-00646

Analysis	Unit	TW12-00646.005 TB34 80-90 Soil	TW12-00646.006 TB34 100-110 Soil	TW12-00646.007 TB34 110-120 Soil	TW12-00646.008 TB41 0-10 Soil
Soil Texture		SC	SC	SC	LS

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Report of Analysis

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TW12-00646

Analysis	Unit	TW12-00646.009 TB41 20-30 Soil	TW12-00646.010 TB41 50-60 Soil	TW12-00646.011 TB41 80-90 Soil	TW12-00646.012 TB41 110-120 Soil
Sulphate	mg/kg	<1	7	4	7
ACIDITY					
pH - Water	pH units	6.53	9.20	9.11	9.28
pH - CaCl2	pH units	5.55	8.14	8.28	8.65
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	3	<1	<1	1
Nitrogen	mg/kg	<1000	1040	<1000	1060
Total Kjeldahl Nitrogen	mg/kg	<1000	1040	<1000	1060
Phosphorus - Colwell extr	mg/kg	1	<1	<1	1
Potassium	mg/kg	10	41	38	38
SECONDARY ELEMENTS					
Calcium Carbonate	%	3	3	4	4
Sulphur - KCl	mg/kg	2.1	22.3	16.9	22.0
Calcium	mg/kg	189	1830	2480	2640
Magnesium	mg/kg	240	962	907	987
Aluminium	mg/kg	2	<1	<1	<1
TRACE ELEMENTS					
Copper	mg/kg	0.4	0.9	0.9	0.5
Zinc	mg/kg	1.0	0.7	0.9	0.9
Manganese	mg/kg	2.2	3.7	3.3	2.1
Iron	mg/kg	32	9.7	12	8.5
Boron	mg/kg	<0.2	0.6	0.8	0.4
ORGANIC MATTER					
Organic Carbon	%	0.4	<0.3	<0.3	<0.3
SALINITY					
Electrical Conductivity	dS/m	0.03	0.38	0.36	0.48
Chloride	mg/kg	24	320	280	440
Sodium	mg/kg	91	836	741	956
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	3.37	20.9	23.3	25.7
Exchangeable Sodium	meq/100g	0.40	3.63	3.22	4.15
Exchangeable Sodium Percent	%	11.8	17.4	13.8	16.2
Exchangeable Potassium	meq/100g	0.03	0.11	0.10	0.10
Exchangeable Potassium Percent	%	0.8	0.5	0.4	0.4
Exchangeable Calcium	meq/100g	0.95	9.13	12.4	13.2
Exchangeable Calcium Percent	%	28.2	43.7	53.3	51.4
Exchangeable Magnesium	meq/100g	2.00	8.02	7.56	8.23
Exchangeable Magnesium Percent	%	59.3	38.4	32.5	32.0
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		0.47	1.14	1.64	1.60
OTHER					
Colour		5/3 10YR	6/6 10YR	6/3 10YR	6/6 10YR

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TW12-00646

Analysis	Unit	TW12-00646.009 TB41 20-30 Soil	TW12-00646.010 TB41 50-60 Soil	TW12-00646.011 TB41 80-90 Soil	TW12-00646.012 TB41 110-120 Soil
Soil Texture		LS	SC	SC	SC

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TW12-00646

Analysis	Unit	TW12-00646.013 TB41 140-150 Soil	TW12-00646.014 TB25 0-10 Soil	TW12-00646.015 TB25 20-30 Soil	TW12-00646.016 TB25 50-60 Soil
Sulphate	mg/kg	5	<1	<1	<1
ACIDITY					
pH - Water	pH units	9.24	5.64	5.47	5.72
pH - CaCl2	pH units	8.31	5.16	4.93	5.04
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	6	<1	<1
Nitrogen	mg/kg	1060	1700	1030	<1000
Total Kjeldahl Nitrogen	mg/kg	1060	1690	1030	<1000
Phosphorus - Colwell extr	mg/kg	<1	1	1	1
Potassium	mg/kg	41	68	32	25
SECONDARY ELEMENTS					
Calcium Carbonate	%	4	2	1	1
Sulphur - KCl	mg/kg	18.9	5.1	0.7	1.4
Calcium	mg/kg	2840	339	211	190
Magnesium	mg/kg	958	102	68	141
Aluminium	mg/kg	<1	2	2	1
TRACE ELEMENTS					
Copper	mg/kg	0.6	0.2	0.1	0.2
Zinc	mg/kg	0.7	0.5	0.3	0.8
Manganese	mg/kg	3.1	5.0	1.8	2.2
Iron	mg/kg	10	51	91	88
Boron	mg/kg	0.4	<0.2	<0.2	<0.2
ORGANIC MATTER					
Organic Carbon	%	<0.3	0.6	0.3	0.4
SALINITY					
Electrical Conductivity	dS/m	0.47	0.02	0.01	0.01
Chloride	mg/kg	420	2	3	15
Sodium	mg/kg	901	12	13	21
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	26.2	2.77	1.78	2.28
Exchangeable Sodium	meq/100g	3.92	0.05	0.05	0.09
Exchangeable Sodium Percent	%	14.9	1.8	3.1	4.0
Exchangeable Potassium	meq/100g	0.10	0.17	0.08	0.06
Exchangeable Potassium Percent	%	0.4	6.3	4.6	2.8
Exchangeable Calcium	meq/100g	14.2	1.70	1.05	0.95
Exchangeable Calcium Percent	%	54.2	61.2	59.0	41.6
Exchangeable Magnesium	meq/100g	7.98	0.85	0.57	1.18
Exchangeable Magnesium Percent	%	30.4	30.7	31.8	51.6
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	0.03	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	1.4	Not Applicable
Calcium/Magnesium Ratio		1.78	2.00	1.85	0.81
OTHER					
Colour		6/6 10YR	4/4 10YR	6/4 10YR	6/4 10YR

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TW12-00646

Analysis	Unit	TW12-00646.013 TB41 140-150 Soil	TW12-00646.014 TB25 0-10 Soil	TW12-00646.015 TB25 20-30 Soil	TW12-00646.016 TB25 50-60 Soil
Soil Texture		SC	LS	LS	LS

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TW12-00646

Analysis	Unit	TW12-00646.017 TB25 80-90 Soil	TW12-00646.018 TB25 110-120 Soil	TW12-00646.019 TB25 140-150 Soil	TW12-00646.020 TB59 0-10 Soil
Sulphate	mg/kg	21	19	18	<1
ACIDITY					
pH - Water	pH units	7.07	6.91	6.79	7.59
pH - CaCl2	pH units	6.61	6.41	6.34	7.06
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	<1	<1	4
Nitrogen	mg/kg	<1000	<1000	<1000	<1000
Total Kjeldahl Nitrogen	mg/kg	<1000	<1000	<1000	<1000
Phosphorus - Colwell extr	mg/kg	1	1	2	2
Potassium	mg/kg	46	38	34	14
SECONDARY ELEMENTS					
Calcium Carbonate	%	<1	2	2	<1
Sulphur - KCl	mg/kg	56.3	48.5	47.7	5.7
Calcium	mg/kg	278	170	161	1180
Magnesium	mg/kg	1340	1390	1170	410
Aluminium	mg/kg	<1	<1	<1	<1
TRACE ELEMENTS					
Copper	mg/kg	0.4	0.3	0.4	0.5
Zinc	mg/kg	1.6	0.4	0.5	1.0
Manganese	mg/kg	1.7	<1	2.1	2.2
Iron	mg/kg	20	14	19	36
Boron	mg/kg	0.6	0.4	0.4	<0.2
ORGANIC MATTER					
Organic Carbon	%	<0.3	<0.3	<0.3	0.8
SALINITY					
Electrical Conductivity	dS/m	0.44	0.53	0.48	0.08
Chloride	mg/kg	700	750	700	34
Sodium	mg/kg	716	903	731	99
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	15.8	16.5	13.8	9.81
Exchangeable Sodium	meq/100g	3.11	3.93	3.18	0.43
Exchangeable Sodium Percent	%	19.7	23.8	23.0	4.4
Exchangeable Potassium	meq/100g	0.12	0.10	0.09	0.04
Exchangeable Potassium Percent	%	0.8	0.6	0.6	0.4
Exchangeable Calcium	meq/100g	1.39	0.85	0.80	5.92
Exchangeable Calcium Percent	%	8.8	5.2	5.8	60.4
Exchangeable Magnesium	meq/100g	11.2	11.6	9.77	3.42
Exchangeable Magnesium Percent	%	70.7	70.4	70.6	34.8
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		0.12	0.07	0.08	1.73
OTHER					
Colour		5/4 10YR	6/4 7.5YR	7/4 7.5YR	4/3 10YR

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TW12-00646

Analysis	Unit	TW12-00646.017 TB25 80-90 Soil	TW12-00646.018 TB25 110-120 Soil	TW12-00646.019 TB25 140-150 Soil	TW12-00646.020 TB59 0-10 Soil
Soil Texture		SC	SC	SC	FSCL

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TW12-00646

Analysis	Unit	TW12-00646.021 TB59 20-30 Soil	TW12-00646.022 TB59 50-60 Soil	TW12-00646.023 TB59 80-90 Soil	TW12-00646.024 TB59 110-120 Soil
Sulphate	mg/kg	7	19	19	30
ACIDITY					
pH - Water	pH units	9.39	9.55	9.56	9.05
pH - CaCl ₂	pH units	8.49	8.39	8.35	7.90
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	2	2	1	<1
Nitrogen	mg/kg	1030	<1000	1740	<1000
Total Kjeldahl Nitrogen	mg/kg	1030	<1000	1740	<1000
Phosphorus - Colwell extr	mg/kg	2	1	2	2
Potassium	mg/kg	26	30	32	26
SECONDARY ELEMENTS					
Calcium Carbonate	%	3	4	5	3
Sulphur - KCl	mg/kg	23.4	52.8	52.3	81.2
Calcium	mg/kg	1610	1680	1550	891
Magnesium	mg/kg	1100	1780	1820	4010
Aluminium	mg/kg	1	<1	1	<1
TRACE ELEMENTS					
Copper	mg/kg	0.6	0.6	0.6	0.4
Zinc	mg/kg	2.1	0.4	0.8	1.3
Manganese	mg/kg	2.0	2.7	3.5	2.2
Iron	mg/kg	17	13	13	14
Boron	mg/kg	0.4	0.6	0.4	0.2
ORGANIC MATTER					
Organic Carbon	%	0.4	<0.3	<0.3	<0.3
SALINITY					
Electrical Conductivity	dS/m	0.26	0.46	0.45	0.65
Chloride	mg/kg	180	390	360	670
Sodium	mg/kg	595	1090	1130	3190
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	19.9	28.1	27.9	51.8
Exchangeable Sodium	meq/100g	2.59	4.74	4.91	13.9
Exchangeable Sodium Percent	%	13.0	16.9	17.6	26.8
Exchangeable Potassium	meq/100g	0.07	0.08	0.08	0.07
Exchangeable Potassium Percent	%	0.3	0.3	0.3	0.1
Exchangeable Calcium	meq/100g	8.05	8.40	7.76	4.45
Exchangeable Calcium Percent	%	40.5	29.9	27.8	8.6
Exchangeable Magnesium	meq/100g	9.15	14.9	15.2	33.4
Exchangeable Magnesium Percent	%	46.1	52.9	54.3	64.5
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		0.88	0.56	0.51	0.13
OTHER					
Colour		4/4 7.5YR	6/4 10YR	5/4 10YR	7/3 10YR

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TW12-00646

Analysis	Unit	TW12-00646.021 TB59 20-30 Soil	TW12-00646.022 TB59 50-60 Soil	TW12-00646.023 TB59 80-90 Soil	TW12-00646.024 TB59 110-120 Soil
Soil Texture		SC	SC	LMC	SC

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TW12-00646

Analysis	Unit	TW12-00646.025 TB63 0-10 Soil	TW12-00646.026 TB63 20-30 Soil	TW12-00646.027 TB63 50-60 Soil	TW12-00646.028 TB63 80-90 Soil
Sulphate	mg/kg	<1	<1	5	8
ACIDITY					
pH - Water	pH units	7.61	8.33	8.35	8.42
pH - CaCl2	pH units	6.80	7.36	7.58	7.67
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	1	1	1
Nitrogen	mg/kg	<1000	<1000	<1000	<1000
Total Kjeldahl Nitrogen	mg/kg	<1000	<1000	<1000	<1000
Phosphorus - Colwell extr	mg/kg	1	1	<1	<1
Potassium	mg/kg	38	41	35	33
SECONDARY ELEMENTS					
Calcium Carbonate	%	3	3	4	2
Sulphur - KCl	mg/kg	3.5	1.9	12.3	17.9
Calcium	mg/kg	5160	5130	5140	4980
Magnesium	mg/kg	1680	1790	1880	1930
Aluminium	mg/kg	2	2	1	32
TRACE ELEMENTS					
Copper	mg/kg	1.1	1.2	1.1	1.1
Zinc	mg/kg	0.9	1.5	0.6	0.8
Manganese	mg/kg	7.6	6.0	5.4	5.7
Iron	mg/kg	15	16	16	14
Boron	mg/kg	0.2	0.2	0.4	0.4
ORGANIC MATTER					
Organic Carbon	%	0.7	0.6	0.6	0.6
SALINITY					
Electrical Conductivity	dS/m	0.03	0.06	0.20	0.23
Chloride	mg/kg	11	13	230	270
Sodium	mg/kg	187	328	518	648
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	40.7	42.1	43.7	43.9
Exchangeable Sodium	meq/100g	0.81	1.43	2.25	2.82
Exchangeable Sodium Percent	%	2.0	3.4	5.2	6.4
Exchangeable Potassium	meq/100g	0.10	0.10	0.09	0.08
Exchangeable Potassium Percent	%	0.2	0.2	0.2	0.2
Exchangeable Calcium	meq/100g	25.8	25.6	25.7	24.9
Exchangeable Calcium Percent	%	63.3	60.9	58.8	56.7
Exchangeable Magnesium	meq/100g	14.0	14.9	15.7	16.1
Exchangeable Magnesium Percent	%	34.4	35.5	35.8	36.7
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		1.84	1.72	1.64	1.55
OTHER					
Colour		4/1 10YR	4/1 10YR	4/1 10YR	4/2 10YR

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TW12-00646

Analysis	Unit	TW12-00646.025 TB63 0-10 Soil	TW12-00646.026 TB63 20-30 Soil	TW12-00646.027 TB63 50-60 Soil	TW12-00646.028 TB63 80-90 Soil
Soil Texture		HC	HC	HC	HC

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TW12-00646

Analysis	Unit	TW12-00646.029 TB63 110-120 Soil	TW12-00646.030 TB63 140-150 Soil	TW12-00646.031 TB78 0-10 Soil	TW12-00646.032 TB78 20-30 Soil
Sulphate	mg/kg	28	21	1	<1
ACIDITY					
pH - Water	pH units	8.36	8.43	6.80	6.35
pH - CaCl2	pH units	7.93	7.95	6.31	5.77
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	<1	4	1
Nitrogen	mg/kg	<1000	<1000	1830	1260
Total Kjeldahl Nitrogen	mg/kg	<1000	<1000	1830	1260
Phosphorus - Colwell extr	mg/kg	1	1	12	2
Potassium	mg/kg	49	49	75	48
SECONDARY ELEMENTS					
Calcium Carbonate	%	3	2	<1	2
Sulphur - KCl	mg/kg	74.4	56.8	3.9	5.0
Calcium	mg/kg	5340	5470	2340	1890
Magnesium	mg/kg	2150	2080	972	1060
Aluminium	mg/kg	37	51	107	30
TRACE ELEMENTS					
Copper	mg/kg	1.0	1.0	2.2	2.8
Zinc	mg/kg	0.6	0.5	0.6	0.4
Manganese	mg/kg	2.6	4.4	9.7	2.6
Iron	mg/kg	12	13	32	71
Boron	mg/kg	0.8	0.6	<0.2	0.2
ORGANIC MATTER					
Organic Carbon	%	0.4	0.4	1.4	0.8
SALINITY					
Electrical Conductivity	dS/m	0.72	0.62	0.04	0.24
Chloride	mg/kg	1100	780	24	390
Sodium	mg/kg	1010	890	90	346
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	49.2	48.7	20.4	19.9
Exchangeable Sodium	meq/100g	4.40	3.87	0.39	1.51
Exchangeable Sodium Percent	%	8.9	7.9	1.9	7.6
Exchangeable Potassium	meq/100g	0.13	0.13	0.19	0.12
Exchangeable Potassium Percent	%	0.3	0.3	0.9	0.6
Exchangeable Calcium	meq/100g	26.7	27.3	11.7	9.43
Exchangeable Calcium Percent	%	54.3	56.2	57.3	47.4
Exchangeable Magnesium	meq/100g	17.9	17.3	8.10	8.85
Exchangeable Magnesium Percent	%	36.5	35.6	39.8	44.5
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		1.49	1.58	1.44	1.07
OTHER					
Colour		5/1 10YR	5/1 10YR	4/2 10YR	5/2 10YR

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TW12-00646

Analysis	Unit	TW12-00646.029 TB63 110-120 Soil	TW12-00646.030 TB63 140-150 Soil	TW12-00646.031 TB78 0-10 Soil	TW12-00646.032 TB78 20-30 Soil
Soil Texture		MC	HC	LMC	SC

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TW12-00646

Analysis	Unit	TW12-00646.033 TB78 50-60 Soil	TW12-00646.034 TB78 80-90 Soil	TW12-00646.035 TB78 110-120 Soil	TW12-00646.036 TB78 140-150 Soil
Sulphate	mg/kg	<1	<1	<1	<1
ACIDITY					
pH - Water	pH units	4.82	4.72	4.36	4.22
pH - CaCl2	pH units	4.33	4.24	3.96	3.84
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	<1	<1	<1
Nitrogen	mg/kg	<1000	1010	<1000	<1000
Total Kjeldahl Nitrogen	mg/kg	<1000	1010	<1000	<1000
Phosphorus - Colwell extr	mg/kg	1	<1	<1	2
Potassium	mg/kg	48	51	53	129
SECONDARY ELEMENTS					
Calcium Carbonate	%	4	3	2	3
Sulphur - KCl	mg/kg	3.9	3.6	1.5	0.7
Calcium	mg/kg	1190	1170	1290	1950
Magnesium	mg/kg	1170	1200	1550	2530
Aluminium	mg/kg	15	<1	2	<1
TRACE ELEMENTS					
Copper	mg/kg	3.1	2.8	3.0	2.7
Zinc	mg/kg	1.4	0.3	1.2	0.8
Manganese	mg/kg	3.7	4.0	4.9	7.1
Iron	mg/kg	79	78	66	48
Boron	mg/kg	0.2	<0.2	0.2	0.2
ORGANIC MATTER					
Organic Carbon	%	0.5	0.4	0.3	<0.3
SALINITY					
Electrical Conductivity	dS/m	0.66	0.78	1.07	1.33
Chloride	mg/kg	1300	1400	1900	2400
Sodium	mg/kg	845	911	1380	2170
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	19.7	19.9	25.5	40.6
Exchangeable Sodium	meq/100g	3.68	3.96	6.02	9.45
Exchangeable Sodium Percent	%	18.7	19.9	23.6	23.3
Exchangeable Potassium	meq/100g	0.12	0.13	0.14	0.33
Exchangeable Potassium Percent	%	0.6	0.7	0.5	0.8
Exchangeable Calcium	meq/100g	5.97	5.86	6.44	9.74
Exchangeable Calcium Percent	%	30.3	29.4	25.2	24.0
Exchangeable Magnesium	meq/100g	9.77	9.99	12.9	21.1
Exchangeable Magnesium Percent	%	49.6	50.1	50.6	51.9
Exchangeable Aluminium	meq/100g	0.17	<0.01	0.02	0.01
Exchangeable Aluminium Percent	%	0.8	<0.1	<0.1	<0.1
Calcium/Magnesium Ratio		0.61	0.59	0.50	0.46
OTHER					
Colour		5/3 10YR	5/3 10YR	6/3 10YR	7/3 10YR

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TW12-00646

Analysis	Unit	TW12-00646.033 TB78 50-60 Soil	TW12-00646.034 TB78 80-90 Soil	TW12-00646.035 TB78 110-120 Soil	TW12-00646.036 TB78 140-150 Soil
Soil Texture		LMC	SC	LMC	LMC

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TW12-00646

Analysis	Unit	TW12-00646.037 TB70 0-10 Soil	TW12-00646.038 TB70 20-30 Soil	TW12-00646.039 TB70 50-60 Soil	TW12-00646.040 TB70 80-90 Soil
Sulphate	mg/kg	<1	<1	54	30
ACIDITY					
pH - Water	pH units	7.93	8.00	8.13	8.30
pH - CaCl2	pH units	7.30	7.02	7.58	7.73
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	7	<1	2	1
Nitrogen	mg/kg	1360	<1000	<1000	<1000
Total Kjeldahl Nitrogen	mg/kg	1350	<1000	<1000	<1000
Phosphorus - Colwell extr	mg/kg	10	2	2	1
Potassium	mg/kg	78	61	54	57
SECONDARY ELEMENTS					
Calcium Carbonate	%	3	3	4	3
Sulphur - KCl	mg/kg	5.2	5.0	130	79.4
Calcium	mg/kg	4110	3830	3740	3990
Magnesium	mg/kg	637	1030	1270	1280
Aluminium	mg/kg	<1	<1	<1	<1
TRACE ELEMENTS					
Copper	mg/kg	2.4	2.4	1.7	2.0
Zinc	mg/kg	1.3	0.6	0.7	2.7
Manganese	mg/kg	20	21	9.8	12
Iron	mg/kg	29	25	17	20
Boron	mg/kg	0.2	0.2	0.4	0.4
ORGANIC MATTER					
Organic Carbon	%	1.6	0.9	0.8	0.8
SALINITY					
Electrical Conductivity	dS/m	0.10	0.05	0.62	0.45
Chloride	mg/kg	19	18	720	470
Sodium	mg/kg	138	286	833	712
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	26.7	29.1	33.0	33.8
Exchangeable Sodium	meq/100g	0.60	1.24	3.62	3.10
Exchangeable Sodium Percent	%	2.2	4.3	11.0	9.1
Exchangeable Potassium	meq/100g	0.20	0.16	0.14	0.15
Exchangeable Potassium Percent	%	0.7	0.5	0.4	0.4
Exchangeable Calcium	meq/100g	20.6	19.1	18.7	20.0
Exchangeable Calcium Percent	%	77.1	65.8	56.6	59.0
Exchangeable Magnesium	meq/100g	5.31	8.56	10.6	10.6
Exchangeable Magnesium Percent	%	19.9	29.4	32.1	31.4
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		3.87	2.24	1.76	1.88
OTHER					
Colour		4/2 10YR	4/1 10YR	4/2 10YR	4/2 10YR

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TW12-00646

Analysis	Unit	TW12-00646.037 TB70 0-10 Soil	TW12-00646.038 TB70 20-30 Soil	TW12-00646.039 TB70 50-60 Soil	TW12-00646.040 TB70 80-90 Soil
Soil Texture		LMC	LMC	LMC	HC

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TW12-00646

Analysis	Unit	TW12-00646.041 TB70 110-120 Soil	TW12-00646.042 TB70 140-150 Soil	TW12-00646.043 TB61 0-10 Soil	TW12-00646.044 TB61 20-30 Soil
Sulphate	mg/kg	55	54	1	2
ACIDITY					
pH - Water	pH units	8.08	6.48	8.44	8.79
pH - CaCl2	pH units	7.38	6.13	7.79	7.99
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	2	<1	<1
Nitrogen	mg/kg	<1000	<1000	<1000	2250
Total Kjeldahl Nitrogen	mg/kg	<1000	<1000	<1000	2250
Phosphorus - Colwell extr	mg/kg	1	4	2	1
Potassium	mg/kg	69	74	87	59
SECONDARY ELEMENTS					
Calcium Carbonate	%	4	<1	5	5
Sulphur - KCl	mg/kg	134	134	7.9	7.2
Calcium	mg/kg	3670	2850	6890	6120
Magnesium	mg/kg	1470	1440	2250	2590
Aluminium	mg/kg	<1	<1	<1	<1
TRACE ELEMENTS					
Copper	mg/kg	1.3	1.4	0.9	0.8
Zinc	mg/kg	2.0	1.2	0.4	1.1
Manganese	mg/kg	5.8	72	10	6.5
Iron	mg/kg	16	22	21	20
Boron	mg/kg	0.8	0.8	0.6	0.4
ORGANIC MATTER					
Organic Carbon	%	0.5	<0.3	1.0	0.8
SALINITY					
Electrical Conductivity	dS/m	0.76	0.66	0.13	0.16
Chloride	mg/kg	1100	1000	22	21
Sodium	mg/kg	1070	1030	373	661
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	35.4	30.9	55.0	55.2
Exchangeable Sodium	meq/100g	4.64	4.49	1.62	2.87
Exchangeable Sodium Percent	%	13.1	14.5	2.9	5.2
Exchangeable Potassium	meq/100g	0.18	0.19	0.22	0.15
Exchangeable Potassium Percent	%	0.5	0.6	0.4	0.3
Exchangeable Calcium	meq/100g	18.4	14.3	34.4	30.6
Exchangeable Calcium Percent	%	51.8	46.1	62.6	55.4
Exchangeable Magnesium	meq/100g	12.3	12.0	18.7	21.6
Exchangeable Magnesium Percent	%	34.6	38.7	34.1	39.1
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		1.50	1.19	1.84	1.42
OTHER					
Colour		5/2 10YR	5/3 10YR	5/2 10YR	4/2 10YR

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TW12-00646

Analysis	Unit	TW12-00646.041 TB70 110-120 Soil	TW12-00646.042 TB70 140-150 Soil	TW12-00646.043 TB61 0-10 Soil	TW12-00646.044 TB61 20-30 Soil
Soil Texture		MC	HC	HC	HC

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TW12-00646

Analysis	Unit	TW12-00646.045 TB61 50-60 Soil	TW12-00646.046 TB61 80-90 Soil	TW12-00646.047 TB61 110-120 Soil	TW12-00646.048 TB61 140-150 Soil
Sulphate	mg/kg	12	55	80	74
ACIDITY					
pH - Water	pH units	8.75	8.48	8.38	8.43
pH - CaCl2	pH units	8.01	7.91	7.95	7.98
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	3	<1	<1	<1
Nitrogen	mg/kg	<1000	1850	1360	<1000
Total Kjeldahl Nitrogen	mg/kg	<1000	1850	1360	<1000
Phosphorus - Colwell extr	mg/kg	2	1	1	2
Potassium	mg/kg	60	57	66	78
SECONDARY ELEMENTS					
Calcium Carbonate	%	5	5	5	5
Sulphur - KCl	mg/kg	30.5	144	223	189
Calcium	mg/kg	6070	5700	5910	6020
Magnesium	mg/kg	2680	2850	3050	3000
Aluminium	mg/kg	<1	<1	<1	<1
TRACE ELEMENTS					
Copper	mg/kg	0.8	0.8	0.7	0.8
Zinc	mg/kg	1.4	0.8	0.5	0.7
Manganese	mg/kg	6.2	4.5	3.2	3.9
Iron	mg/kg	19	18	14	15
Boron	mg/kg	0.4	0.6	0.4	0.6
ORGANIC MATTER					
Organic Carbon	%	0.8	0.7	0.5	0.6
SALINITY					
Electrical Conductivity	dS/m	0.22	0.47	0.83	0.70
Chloride	mg/kg	86	370	920	840
Sodium	mg/kg	805	1040	1180	1140
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	56.4	56.9	60.3	60.3
Exchangeable Sodium	meq/100g	3.50	4.53	5.14	4.96
Exchangeable Sodium Percent	%	6.2	8.0	8.5	8.2
Exchangeable Potassium	meq/100g	0.15	0.15	0.17	0.20
Exchangeable Potassium Percent	%	0.3	0.3	0.3	0.3
Exchangeable Calcium	meq/100g	30.4	28.5	29.6	30.1
Exchangeable Calcium Percent	%	53.9	50.1	49.0	49.9
Exchangeable Magnesium	meq/100g	22.4	23.7	25.4	25.0
Exchangeable Magnesium Percent	%	39.7	41.7	42.2	41.5
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		1.36	1.20	1.16	1.20
OTHER					
Colour		4/2 10YR	4/1 10YR	5/2 10YR	4/210YR

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TW12-00646

Analysis	Unit	TW12-00646.045 TB61 50-60 Soil	TW12-00646.046 TB61 80-90 Soil	TW12-00646.047 TB61 110-120 Soil	TW12-00646.048 TB61 140-150 Soil
Soil Texture		HC	HC	HC	MC

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TW12-00646

Analysis	Unit	TW12-00646.049 TB26 0-10 Soil	TW12-00646.050 TB26 20-30 Soil	TW12-00646.051 TB26 40-50 Soil	TW12-00646.052 TB42 0-10 Soil
Sulphate	mg/kg	<1	<1	2	<1
ACIDITY					
pH - Water	pH units	5.90	6.36	7.37	5.05
pH - CaCl2	pH units	5.39	5.35	6.40	4.44
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	7	<1	<1	<1
Nitrogen	mg/kg	2380	1080	1290	<1000
Total Kjeldahl Nitrogen	mg/kg	2370	1080	1290	<1000
Phosphorus - Colwell extr	mg/kg	8	1	<1	3
Potassium	mg/kg	65	38	51	32
SECONDARY ELEMENTS					
Calcium Carbonate	%	3	3	4	3
Sulphur - KCl	mg/kg	8.6	2.2	7.3	2.1
Calcium	mg/kg	778	176	66	147
Magnesium	mg/kg	236	450	937	52
Aluminium	mg/kg	1	1	1	1
TRACE ELEMENTS					
Copper	mg/kg	0.2	0.2	0.3	0.2
Zinc	mg/kg	0.9	1.4	1.6	0.5
Manganese	mg/kg	4.8	1.4	1.2	12
Iron	mg/kg	93	100	40	60
Boron	mg/kg	<0.2	<0.2	0.2	<0.2
ORGANIC MATTER					
Organic Carbon	%	1.9	0.7	0.6	0.7
SALINITY					
Electrical Conductivity	dS/m	0.04	0.04	0.11	0.01
Chloride	mg/kg	19	26	80	<1
Sodium	mg/kg	25	92	333	6
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	6.13	5.13	9.72	1.28
Exchangeable Sodium	meq/100g	0.11	0.40	1.45	0.03
Exchangeable Sodium Percent	%	1.7	7.8	14.9	2.2
Exchangeable Potassium	meq/100g	0.17	0.10	0.13	0.08
Exchangeable Potassium Percent	%	2.7	1.9	1.3	6.4
Exchangeable Calcium	meq/100g	3.89	0.88	0.33	0.73
Exchangeable Calcium Percent	%	63.5	17.2	3.4	57.1
Exchangeable Magnesium	meq/100g	1.97	3.75	7.81	0.43
Exchangeable Magnesium Percent	%	32.1	73.1	80.3	33.5
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	0.01
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	0.9
Calcium/Magnesium Ratio		1.98	0.23	0.04	1.70
OTHER					
Colour		5/2 10YR	6/3 10YR	6/3 10YR	4/2 10YR

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TW12-00646

Analysis	Unit	TW12-00646.049 TB26 0-10 Soil	TW12-00646.050 TB26 20-30 Soil	TW12-00646.051 TB26 40-50 Soil	TW12-00646.052 TB42 0-10 Soil
Soil Texture		FSCL	FSCL	SC	LS

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TW12-00646

Analysis	Unit	TW12-00646.053 TB42 20-30 Soil	TW12-00646.054 TB42 50-60 Soil	TW12-00646.055 TB42 80-90 Soil	TW12-00646.056 TB42 110-120 Soil
Sulphate	mg/kg	<1	<1	2	1
ACIDITY					
pH - Water	pH units	4.81	4.66	4.59	5.13
pH - CaCl2	pH units	4.28	4.02	4.04	4.31
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	<1	<1	<1
Nitrogen	mg/kg	<1000	1550	<1000	1230
Total Kjeldahl Nitrogen	mg/kg	<1000	1550	<1000	1230
Phosphorus - Colwell extr	mg/kg	2	1	1	1
Potassium	mg/kg	11	11	12	14
SECONDARY ELEMENTS					
Calcium Carbonate	%	4	5	2	5
Sulphur - KCl	mg/kg	1.2	2.0	6.0	2.7
Calcium	mg/kg	91	96	116	92
Magnesium	mg/kg	25	34	72	268
Aluminium	mg/kg	1	1	<1	1
TRACE ELEMENTS					
Copper	mg/kg	<0.1	0.1	0.1	0.2
Zinc	mg/kg	0.2	0.3	0.3	0.3
Manganese	mg/kg	2.9	2.0	<1	1.4
Iron	mg/kg	50	41	35	40
Boron	mg/kg	<0.2	<0.2	<0.2	<0.2
ORGANIC MATTER					
Organic Carbon	%	0.4	0.3	0.4	0.4
SALINITY					
Electrical Conductivity	dS/m	0.01	0.01	0.02	0.01
Chloride	mg/kg	<1	3	<1	3
Sodium	mg/kg	6	8	5	14
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	0.73	0.84	1.24	2.80
Exchangeable Sodium	meq/100g	0.03	0.04	0.02	0.06
Exchangeable Sodium Percent	%	3.6	4.3	1.6	2.1
Exchangeable Potassium	meq/100g	0.03	0.03	0.03	0.04
Exchangeable Potassium Percent	%	4.0	3.2	2.5	1.3
Exchangeable Calcium	meq/100g	0.45	0.48	0.58	0.46
Exchangeable Calcium Percent	%	62.1	57.2	46.7	16.5
Exchangeable Magnesium	meq/100g	0.21	0.28	0.60	2.23
Exchangeable Magnesium Percent	%	28.6	33.9	48.3	79.6
Exchangeable Aluminium	meq/100g	0.01	0.01	0.01	0.01
Exchangeable Aluminium Percent	%	1.7	1.4	0.9	0.4
Calcium/Magnesium Ratio		2.17	1.68	0.97	0.21
OTHER					
Colour		5/3 10YR	6/4 10YR	7/6 10YR	6/6 10YR

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Report of Analysis

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TW12-00646

Analysis	Unit	TW12-00646.053 TB42 20-30 Soil	TW12-00646.054 TB42 50-60 Soil	TW12-00646.055 TB42 80-90 Soil	TW12-00646.056 TB42 110-120 Soil
Soil Texture		LS	CS	CS	CS

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TW12-00646

Analysis	Unit	TW12-00646.057 TB42 140-150 Soil	TW12-00646.058 TB72 0-10 Soil	TW12-00646.059 TB077 0-10 Soil	TW12-00646.060 TB077 20-30 Soil
Sulphate	mg/kg	<1	<1	<1	<1
ACIDITY					
pH - Water	pH units	5.45	6.55	5.86	6.39
pH - CaCl2	pH units	4.58	5.96	5.15	5.36
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	12	1	<1
Nitrogen	mg/kg	<1000	1370	1810	<1000
Total Kjeldahl Nitrogen	mg/kg	<1000	1360	1810	<1000
Phosphorus - Colwell extr	mg/kg	2	128	9	2
Potassium	mg/kg	14	655	56	32
SECONDARY ELEMENTS					
Calcium Carbonate	%	3	6	5	3
Sulphur - KCl	mg/kg	2.1	3.1	3.7	3.5
Calcium	mg/kg	51	2370	1490	1580
Magnesium	mg/kg	287	523	796	1140
Aluminium	mg/kg	15	20	56	117
TRACE ELEMENTS					
Copper	mg/kg	0.2	1.5	1.9	2.3
Zinc	mg/kg	0.4	1.3	1.0	1.8
Manganese	mg/kg	<1	35	28	20
Iron	mg/kg	34	55	41	42
Boron	mg/kg	<0.2	<0.2	0.4	0.2
ORGANIC MATTER					
Organic Carbon	%	0.3	1.9	1.3	0.8
SALINITY					
Electrical Conductivity	dS/m	0.01	0.05	0.02	0.03
Chloride	mg/kg	3	26	4	12
Sodium	mg/kg	14	35	52	161
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	2.91	18.1	14.5	18.2
Exchangeable Sodium	meq/100g	0.06	0.15	0.23	0.70
Exchangeable Sodium Percent	%	2.1	0.8	1.6	3.8
Exchangeable Potassium	meq/100g	0.04	1.68	0.14	0.08
Exchangeable Potassium Percent	%	1.2	9.3	1.0	0.5
Exchangeable Calcium	meq/100g	0.25	11.9	7.46	7.91
Exchangeable Calcium Percent	%	8.7	65.7	51.6	43.6
Exchangeable Magnesium	meq/100g	2.39	4.36	6.63	9.47
Exchangeable Magnesium Percent	%	82.1	24.1	45.8	52.1
Exchangeable Aluminium	meq/100g	0.17	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	5.9	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		0.11	2.72	1.13	0.84
OTHER					
Colour		6/6 10YR	4/4 10YR	4/6 5YR	3/4 5YR

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TW12-00646

Analysis	Unit	TW12-00646.057 TB42 140-150 Soil	TW12-00646.058 TB72 0-10 Soil	TW12-00646.059 TB077 0-10 Soil	TW12-00646.060 TB077 20-30 Soil
Soil Texture		CS	CS	CL	CL

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TW12-00646

Analysis	Unit	TW12-00646.061 TB077 50-60 Soil	TW12-00646.062 TB077 80-90 Soil	TW12-00646.063 TB077 110-120 Soil	TW12-00646.064 TB077 140-150 Soil
Sulphate	mg/kg	7	8	12	10
ACIDITY					
pH - Water	pH units	8.32	8.49	8.68	8.67
pH - CaCl ₂	pH units	7.71	7.89	8.07	8.07
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	<1	<1	<1
Nitrogen	mg/kg	1940	<1000	1340	1060
Total Kjeldahl Nitrogen	mg/kg	1940	<1000	1340	1060
Phosphorus - Colwell extr	mg/kg	1	1	1	1
Potassium	mg/kg	40	40	36	36
SECONDARY ELEMENTS					
Calcium Carbonate	%	6	3	<1	3
Sulphur - KCl	mg/kg	19.0	23.5	30.5	27.7
Calcium	mg/kg	3790	4030	3670	3490
Magnesium	mg/kg	1640	1730	1740	1570
Aluminium	mg/kg	1	1	1	1
TRACE ELEMENTS					
Copper	mg/kg	1.4	1.3	1.0	0.8
Zinc	mg/kg	0.7	0.7	2.2	0.6
Manganese	mg/kg	7.7	6.9	3.7	3.7
Iron	mg/kg	18	15	11	12
Boron	mg/kg	1.0	1.2	1.4	1.8
ORGANIC MATTER					
Organic Carbon	%	0.6	0.5	0.4	0.4
SALINITY					
Electrical Conductivity	dS/m	0.25	0.28	0.35	0.32
Chloride	mg/kg	110	210	370	330
Sodium	mg/kg	420	511	599	524
EXCHANGEABLE CATIONS					
Cation Exchange	meq/100g	34.5	36.9	35.6	32.9
Exchangeable Sodium	meq/100g	1.83	2.22	2.60	2.28
Exchangeable Sodium Percent	%	5.3	6.0	7.3	6.9
Exchangeable Potassium	meq/100g	0.10	0.10	0.09	0.09
Exchangeable Potassium Percent	%	0.3	0.3	0.3	0.3
Exchangeable Calcium	meq/100g	18.9	20.2	18.4	17.5
Exchangeable Calcium Percent	%	54.9	54.7	51.6	53.1
Exchangeable Magnesium	meq/100g	13.6	14.4	14.5	13.1
Exchangeable Magnesium Percent	%	39.5	39.0	40.8	39.7
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Calcium/Magnesium Ratio		1.39	1.40	1.26	1.34
OTHER					
Colour		4/6 5YR	4/6 5YR	5/6 5YR	4/6 5YR

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TW12-00646

Analysis	Unit	TW12-00646.061 TB077 50-60 Soil	TW12-00646.062 TB077 80-90 Soil	TW12-00646.063 TB077 110-120 Soil	TW12-00646.064 TB077 140-150 Soil
Soil Texture		CL	CL	MC	LC

Results are on an 'air dried' basis.

Analysed Between 19/01/2012 - 07/03/2012

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TW12-00646

Method of Analysis			
Analysis	Unit	Det.Lim.	Method
Calcium Carbonate	%	1	SOL004
Colour			
Soil Texture			SOL011
pH - Water	pH units	0.01	SOL003/SOL001/2
Electrical Conductivity	dS/m	0.01	SOL003/SOL001/2
pH - CaCl ₂	pH units	0.01	SOL003/SOL001/2
Organic Carbon	%	0.3	CAR002/SOL002/1
Nitrate Nitrogen	mg/kg	1	SOL030
Chloride	mg/kg	1	SOL030
Nitrogen	mg/kg	1000	PRN002
Total Kjeldahl Nitrogen	mg/kg	1	
Sulphur - KCl	mg/kg	0.1	SOL001/6-2
Sulphate	mg/kg	1	ANL001
Phosphorus - Colwell extr	mg/kg	1	SOL005/001/4
Sodium	mg/kg	1	SOL044
Potassium	mg/kg	1	SOL044
Calcium	mg/kg	1	SOL044
Magnesium	mg/kg	1	SOL044
Cation Exchange	meq/100g	0.01	SOL044
Exchangeable Sodium	meq/100g	0.01	SOL044
Exchangeable Sodium Percent	%	0.1	SOL044
Exchangeable Potassium	meq/100g	0.01	SOL044
Exchangeable Potassium Percent	%	0.1	SOL044
Exchangeable Calcium	meq/100g	0.01	SOL044
Exchangeable Calcium Percent	%	0.1	SOL044
Exchangeable Magnesium	meq/100g	0.01	SOL044
Exchangeable Magnesium Percent	%	0.1	SOL044
Exchangeable Aluminium	meq/100g	0.01	SOL044
Exchangeable Aluminium Percent	%	0.1	SOL044
Calcium/Magnesium Ratio		0.01	SOL044
Copper	mg/kg	0.1	SOL001/9/10/12
Zinc	mg/kg	0.1	SOL001/9/10/12
Manganese	mg/kg	1.0	SOL001/9/10/12
Iron	mg/kg	1.0	SOL001/9/10/12
Boron	mg/kg	0.2	SOL001/13
Aluminium	mg/kg	1	SOL002/1-2

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TW12-00646

The analyses presented in the report refer exclusively to the samples analysed.

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Keegan Roache - PSW Section Manager

For and on behalf of SGS Australia Pty Ltd

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Report of Analysis

TW12-06943

Client:

AUSTRALASIAN RESOURCE CONSULTANTS
SUITE 5B
1 SWANN ROAD
TARINGA QLD 4068

Order Number:

TW12/08/14-1

Report Date:

31-August-2012

Received Date:

22-August-2012

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Analysis	Unit	TW12-06943.001 TB 0 32 0-10 Soil	TW12-06943.002 TB 0 32 20-30 Soil	TW12-06943.003 TB 0 32 50-60 Soil	TW12-06943.004 TB 0 32 80-90 Soil
ACIDITY					
pH - Water	pH units	7.67	7.86	8.19	8.44
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	5	<1	<1	<1
Phosphorus - Colwell extr	mg/kg	4	2	2	2
Potassium	mg/kg	314	104	99	100
Nitrogen	mg/kg	707	944	658	791
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	0.5	0.5	1.3	1.5
Aluminium	mg/kg	1	<1	<1	<1
Calcium	mg/kg	10600	10900	11100	11300
Magnesium	mg/kg	1680	1690	1750	1840
Calcium Carbonate	%	2	2	2	2
Sulphate	mg/kg	15	25	15	16
TRACE ELEMENTS					
Boron	mg/kg	0.6	0.6	0.6	0.6
Copper	mg/kg	1.6	1.5	1.5	1.5
Iron	mg/kg	15	15	15	16
Manganese	mg/kg	13	9	6	5
Zinc	mg/kg	0.3	0.2	0.2	0.2
ORGANIC MATTER					
Organic Matter	%	1.8	1.6	1.5	1.5
SALINITY					
Electrical Conductivity	dS/m	0.04	0.05	0.06	0.08
Chloride	mg/kg	1	<1	<1	<1
Sodium	mg/kg	259	280	305	345
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	1.12	1.22	1.33	1.50
Exchangeable Potassium	meq/100g	0.80	0.27	0.25	0.26
Exchangeable Calcium	meq/100g	53.0	54.7	55.7	56.3
Exchangeable Magnesium	meq/100g	14.0	14.1	14.6	15.3
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	1.6	1.7	1.8	2.0
Exchangeable Potassium Percent	%	1.2	0.4	0.4	0.3
Exchangeable Calcium Percent	%	76.9	77.8	77.5	76.7
Exchangeable Magnesium Percent	%	20.3	20.0	20.3	20.9
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable

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TW12-06943

Analysis	Unit	TW12-06943.001 TB 0 32 0-10 Soil	TW12-06943.002 TB 0 32 20-30 Soil	TW12-06943.003 TB 0 32 50-60 Soil	TW12-06943.004 TB 0 32 80-90 Soil
Cation Exchange	meq/100g	68.9	70.3	71.9	73.3
Calcium/Magnesium Ratio		3.78	3.88	3.83	3.68
OTHER					
Colour		2.5/2 7.5YR	2/2 10YR	2/2 10YR	2/2 10YR
Soil Texture		HC	MC	HC	HC

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TW12-06943

Analysis	Unit	TW12-06943.005 TB 0 32 90-100 Soil	TW12-06943.006 TB 0 32 110-120 Soil	TW12-06943.007 TB 0 32 140-150 Soil	TW12-06943.008 TB 0 40 0-10 Soil
ACIDITY					
pH - Water	pH units	8.59	8.74	8.73	8.40
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	<1	<1	59
Phosphorus - Colwell extr	mg/kg	3	4	5	5
Potassium	mg/kg	75	80	78	261
Nitrogen	mg/kg	800	908	967	943
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	1.7	4.8	8.0	4.1
Aluminium	mg/kg	<1	<1	<1	<1
Calcium	mg/kg	11200	11100	11300	9730
Magnesium	mg/kg	1810	1710	1760	2950
Calcium Carbonate	%	10	19	19	9
Sulphate	mg/kg	12	18	46	18
TRACE ELEMENTS					
Boron	mg/kg	0.6	0.4	0.4	0.4
Copper	mg/kg	1.4	0.7	0.5	1.1
Iron	mg/kg	13	9	9	8
Manganese	mg/kg	3	<1	4	3
Zinc	mg/kg	0.3	0.2	0.2	0.3
ORGANIC MATTER					
Organic Matter	%	1.3	0.5	0.2	1.4
SALINITY					
Electrical Conductivity	dS/m	0.11	0.10	0.10	0.25
Chloride	mg/kg	1	6	6	272
Sodium	mg/kg	377	366	380	406
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	1.64	1.59	1.65	1.76
Exchangeable Potassium	meq/100g	0.19	0.20	0.20	0.67
Exchangeable Calcium	meq/100g	56.2	55.3	56.3	48.6
Exchangeable Magnesium	meq/100g	15.1	14.2	14.7	24.6
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	2.2	2.2	2.3	2.3
Exchangeable Potassium Percent	%	0.3	0.3	0.3	0.9
Exchangeable Calcium Percent	%	76.8	77.5	77.3	64.3
Exchangeable Magnesium Percent	%	20.7	20.0	20.2	32.5
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	73.1	71.3	72.9	75.7
Calcium/Magnesium Ratio		3.71	3.88	3.84	1.98
OTHER					
Colour		2/2 10YR	3/3 10YR	3/3 10YR	3/1 10YR
Soil Texture		MC	LC	SC	MC

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TW12-06943

Analysis	Unit	TW12-06943.009 TB 0 40 20-30 Soil	TW12-06943.010 TB 0 40 50-60 Soil	TW12-06943.011 TB 0 40 80-90 Soil	TW12-06943.012 TB 0 40 110-120 Soil
ACIDITY					
pH - Water	pH units	8.82	9.19	9.33	9.19
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	18	14	6	10
Phosphorus - Colwell extr	mg/kg	1	<1	<1	1
Potassium	mg/kg	116	83	90	105
Nitrogen	mg/kg	986	1020	886	948
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	1.6	1.3	4.2	21.4
Aluminium	mg/kg	<1	<1	<1	<1
Calcium	mg/kg	8970	7650	6980	6740
Magnesium	mg/kg	3390	3830	4300	4400
Calcium Carbonate	%	10	10	10	10
Sulphate	mg/kg	13	12	12	220
TRACE ELEMENTS					
Boron	mg/kg	1.0	0.8	2.0	3.2
Copper	mg/kg	1.2	1.3	1.3	1.3
Iron	mg/kg	9	8	10	9
Manganese	mg/kg	2	2	2	2
Zinc	mg/kg	0.1	0.2	0.2	0.3
ORGANIC MATTER					
Organic Matter	%	1.4	1.2	1.2	1.2
SALINITY					
Electrical Conductivity	dS/m	0.15	0.20	0.24	0.34
Chloride	mg/kg	94	79	82	292
Sodium	mg/kg	477	962	1500	1690
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	2.07	4.18	6.53	7.34
Exchangeable Potassium	meq/100g	0.30	0.21	0.23	0.27
Exchangeable Calcium	meq/100g	44.8	38.2	34.9	33.7
Exchangeable Magnesium	meq/100g	28.3	31.9	35.9	36.7
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	2.7	5.6	8.4	9.4
Exchangeable Potassium Percent	%	0.4	0.3	0.3	0.3
Exchangeable Calcium Percent	%	59.4	51.3	45.0	43.2
Exchangeable Magnesium Percent	%	37.4	42.8	46.2	47.0
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	75.5	74.5	77.5	78.0
Calcium/Magnesium Ratio		1.59	1.20	0.97	0.92
OTHER					
Colour		3/2 10YR	3/1 10YR	3/2 7.5YR	3/1 10YR
Soil Texture		MC	HC	HC	MC

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TW12-06943

Analysis	Unit	TW12-06943.013 TB 0 40 140-150 Soil	TW12-06943.014 TB 0 46 0-10 Soil	TW12-06943.015 TB 0 46 20-30 Soil	TW12-06943.016 TB 0 46 50-60 Soil
ACIDITY					
pH - Water	pH units	9.05	8.41	8.33	8.51
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	7	1	3	3
Phosphorus - Colwell extr	mg/kg	1	7	3	3
Potassium	mg/kg	101	420	215	217
Nitrogen	mg/kg	882	1100	1130	1100
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	86.3	1.7	1.3	1.7
Aluminium	mg/kg	<1	<1	<1	<1
Calcium	mg/kg	6140	11200	11000	11100
Magnesium	mg/kg	4580	1490	1870	1930
Calcium Carbonate	%	10	7	7	10
Sulphate	mg/kg	630	9	18	14
TRACE ELEMENTS					
Boron	mg/kg	3.8	0.8	0.4	0.8
Copper	mg/kg	1.3	1.2	1.4	1.4
Iron	mg/kg	9	17	20	22
Manganese	mg/kg	2	4	4	4
Zinc	mg/kg	0.2	0.3	0.9	1.4
ORGANIC MATTER					
Organic Matter	%	1.2	1.6	1.6	1.7
SALINITY					
Electrical Conductivity	dS/m	0.60	0.08	0.08	0.10
Chloride	mg/kg	508	4	3	<1
Sodium	mg/kg	2070	304	303	333
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	9.02	1.32	1.32	1.45
Exchangeable Potassium	meq/100g	0.26	1.08	0.55	0.56
Exchangeable Calcium	meq/100g	30.7	56.1	55.1	55.5
Exchangeable Magnesium	meq/100g	38.2	12.4	15.6	16.1
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	11.5	1.9	1.8	2.0
Exchangeable Potassium Percent	%	0.3	1.5	0.8	0.8
Exchangeable Calcium Percent	%	39.3	79.1	76.0	75.5
Exchangeable Magnesium Percent	%	48.9	17.5	21.4	21.8
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	78.2	70.9	72.6	73.6
Calcium/Magnesium Ratio		0.80	4.53	3.54	3.46
OTHER					
Colour		3/1 10YR	3/2 7.5YR	2/2 10YR	2/2 10YR
Soil Texture		MC	MC	MC	HC

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Report of Analysis

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TW12-06943

Analysis	Unit	TW12-06943.017 TB 0 46 60-70 Soil	TW12-06943.018 TB 0 46 80-90 Soil	TW12-06943.019 TB 0 46 110-120 Soil	TW12-06943.020 TB 0 48 0-10 Soil
ACIDITY					
pH - Water	pH units	8.55	8.76	8.76	7.96
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	3	1	2	6
Phosphorus - Colwell extr	mg/kg	3	3	3	10
Potassium	mg/kg	185	266	416	249
Nitrogen	mg/kg	1110	1000	1010	1080
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	2.0	0.8	0.7	1.2
Aluminium	mg/kg	<1	<1	<1	<1
Calcium	mg/kg	10600	8790	8340	10200
Magnesium	mg/kg	1680	1140	1130	2130
Calcium Carbonate	%	11	13	11	2
Sulphate	mg/kg	13	10	12	22
TRACE ELEMENTS					
Boron	mg/kg	0.6	0.2	0.2	0.6
Copper	mg/kg	1.1	0.4	0.5	1.1
Iron	mg/kg	21	38	45	18
Manganese	mg/kg	3	3	4	10
Zinc	mg/kg	2.0	1.2	1.5	2.1
ORGANIC MATTER					
Organic Matter	%	1.3	0.4	0.4	1.8
SALINITY					
Electrical Conductivity	dS/m	0.10	0.10	0.11	0.07
Chloride	mg/kg	<1	<1	<1	4
Sodium	mg/kg	315	294	309	254
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	1.37	1.28	1.34	1.10
Exchangeable Potassium	meq/100g	0.47	0.68	1.07	0.64
Exchangeable Calcium	meq/100g	53.1	43.9	41.7	51.2
Exchangeable Magnesium	meq/100g	14.0	9.50	9.38	17.8
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	2.0	2.3	2.5	1.6
Exchangeable Potassium Percent	%	0.7	1.2	2.0	0.9
Exchangeable Calcium Percent	%	77.0	79.3	78.0	72.4
Exchangeable Magnesium Percent	%	20.4	17.2	17.5	25.1
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	69.0	55.4	53.5	70.7
Calcium/Magnesium Ratio		3.78	4.62	4.45	2.89
OTHER					
Colour		3/3 10YR	3/3 7.5YR	3/3 10YR	4/2 10YR
Soil Texture		MC	SC	SC	SC

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TW12-06943

Analysis	Unit	TW12-06943.021 TB 0 48 20-30 Soil	TW12-06943.022 TB 0 48 50-60 Soil	TW12-06943.023 TB 0 48 80-90 Soil	TW12-06943.024 TB 0 48 110-120 Soil
ACIDITY					
pH - Water	pH units	7.95	7.97	8.58	8.56
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	6	5	3	1
Phosphorus - Colwell extr	mg/kg	3	3	1	1
Potassium	mg/kg	111	144	33	37
Nitrogen	mg/kg	642	561	759	769
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	1.0	1.2	0.4	0.8
Aluminium	mg/kg	<1	<1	<1	<1
Calcium	mg/kg	10200	10100	9980	11200
Magnesium	mg/kg	2290	2350	2170	2580
Calcium Carbonate	%	7	2	34	20
Sulphate	mg/kg	12	14	9	9
TRACE ELEMENTS					
Boron	mg/kg	0.6	0.6	0.8	0.8
Copper	mg/kg	1.1	1.1	0.4	0.4
Iron	mg/kg	25	27	23	25
Manganese	mg/kg	8	9	3	3
Zinc	mg/kg	1.7	0.8	2.4	1.6
ORGANIC MATTER					
Organic Matter	%	1.5	1.6	0.8	0.6
SALINITY					
Electrical Conductivity	dS/m	0.07	0.06	0.11	0.12
Chloride	mg/kg	3	2	2	2
Sodium	mg/kg	260	258	292	366
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	1.13	1.12	1.27	1.59
Exchangeable Potassium	meq/100g	0.29	0.37	0.08	0.09
Exchangeable Calcium	meq/100g	51.2	50.5	49.9	56.2
Exchangeable Magnesium	meq/100g	19.1	19.6	18.1	21.5
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	1.6	1.6	1.8	2.0
Exchangeable Potassium Percent	%	0.4	0.5	0.1	0.1
Exchangeable Calcium Percent	%	71.4	70.5	72.0	70.8
Exchangeable Magnesium Percent	%	26.6	27.4	26.1	27.1
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	71.6	71.6	69.3	79.4
Calcium/Magnesium Ratio		2.68	2.57	2.76	2.62
OTHER					
Colour		3/3 10YR	3/3 10YR	3/3 10YR	4/3 10YR
Soil Texture		LC	MC	HC	LMC

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TW12-06943

Analysis	Unit	TW12-06943.025 TB 0 48 140-150 Soil	TW12-06943.026 TB 0 57 0-10 Soil	TW12-06943.027 TB 0 57 20-30 Soil	TW12-06943.028 TB 0 57 50-60 Soil
ACIDITY					
pH - Water	pH units	8.57	7.64	7.66	7.92
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	6	4	3
Phosphorus - Colwell extr	mg/kg	2	4	1	1
Potassium	mg/kg	41	121	56	60
Nitrogen	mg/kg	893	1000	921	781
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	1.3	1.6	2.1	2.1
Aluminium	mg/kg	<1	<1	<1	<1
Calcium	mg/kg	11100	7440	7470	7480
Magnesium	mg/kg	2400	2810	2880	2910
Calcium Carbonate	%	10	5	6	6
Sulphate	mg/kg	11	19	12	11
TRACE ELEMENTS					
Boron	mg/kg	0.4	0.6	0.6	0.6
Copper	mg/kg	0.4	1.2	1.2	1.2
Iron	mg/kg	25	29	32	32
Manganese	mg/kg	3	17	15	9
Zinc	mg/kg	1.0	1.2	1.8	1.7
ORGANIC MATTER					
Organic Matter	%	0.6	1.2	1.3	1.1
SALINITY					
Electrical Conductivity	dS/m	0.12	0.07	0.05	0.04
Chloride	mg/kg	<1	3	<1	3
Sodium	mg/kg	367	189	208	241
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	1.59	0.82	0.90	1.05
Exchangeable Potassium	meq/100g	0.11	0.31	0.14	0.15
Exchangeable Calcium	meq/100g	55.6	37.2	37.4	37.4
Exchangeable Magnesium	meq/100g	20.0	23.4	24.0	24.3
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	2.1	1.3	1.4	1.7
Exchangeable Potassium Percent	%	0.1	0.5	0.2	0.2
Exchangeable Calcium Percent	%	71.9	60.2	59.9	59.5
Exchangeable Magnesium Percent	%	25.9	37.9	38.4	38.6
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	77.3	61.7	62.4	62.9
Calcium/Magnesium Ratio		2.78	1.59	1.56	1.54
OTHER					
Colour		4/4 10YR	4/2 10YR	3/2 7.5YR	3/2 7.5YR
Soil Texture		LC	LC	HC	HC

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TW12-06943

Analysis	Unit	TW12-06943.029 TB 0 57 80-90 Soil	TW12-06943.030 TB 0 57 110-120 Soil	TW12-06943.031 TB 0 57 140-150 Soil	TW12-06943.032 TB 0 37 0-10 Soil
ACIDITY					
pH - Water	pH units	8.34	8.41	8.51	8.49
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	4	3	2	1
Phosphorus - Colwell extr	mg/kg	1	1	2	2
Potassium	mg/kg	53	60	48	133
Nitrogen	mg/kg	585	560	1030	1160
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	4.5	12.1	9.2	7.9
Aluminium	mg/kg	<1	<1	<1	<1
Calcium	mg/kg	7620	7730	8330	3820
Magnesium	mg/kg	3030	3060	3180	1080
Calcium Carbonate	%	6	7	7	6
Sulphate	mg/kg	16	110	79	3
TRACE ELEMENTS					
Boron	mg/kg	0.8	0.8	1.0	0.4
Copper	mg/kg	1.0	1.0	0.9	1.8
Iron	mg/kg	24	27	24	17
Manganese	mg/kg	4	4	3	5
Zinc	mg/kg	1.3	1.1	1.3	1.1
ORGANIC MATTER					
Organic Matter	%	1.0	1.1	0.8	1.9
SALINITY					
Electrical Conductivity	dS/m	0.07	0.13	0.16	0.11
Chloride	mg/kg	4	16	32	22
Sodium	mg/kg	274	299	327	138
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	1.19	1.30	1.42	0.60
Exchangeable Potassium	meq/100g	0.13	0.15	0.12	0.34
Exchangeable Calcium	meq/100g	38.1	38.6	41.6	19.1
Exchangeable Magnesium	meq/100g	25.3	25.5	26.5	8.98
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	1.8	2.0	2.0	2.1
Exchangeable Potassium Percent	%	0.2	0.2	0.2	1.2
Exchangeable Calcium Percent	%	58.9	58.9	59.7	65.8
Exchangeable Magnesium Percent	%	39.1	38.9	38.1	30.9
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	64.7	65.6	69.7	29.0
Calcium/Magnesium Ratio		1.51	1.51	1.57	2.13
OTHER					
Colour		3/1 10YR	2.5/2 2.5YR	4/2 10YR	4/2 10YR
Soil Texture		HC	HC	HC	MC

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TW12-06943

Analysis	Unit	TW12-06943.033 TB 0 37 20-30 Soil	TW12-06943.034 TB 0 37 50-60 Soil	TW12-06943.035 TB 0 37 80-90 Soil	TW12-06943.036 TB 0 37 110-120 Soil
ACIDITY					
pH - Water	pH units	8.56	7.47	6.37	5.21
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	5	4	5
Phosphorus - Colwell extr	mg/kg	1	1	2	2
Potassium	mg/kg	114	106	77	69
Nitrogen	mg/kg	889	642	949	929
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	13.8	776	1010	591
Aluminium	mg/kg	<1	<1	<1	3
Calcium	mg/kg	3920	5210	4530	3090
Magnesium	mg/kg	1100	1160	1160	1200
Calcium Carbonate	%	5	6	5	<1
Sulphate	mg/kg	58	7600	7400	5200
TRACE ELEMENTS					
Boron	mg/kg	0.6	0.8	1.6	1.4
Copper	mg/kg	1.8	2.1	2.1	2.3
Iron	mg/kg	21	19	22	24
Manganese	mg/kg	5	6	6	6
Zinc	mg/kg	0.9	0.9	1.0	1.1
ORGANIC MATTER					
Organic Matter	%	1.5	0.9	0.9	0.6
SALINITY					
Electrical Conductivity	dS/m	0.16	1.93	2.46	2.15
Chloride	mg/kg	46	630	1543	1773
Sodium	mg/kg	179	648	882	875
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	0.78	2.82	3.83	3.80
Exchangeable Potassium	meq/100g	0.29	0.27	0.20	0.18
Exchangeable Calcium	meq/100g	19.6	26.0	22.7	15.5
Exchangeable Magnesium	meq/100g	9.14	9.64	9.64	9.97
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	0.03
Exchangeable Sodium Percent	%	2.6	7.3	10.6	12.9
Exchangeable Potassium Percent	%	1.0	0.7	0.5	0.6
Exchangeable Calcium Percent	%	65.7	67.2	62.4	52.5
Exchangeable Magnesium Percent	%	30.7	24.9	26.5	33.9
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	0.1
Cation Exchange	meq/100g	29.8	38.8	36.3	29.4
Calcium/Magnesium Ratio		2.14	2.70	2.35	1.55
OTHER					
Colour		4/3 10YR	4/4 10YR	4/2 10YR	4/4 10YR
Soil Texture		LC	LC	LMC	LC

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TW12-06943

Analysis	Unit	TW12-06943.037 TB 0 37 140-150 Soil	TW12-06943.038 TB 0 53 0-10 Soil	TW12-06943.039 TB 0 53 20-30 Soil	TW12-06943.040 TB 0 53 50-60 Soil
ACIDITY					
pH - Water	pH units	5.28	6.76	7.35	9.15
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	3	5	4	2
Phosphorus - Colwell extr	mg/kg	2	12	6	2
Potassium	mg/kg	70	115	80	68
Nitrogen	mg/kg	1110	929	972	1030
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	177	4.7	2.6	3.7
Aluminium	mg/kg	3	<1	<1	<1
Calcium	mg/kg	2010	1860	2280	4140
Magnesium	mg/kg	1240	483	676	1090
Calcium Carbonate	%	<1	5	5	7
Sulphate	mg/kg	860	1	<1	1
TRACE ELEMENTS					
Boron	mg/kg	1.0	0.6	0.4	1.0
Copper	mg/kg	3.0	1.0	1.0	0.6
Iron	mg/kg	35	50	30	17
Manganese	mg/kg	6	8	7	3
Zinc	mg/kg	1.1	1.5	1.2	1.8
ORGANIC MATTER					
Organic Matter	%	0.8	2.6	1.9	0.9
SALINITY					
Electrical Conductivity	dS/m	1.13	0.04	0.04	0.19
Chloride	mg/kg	1624	13	13	71
Sodium	mg/kg	825	49	90	381
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	3.59	0.21	0.39	1.65
Exchangeable Potassium	meq/100g	0.18	0.29	0.21	0.18
Exchangeable Calcium	meq/100g	10.1	9.28	11.4	20.7
Exchangeable Magnesium	meq/100g	10.3	4.02	5.63	9.06
Exchangeable Aluminium	meq/100g	0.03	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	14.8	1.5	2.2	5.2
Exchangeable Potassium Percent	%	0.7	2.1	1.2	0.6
Exchangeable Calcium Percent	%	41.6	67.2	64.6	65.5
Exchangeable Magnesium Percent	%	42.6	29.1	32.0	28.7
Exchangeable Aluminium Percent	%	0.1	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	24.2	13.8	17.6	31.6
Calcium/Magnesium Ratio		0.98	2.31	2.02	2.28
OTHER					
Colour		4/3 10YR	3/4 7.5YR	2.5/2 7.5YR	4/3 10YR
Soil Texture		MC	SC	LC	LC

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TW12-06943

Analysis	Unit	TW12-06943.041 TB 0 53 80-90 Soil	TW12-06943.042 TB 0 53 110-120 Soil	TW12-06943.043 TB 0 53 140-150 Soil	TW12-06943.044 TB 0 54 0-10 Soil
ACIDITY					
pH - Water	pH units	9.30	9.35	9.19	8.17
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	1	<1	<1	<1
Phosphorus - Colwell extr	mg/kg	2	2	1	13
Potassium	mg/kg	58	36	35	407
Nitrogen	mg/kg	938	915	1100	1240
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	9.1	11.9	14.3	1.1
Aluminium	mg/kg	<1	<1	<1	<1
Calcium	mg/kg	3890	3510	3430	7130
Magnesium	mg/kg	1130	1030	1100	1750
Calcium Carbonate	%	13	30	20	6
Sulphate	mg/kg	2	40	67	6
TRACE ELEMENTS					
Boron	mg/kg	1.8	1.8	2.6	0.6
Copper	mg/kg	0.4	0.3	0.2	0.9
Iron	mg/kg	14	9	14	22
Manganese	mg/kg	3	2	1	5
Zinc	mg/kg	1.6	1.0	0.2	0.6
ORGANIC MATTER					
Organic Matter	%	0.9	0.9	0.5	1.6
SALINITY					
Electrical Conductivity	dS/m	0.29	0.52	0.75	0.08
Chloride	mg/kg	278	538	1153	5
Sodium	mg/kg	559	753	1010	166
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	2.43	3.27	4.40	0.72
Exchangeable Potassium	meq/100g	0.15	0.09	0.09	1.04
Exchangeable Calcium	meq/100g	19.4	17.6	17.1	35.7
Exchangeable Magnesium	meq/100g	9.44	8.55	9.13	14.5
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	7.7	11.1	14.3	1.4
Exchangeable Potassium Percent	%	0.5	0.3	0.3	2.0
Exchangeable Calcium Percent	%	61.8	59.6	55.7	68.6
Exchangeable Magnesium Percent	%	30.0	29.0	29.7	28.0
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	31.5	29.5	30.8	52.0
Calcium/Magnesium Ratio		2.06	2.06	1.88	2.45
OTHER					
Colour		3/3 10YR	6/8 10YR	5/6 10YR	4/2 10YR
Soil Texture		LMC	SC	LC	MC

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Report of Analysis

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TW12-06943

Analysis	Unit	TW12-06943.045 TB 0 54 20-30 Soil	TW12-06943.046 TB 0 54 50-60 Soil	TW12-06943.047 TB 0 54 80-90 Soil	TW12-06943.048 TB 0 54 110-120 Soil
ACIDITY					
pH - Water	pH units	8.30	8.45	8.67	8.66
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	<1	<1	<1
Phosphorus - Colwell extr	mg/kg	4	2	5	6
Potassium	mg/kg	248	242	272	303
Nitrogen	mg/kg	1110	1320	1230	1380
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	0.8	1.1	1.1	0.7
Aluminium	mg/kg	<1	<1	<1	<1
Calcium	mg/kg	7650	8090	8290	8560
Magnesium	mg/kg	2020	2350	2140	2140
Calcium Carbonate	%	6	7	19	7
Sulphate	mg/kg	6	9	5	7
TRACE ELEMENTS					
Boron	mg/kg	0.4	0.6	0.4	0.2
Copper	mg/kg	1.0	1.1	0.4	0.5
Iron	mg/kg	26	29	31	32
Manganese	mg/kg	5	5	2	3
Zinc	mg/kg	0.8	1.1	0.4	0.7
ORGANIC MATTER					
Organic Matter	%	1.4	1.7	0.6	0.7
SALINITY					
Electrical Conductivity	dS/m	0.08	0.11	0.14	0.13
Chloride	mg/kg	3	10	10	8
Sodium	mg/kg	187	221	261	266
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	0.81	0.96	1.13	1.16
Exchangeable Potassium	meq/100g	0.63	0.62	0.70	0.78
Exchangeable Calcium	meq/100g	38.3	40.4	41.4	42.8
Exchangeable Magnesium	meq/100g	16.8	19.5	17.8	17.9
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	1.4	1.6	1.9	1.8
Exchangeable Potassium Percent	%	1.1	1.0	1.1	1.2
Exchangeable Calcium Percent	%	67.7	65.7	67.8	68.4
Exchangeable Magnesium Percent	%	29.7	31.8	29.2	28.5
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	56.5	61.6	61.1	62.6
Calcium/Magnesium Ratio		2.28	2.07	2.33	2.40
OTHER					
Colour		4/2 10YR	3/1 7.5YR	4/2 10YR	4/2 10YR
Soil Texture		MC	MC	MC	LC

Results are on an 'air dried' basis.

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TW12-06943

Analysed Between 22/08/2012 - 31/08/2012

Method of Analysis			
Analysis	Unit	Det.Lim.	Method
pH - Water	pH units	0.01	SOL003/SOL001/2
Electrical Conductivity	dS/m	0.01	SOL003/SOL001/2
Nitrate Nitrogen	mg/kg	1	SOL030
Chloride	mg/kg	1	SOL030
Boron	mg/kg	0.2	SOL001/13
Organic Matter	%	0.1	CAR002/SOL002/1
Phosphorus - Colwell extr	mg/kg	1	SOL005/001/4
Sulphur - KCl	mg/kg	0.1	SOL001/6-2
Copper	mg/kg	0.1	SOL001/9/10/12
Iron	mg/kg	1	SOL001/9/10/12
Manganese	mg/kg	1	SOL001/9/10/12
Zinc	mg/kg	0.1	SOL001/9/10/12
Aluminium	mg/kg	1	SOL002/1-2
Sodium	mg/kg	1	SOL044
Potassium	mg/kg	1	SOL044
Calcium	mg/kg	1	SOL044
Magnesium	mg/kg	1	SOL044
Exchangeable Sodium	meq/100g	0.01	SOL044
Exchangeable Potassium	meq/100g	0.01	SOL044
Exchangeable Calcium	meq/100g	0.01	SOL044
Exchangeable Magnesium	meq/100g	0.01	SOL044
Exchangeable Aluminium	meq/100g	0.01	SOL044
Exchangeable Sodium Percent	%	0.1	SOL044
Exchangeable Potassium Percent	%	0.1	SOL044
Exchangeable Calcium Percent	%	0.1	SOL044
Exchangeable Magnesium Percent	%	0.1	SOL044
Exchangeable Aluminium Percent	%	0.1	SOL044
Cation Exchange	meq/100g	0.01	SOL044
Calcium/Magnesium Ratio		0.01	SOL044
Colour			
Calcium Carbonate	%	1	SOL004
Soil Texture			SOL011
Nitrogen	mg/kg	300	PRN002
Sulphate	mg/kg	1	ANL001

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Peter Klettke - Instrument Chemist

For and on behalf of SGS Australia Pty Ltd

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Report of Analysis

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TW13-06790

Client:

AUSTRALASIAN RESOURCE CONSULTANTS PTY LTD
SUITE 5B
1 SWANN ROAD
TARINGA QLD 4068

Order Number:

Taraborah Project

Report Date:

07-November-2013

Received Date:

30-October-2013

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Analysis	Unit	TW13-06790.001 Site TB10 (cm) 0-10 Soil	TW13-06790.002 Site TB10 (cm) 20-30 Soil	TW13-06790.003 Site TB10 (cm) 40-50 Soil	TW13-06790.004 Site TB10 (cm) 50-60 Soil
ACIDITY					
pH - Water	pH units	6.44	7.45	9.03	8.75
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	2	2	7
Phosphorus - Colwell extr	mg/kg	15	<1	<1	1
Potassium	mg/kg	56	67	50	50
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	1.8	16.7	21.2	18.3
Aluminium	mg/kg	<1	<1	<1	<1
Calcium	mg/kg	322	493	739	2360
Magnesium	mg/kg	203	1230	1380	1190
TRACE ELEMENTS					
Boron	mg/kg	<0.2	0.2	0.4	0.6
Copper	mg/kg	0.4	0.9	0.8	0.7
Iron	mg/kg	58	20	7	23
Manganese	mg/kg	6	2	<1	1
Zinc	mg/kg	0.4	0.1	<0.1	0.1
ORGANIC MATTER					
Organic Matter	%	0.9	0.5	0.3	0.6
SALINITY					
Electrical Conductivity	dS/m	0.09	0.31	0.53	0.46
Chloride	mg/kg	24	269	431	280
Sodium	mg/kg	62	613	982	644
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	0.27	2.66	4.27	2.80
Exchangeable Potassium	meq/100g	0.14	0.17	0.13	0.13
Exchangeable Calcium	meq/100g	1.61	2.47	3.70	11.8
Exchangeable Magnesium	meq/100g	1.69	10.3	11.5	9.92
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	7.3	17.1	21.8	11.4
Exchangeable Potassium Percent	%	3.9	1.1	0.7	0.5
Exchangeable Calcium Percent	%	43.3	15.8	18.8	47.8
Exchangeable Magnesium Percent	%	45.5	66.0	58.7	40.3
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	3.72	15.6	19.6	24.6
Calcium/Magnesium Ratio		0.95	0.24	0.32	1.19



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Analysis	Unit	TW13-06790.005 Site TB10 (cm) 80-90 Soil	TW13-06790.006 Site TB10 (cm) 110-120 Soil	TW13-06790.007 Site TB10 (cm) 140-150 Soil	TW13-06790.008 Site TB11 (cm) 0-10 Soil
ACIDITY					
pH - Water	pH units	9.48	9.18	8.51	6.01
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	5	3	<1	<1
Phosphorus - Colwell extr	mg/kg	<1	<1	<1	1
Potassium	mg/kg	31	24	18	59
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	41.8	42.9	52.9	2.5
Aluminium	mg/kg	<1	<1	<1	1
Calcium	mg/kg	1440	459	195	736
Magnesium	mg/kg	966	692	492	336
TRACE ELEMENTS					
Boron	mg/kg	0.4	1.4	1.0	<0.2
Copper	mg/kg	0.3	0.2	0.1	1.8
Iron	mg/kg	4	3	3	33
Manganese	mg/kg	<1	<1	<1	130
Zinc	mg/kg	<0.1	<0.1	<0.1	0.3
ORGANIC MATTER					
Organic Matter	%	0.3	0.4	0.1	1.5
SALINITY					
Electrical Conductivity	dS/m	0.72	0.71	0.77	0.06
Chloride	mg/kg	728	835	1021	8
Sodium	mg/kg	1190	1610	1680	38
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	5.17	7.01	7.30	0.17
Exchangeable Potassium	meq/100g	0.08	0.06	0.05	0.15
Exchangeable Calcium	meq/100g	7.22	2.29	0.97	3.68
Exchangeable Magnesium	meq/100g	8.05	5.77	4.10	2.80
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	25.2	46.3	58.8	2.4
Exchangeable Potassium Percent	%	0.4	0.4	0.4	2.2
Exchangeable Calcium Percent	%	35.2	15.2	7.8	54.1
Exchangeable Magnesium Percent	%	39.2	38.1	33.0	41.2
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	20.5	15.1	12.4	6.80
Calcium/Magnesium Ratio		0.90	0.40	0.24	1.31



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Analysis	Unit	TW13-06790.009 Site TB11 (cm) 20-30 Soil	TW13-06790.010 Site TB11 (cm) 50-60 Soil	TW13-06790.011 Site TB11 (cm) 80-90 Soil	TW13-06790.012 Site TB11 (cm) 110-120 Soil
ACIDITY					
pH - Water	pH units	5.85	6.33	6.60	8.51
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	<1	<1	<1	<1
Phosphorus - Colwell extr	mg/kg	1	<1	1	<1
Potassium	mg/kg	48	52	54	47
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	1.7	3.7	7.0	3.7
Aluminium	mg/kg	5	2	<1	<1
Calcium	mg/kg	776	1540	1850	6790
Magnesium	mg/kg	397	967	1180	1440
TRACE ELEMENTS					
Boron	mg/kg	0.2	0.2	1.2	1.0
Copper	mg/kg	1.7	1.1	0.6	0.4
Iron	mg/kg	27	26	21	7
Manganese	mg/kg	86	8	6	5
Zinc	mg/kg	0.2	<0.1	<0.1	<0.1
ORGANIC MATTER					
Organic Matter	%	1.2	0.7	0.4	0.5
SALINITY					
Electrical Conductivity	dS/m	0.05	0.05	0.06	0.18
Chloride	mg/kg	4	2	10	11
Sodium	mg/kg	23	65	88	115
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	0.10	0.28	0.38	0.50
Exchangeable Potassium	meq/100g	0.12	0.13	0.14	0.12
Exchangeable Calcium	meq/100g	3.88	7.68	9.25	33.9
Exchangeable Magnesium	meq/100g	3.31	8.06	9.86	12.0
Exchangeable Aluminium	meq/100g	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exchangeable Sodium Percent	%	1.3	1.7	2.0	1.1
Exchangeable Potassium Percent	%	1.7	0.8	0.7	0.3
Exchangeable Calcium Percent	%	52.3	47.6	47.1	72.9
Exchangeable Magnesium Percent	%	44.7	49.9	50.2	25.7
Exchangeable Aluminium Percent	%	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange	meq/100g	7.41	16.2	19.6	46.5
Calcium/Magnesium Ratio		1.17	0.95	0.94	2.84



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Analysis	Unit	TW13-06790.013 Site TB11 (cm) 140-150 Soil			
ACIDITY					
pH - Water	pH units	8.08			
MAJOR ELEMENTS					
Nitrate Nitrogen	mg/kg	1			
Phosphorus - Colwell extr	mg/kg	<1			
Potassium	mg/kg	55			
SECONDARY ELEMENTS					
Sulphur - KCl	mg/kg	8.1			
Aluminium	mg/kg	<1			
Calcium	mg/kg	2830			
Magnesium	mg/kg	1090			
TRACE ELEMENTS					
Boron	mg/kg	1.2			
Copper	mg/kg	0.6			
Iron	mg/kg	10			
Manganese	mg/kg	9			
Zinc	mg/kg	<0.1			
ORGANIC MATTER					
Organic Matter	%	0.6			
SALINITY					
Electrical Conductivity	dS/m	0.15			
Chloride	mg/kg	11			
Sodium	mg/kg	85			
EXCHANGEABLE CATIONS					
Exchangeable Sodium	meq/100g	0.37			
Exchangeable Potassium	meq/100g	0.14			
Exchangeable Calcium	meq/100g	14.1			
Exchangeable Magnesium	meq/100g	9.06			
Exchangeable Aluminium	meq/100g	Not Applicable			
Exchangeable Sodium Percent	%	1.6			
Exchangeable Potassium Percent	%	0.6			
Exchangeable Calcium Percent	%	59.6			
Exchangeable Magnesium Percent	%	38.2			
Exchangeable Aluminium Percent	%	Not Applicable			
Cation Exchange	meq/100g	23.7			
Calcium/Magnesium Ratio		1.56			

Results are on an 'air dried' basis.

Analysed Between 30/10/2013 - 07/11/2013



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Method of Analysis			
Analysis	Unit	Det.Lim.	Method
pH - Water	pH units	0.01	SOL003/1/1
Electrical Conductivity	dS/m	0.01	SOL007/2/2
Nitrate Nitrogen	mg/kg	1	SOL030
Chloride	mg/kg	1	SOL030
Boron	mg/kg	0.2	SOL001/13
Organic Matter	%	0.1	CAR002/SOL002/1
Phosphorus - Colwell extr	mg/kg	1	SOL005/001/4
Sulphur - KCl	mg/kg	0.1	SOL001/6-2
Copper	mg/kg	0.1	SOL001/9/10/12
Iron	mg/kg	1	SOL001/9/10/12
Manganese	mg/kg	1	SOL001/9/10/12
Zinc	mg/kg	0.1	SOL001/9/10/12
Aluminium	mg/kg	1	SOL002/1-2
Sodium	mg/kg	1	SOL044
Potassium	mg/kg	1	SOL044
Calcium	mg/kg	1	SOL044
Magnesium	mg/kg	1	SOL044
Exchangeable Sodium	meq/100g	0.01	SOL044
Exchangeable Potassium	meq/100g	0.01	SOL044
Exchangeable Calcium	meq/100g	0.01	SOL044
Exchangeable Magnesium	meq/100g	0.01	SOL044
Exchangeable Aluminium	meq/100g	0.01	SOL044
Exchangeable Sodium Percent	%	0.1	SOL044
Exchangeable Potassium Percent	%	0.1	SOL044
Exchangeable Calcium Percent	%	0.1	SOL044
Exchangeable Magnesium Percent	%	0.1	SOL044
Exchangeable Aluminium Percent	%	0.1	SOL044
Cation Exchange	meq/100g	0.01	SOL044
Calcium/Magnesium Ratio		0.01	SOL044



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Robert Lascelles - Chief Chemist

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Appendix D: Soil Information

Soil Information – Soil Chemical Properties

Compiled for AARC by GJR Holdings 2007

Major Soil Nutrients

With respect to topsoil suitability and existing general levels of soil fertility, depending on soil texture and plant available moisture capacity, some of the more important soil chemical requirements relate to the general levels of soil available nitrogen, phosphorus, potassium and organic matter content. With respect to the surficial soil horizons, the general levels of soil nutrients relevant for normal plant growth are as follows:

Soil Nutrient Level Ratings						
Parameter	Unit	Very Low	Low	Moderate	High	Very High
Nitrate Nitrogen	mg/kg	<5	5-15	15-25	25-50	>50
Phosphorus	mg/kg	<5	5-10	10-17	18-25	25
Potassium (Ex.)	me/100g	<0.2	0.2-0.3	0.3-0.7	0.7-2.0	>2.0
Potassium (Total)	mg/kg	<100	100-150	150-250	250-300	>300

Soil pH

Soil pH is a measure of the acidity or alkalinity of a soil. It characterises the chemical environment of the soil and provides a guide to likely mineral deficiencies and toxicities for plant growth. The general interpretation for soil pH (1:5 H₂O) is as follows:

pH	Soil Acidity/Alkalinity
8.5	Greater is strongly to very strongly alkaline
7.4 to 8.4	Mildly to moderately alkaline
6.6 to 7.3	Neutral
5.6 to 6.5	Moderately to slightly acidic
5.5 to 4.5	Strongly to very strongly acidic
<4.5	Extremely acidic

The preferred range for most plants varies between pH = 5.6 to 8.4 depending on the plant species.

Salinity – Electrical Conductivity (EC)

Salinity relates to the presence of water soluble salts, mainly sodium, calcium and magnesium, which may be in the form of chlorides, sulfates or carbonates. High levels of salinity can severely affect plant growth and as a consequence increase the soil erosion potential. Salinity levels based on the laboratory determined EC (1:5 H₂O) expressed as mS/cm (dS/m), vary depending on the soil texture and have been rated as follows:

Salinity Level	Electrical Conductivity		
	Sand	Loam	Medium to Heavy Clays
Non saline	<0.10 mS/cm	<0.20 mS/cm	<0.30 mS/cm
Slightly saline	0.10-0.25 mS/cm	0.20-0.40 mS/cm	0.30-0.55 mS/cm
Moderately saline	0.25-0.47 mS/cm	0.40-0.80 mS/cm	0.55-1.15 mS/cm
Highly saline	0.47-0.95 mS/cm	0.80-1.60 mS/cm	1.15-2.30 mS/cm
Extremely saline	>0.95 mS/cm	>1.60 mS/cm	>2.30 mS/cm

Exchangeable Cations and Cation Exchange Capacity (CEC)

Cation Exchange Capacity reflects the capacity of the soil to hold and exchange cations. It is a major controlling agent of stability of soil structure and nutrient availability for plant growth. Units are expressed as milli-equivalents per 100 g of soil (meq/100 g). Ratings for CEC range from <6 meq/100 g (very low), 6-12 meq/100 g (low), 12-25 meq/100 g (moderate), 25-40 meq/100 g (high) and >40 meq/100 g (very high).

The five most abundant cations present in soils are calcium (Ca²⁺), magnesium (Mg²⁺), potassium, (K⁺), sodium (Na⁺) and in strongly acid soils, aluminium (Al³⁺). The cations, manganese (Mn), iron (Fe), copper (Cu) and zinc (Zn) are usually present in small amounts that do not contribute significantly to the total cation compliment. It is common practice therefore to measure the concentrations of only the four or five most abundant cations. CEC may be measured directly, or the sum of the four major cations (Ca, Mg, Na, K) may be determined to give an approximate value of CEC termed - Effective CEC (ECEC). The individual major cations may then be expressed as a percentage of the CEC or ECEC.

The following rankings are applicable:

Basic Cation Concentrations (meq/100 g)					
Cation	Very Low	Low	Moderate	High	Very High
Calcium	0-2	2-5	5-10	10-20	>20
Magnesium	0-0.3	0.3-1.0	1-3	3-8	>8
Sodium	0-0.1	0.1-0.3	0.3-0.7	0.7-2.0	>2.0
Potassium	0-0.2	0.2-0.3	0.3-0.7	0.7-2.0	>2.0

Sodicity

Sodicity is the level of exchangeable sodium in the soil. Sodicity is determined using the exchangeable sodium percentage (ESP) which is the amount of exchangeable sodium expressed as a percentage of the effective cation exchanges capacity (ECEC). General ratings for sodicity are as follows:

ESP%	Rating
<6	Non-Sodic
6-14	Sodic
>14-25	Strongly Sodic
>25	Very Strongly Sodic

Sodic soils tend to exhibit the following problems:

- Very severe surface crusting;
- Likely dispersion on wetting;
- Very low infiltration and hydraulic conductivity;
- Very hard dense subsoils;
- High susceptibility to severe gully erosion;
- High susceptibility to tunnel erosion.

Ca/Mg Ratio

Values of Exchangeable Calcium to Exchangeable Magnesium (Ca/Mg) ratio of <2 and in particular those approaching 1 or that are <1, are considered to favour clay dispersion.

Organic Carbon (OC%) Content

Organic matter is derived from the breakdown of plants and animal matter and is largely responsible for much of the physical and chemical fertility of the soil. Organic matter content is normally only measured in the topsoil horizon and is calculated from the levels of organic carbon (OC%) determined in the soil, multiplied by a factor of 1.72. A ranking for soil organic matter content (OM%), based on (OC%) is as follows:

% Organic Carbon	Ranking	Soil Structure
<0.3%	Extremely low	Typical of subsoil levels or severely degraded or eroded surface soils
0.3-1.2%	Very low to low	Indicative of very poor to poor structural condition and structural stability.
1.2-2.9%	Moderate to high	Indicative of average to good structural condition and structural stability
>2.9%	High or very high	Indicative of good structural condition and high structural stability

Appendix E: Summary of The Australian Soil Classification

Soil Order	Description (Isbell 2002)
Anthrosols	Soils formed by humans. Formed by the modification or mixing of the original soil, or the creation of new soil parent material as a result of human activities. Identified by the presence of artefacts in the profile or knowledge that the soils or parent materials have been made or altered by human action.
Calcarosols	Soils dominated by carbonate. Soils which feature the presence of variable amounts and forms of identifiable pedogenic calcium carbonate. Limitations include shallow depth, low water retention due to hard carbonate content and wind erosion of the sandier types. High salinity, alkalinity and sodicity may also be a problem. Soil fertility deficiencies are widespread.
Chromosols	Neutral to alkaline soils with sharp increase in texture. Soils with an abrupt increase in clay; or, texture contrast. Mildly acidic B horizon, and non-sodic in its upper 0.2m. May have impeded internal drainage, and long periods of agriculture often degrade soil structure.
Dermosols	Structured B horizons and minor changes in texture. Lack texture contrast, are not calcareous, and have moderately to strongly structured lower B horizons. Moderately deep and relatively well-drained soils of wetter areas in eastern Australia. May be strongly acid in the high rainfall areas or highly alkaline if they contain calcareous subsoils.
Ferrosols	High iron levels and minor changes in texture. Iron rich soils. High in free-iron oxide and clay contents. Often feature strongly developed polyhedral peds in B horizons. In high rainfall zones they may be very deep and well drained.
Hydrosols	Wet soils. Seasonally or permanently wet soils, which are saturated for 2-3 months or more due to site or tidal influence. Distribution is often limited to wet drainage depressions, low lying narrow coastal plains and seepage areas on lower slopes.
Kandosols	Strongly weathered earths with minor changes in texture. Structureless soils. Mostly well-drained, permeable soils, although some Yellow and most Grey Kandosols have impeded subsoil drainage. Most have low fertility and land use is restricted to grazing of native pastures.
Kurosols	Acid soils with sharp increases in texture. Acidic soils with a clear or abrupt textural B horizon. Often feature a strongly bleached lower A horizon, and mottled B horizon.
Organosols	Organic soils. Dominated by organic materials of specified thickness and organic carbon content which varies according to clay content. Occur in wet landscapes and many have long been known as peats.
Podosols	Soils with accumulations of organic matter, iron and aluminium. Feature B horizons dominated by the accumulation of compounds of organic matter and aluminium, with or without iron. Usually sand textured to depth. B horizons can be very deep, as far as 20m in giant forms. Often have conspicuously bleached lower A horizon. Most are very permeable unless indurated pans are present, and site drainage may also cause periods of saturation.
Rudosols	Minimally developed soils. Soils which consist of materials that have not been greatly affected by pedological processes. Widespread soils with few commercial land uses.
Tenosols	Slightly developed soils. Only weak pedological development (with the exception of the A horizon). Soils with low water retention, low fertility. Occur generally in low and erratic rainfall areas.

Soil Order	Description (Isbell 2002)
Sodosols	Alkaline and sodic soils with sharp increases in texture. Key feature is the presence of a clear or abrupt textural B horizon, the upper 0.2 m of which has an ESP of 6 or greater and is not strongly acidic (pH greater than 5.5).
Vertosols	Cracking clays. Shrink and swell soils with a clay-field texture containing 35% or more clay throughout the solum. When dry, these soils often crack to considerable depth. . Problems of water infiltration are usually related to tillage practices and adverse soil physical conditions at least partly induced by high sodium in the upper part of many profiles.

Appendix F: Summary of typical chemical characteristics of each Soil Management Unit

SMU				ACIDITY	MAJOR ELEMENTS				SECONDARY ELEMENTS				TRACE ELEMENTS				ORGANIC	SALINITY				EXCHANGEABLE CATIONS											
Soil Management Unit	Sample Depth	Nitrogen (mg/kg)	Total Kjeldahl Nitrogen (mg/kg)	pH-Water	Potassium (mg/kg)	Nitrate Nitrogen (mg/kg)	Phosphorus - Colwell extr (mg/kg)	Aluminium (mg/kg)	Calcium (mg/kg)	Magnesium (mg/kg)	Calcium Carbonate (%)	Sulphur - KCl (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)	Boron (mg/kg)	Organic Carbon (%)	Electrical Conductivity (dS/m)	Sodium (mg/kg)	Chloride (mg/kg)	Calcium / Magnesium Ratio	Cation Exchange (meq/100g)	Exchangeable Aluminium (meq/100g)	Exchangeable Aluminium %	Exchangeable Calcium (meq/100g)	Exchangeable Calcium %	Exchangeable Magnesium (meq/100g)	Exchangeable Magnesium %	Exchangeable Potassium (meq/100g)	Exchangeable Potassium %	Exchangeable Sodium (meq/100g)	Exchangeable Sodium %
Rolleston/Glengallan	0-10	1812.00	1802.00	6.16	59.83	7.00	5.17	3.67	811.83	368.67	2.00	5.58	0.38	67.33	8.95	0.98	0.20	1.23	0.06	57.17	23.67	1.79	7.57	0.17	7.10	4.07	58.07	3.08	35.53	0.16	2.62	0.25	2.62
	20-30	1216.00	1214.00	7.07	34.67	2.67	1.33	1.33	906.00	626.50	2.60	9.23	0.33	61.67	4.23	0.92	0.47	0.85	0.13	239.17	109.83	1.67	10.88	0.03	1.40	4.53	44.07	5.23	46.37	0.09	1.48	1.04	7.82
	40-60	1108.33	1108.33	7.66	37.86	1.57	1.14	1.00	1164.29	931.29	2.83	27.00	0.46	38.10	2.27	0.71	0.57	0.43	0.32	529.00	367.14	1.26	15.98			5.82	41.11	7.77	47.41	0.10	0.99	2.30	10.46
	80-90	1250.00	1250.00	8.34	42.60	1.20	1.20	1.00	1288.00	1389.80	3.00	57.10	0.54	15.20	2.10	0.94	1.04	0.30	0.62	879.20	811.80	0.70	21.95			6.44	30.98	11.60	53.04	0.11	0.60	3.82	15.38
	110-120	1192.00	1192.00	8.21	32.00	1.40	1.20	1.00	918.40	1621.00	2.60	34.06	0.42	13.10	1.46	0.72	0.28	0.32	0.36	1074.80	386.80	0.48	22.86			4.59	21.36	13.50	61.84	0.08	0.50	4.68	16.28
	140-150	1030.00	1030.00	8.02	37.50	1.00	1.50	1.00	1500.50	1064.00	3.00	33.30	0.50	14.50	2.60	0.60	0.40	0.30	0.48	816.00	560.00	0.93	20.00			7.50	30.00	8.88	50.50	0.10	0.50	3.55	18.95
Orion/Jimbaroo	0-10	971.67	1000.00	7.80	214.63	11.00	4.88	1.13	8256.25	2131.25	4.67	2.91	1.44	19.75	12.33	1.38	0.58	2.73	0.09	244.38	43.13	2.51	60.70			41.31	66.93	17.76	30.46	0.55	0.85	1.06	1.74
	20-30	937.17	1000.00	8.18	94.00	4.75	1.63	1.13	8397.50	2367.50	5.83	1.69	1.34	19.38	8.00	1.06	0.65	1.53	0.08	311.50	17.38	2.31	63.38			42.04	65.58	19.74	31.84	0.24	0.35	1.35	2.20
	50-60	853.33	1000.00	8.50	96.29	4.14	1.71	1.00	8181.43	2562.86	5.67	3.13	1.29	19.43	5.34	0.83	0.74	0.80	0.12	467.43	45.71	2.16	64.57			40.93	62.40	21.37	33.94	0.25	0.37	2.03	3.31
	80-90	836.83	1000.00	8.65	95.83	2.67	1.50	6.17	8275.00	2401.67	11.17	4.88	0.95	20.83	3.78	1.02	0.80	0.60	0.14	558.83	60.00	2.52	64.02			41.33	64.77	20.03	31.03	0.24	0.38	2.43	3.78
	110-120	865.83	1000.00	8.67	124.50	3.00	1.83	7.00	8408.33	2505.00	11.67	19.03	0.82	21.17	2.77	0.88	1.03	0.40	0.25	673.33	236.17	2.48	66.17			42.03	63.78	20.86	31.17	0.32	0.53	2.93	4.50
	140-150	954.40	1000.00	8.66	63.40	2.40	2.20	11.00	8468.00	2800.00	9.60	32.32	0.82	16.00	3.28	0.64	1.24	0.40	0.32	806.80	265.40	2.11	69.36			42.30	60.88	23.34	33.74	0.16	0.24	3.51	5.16
College/Lascelles	0-10	1595.00	1590.00	7.37	76.50	5.50	11.00	54.00	3225.00	804.50	2.00	4.55	2.30	30.50	14.85	0.95	0.20	1.50	0.07	114.00	21.50	2.66	23.55			16.15	67.20	6.71	29.85	0.20	0.80	0.50	2.05
	20-30	1130.00	1130.00	7.18	54.50	1.00	2.00	15.50	2860.00	1045.00	2.50	5.00	2.60	48.00	11.80	0.50	0.20	0.85	0.15	316.00	204.00	1.66	24.50			14.27	56.60	8.71	36.95	0.14	0.55	1.38	5.95
	50-60	1000.00	1000.00	6.48	51.00	1.50	1.50	8.00	2465.00	1220.00	4.00	66.95	2.40	48.00	6.75	1.05	0.30	0.65	0.64	839.00	1010.00	1.19	26.35			12.34	43.45	10.19	40.85	0.13	0.50	3.65	14.85
	80-90	1005.00	1005.00	6.51	54.00	1.00	1.00	1.00	2580.00	1240.00	3.00	41.50	2.40	49.00	8.00	1.50	0.30	0.60	0.62	811.50	935.00	1.24	26.85	0.01	0.10	12.93	44.20	10.30	40.75	0.14	0.55	3.53	14.50
	110-120	1000.00	1000.00	6.22	61.00	1.00	1.00	1.50	2480.00	1510.00	3.00	67.75	2.15	41.00	5.35	1.60	0.50	0.40	0.92	1225.00	1500.00	1.00	30.45		0.10	12.42	38.50	12.60	42.60	0.16	0.50	5.33	18.35
	140-150	1000.00	1000.00	5.35	101.50	1.50	3.00	1.00	2400.00	1985.00	2.00	67.35	2.05	35.00	39.55	1.00	0.50	0.30	1.00	1600.00	1700.00	0.83	35.75		0.10	12.02	35.05	16.55	45.30	0.26	0.70	6.97	18.90
Adelong	0-10	1240.00		8.17	407.00	1.00	13.00	1.00	7130.00	1750.00	6.00	1.10	0.90	22.00	5.00	0.60	0.60		0.08	166.00	5.00	2.45	52.00			35.70	68.60	14.50	28.00	1.04	2.00	0.72	1.40
	20-30	1110.00		8.30	248.00	1.00	4.00	1.00	7650.00	2020.00	6.00	0.80	1.00	26.00	5.00	0.80	0.40		0.08	187.00	3.00	2.28	56.50			38.30	67.70	16.80	29.70	0.63	1.10	0.81	1.40
	50-60	1320.00		8.45	242.00	1.00	2.00	1.00	8090.00	2350.00	7.00	1.10	1.10	29.00	5.00	1.10	0.60		0.11	221.00	10.00	2.07	61.60			40.40	65.70	19.50	31.80	0.62	1.00	0.96	1.60
	80-90	1230.00		8.67	272.00	1.00	5.00	1.00	8290.00	2140.00	19.00	1.10	0.40	31.00	2.00	0.40	0.40		0.14	261.00	10.00	2.33	61.10			41.40	67.80	17.80	29.20	0.70	1.10	1.13	1.90
	110-120	1380.00		8.66	303.00	1.00	6.00	1.00	8560.00	2140.00	7.00	0.70	0.50	32.00	3.00	0.70	0.20		0.13	266.00	8.00	2.40	62.60			42.80	68.40	17.90	28.50	0.78	1.20	1.16	1.80
Jimbaroo	0-10	1370.00	1360.00	6.55	655.00	12.00	128.00	20.00	2370.00	523.00	6.00	3.10	1.50	55.00	35.00	1.30	0.20	1.90	0.05	35.00	26.00	2.72	18.10			11.90	65.70	4.36	24.10	1.68	9.30	0.15	0.80
Picardy	0-10	1810.00	1810.00	5.86	56.00	1.00	9.00	56.00	1490.00	796.00	5.00	3.70	1.90	41.00	28.00	1.00	0.40	1.30	0.02	52.00	4.00	1.13	14.50			7.46	51.60	6.63	45.80	0.14	1.00	0.23	1.60
	20-30	1000.00	1000.00	6.39	32.00	1.00	2.00	117.00	1580.00	1140.00	3.00	3.50	2.30	42.00	20.00	1.80	0.20	0.80	0.03	161.00	12.00	0.84	18.20			7.91	43.60	9.47	52.10	0.08	0.50	0.70	3.80
	50-60	1940.00	1940.00	8.32	40.00	1.00	1.00	1.00	3790.00	1640.00	6.00	19.00	1.40	18.00	7.70	0.70	1.00	0.60	0.25	420.00	110.00	1.39	34.50			18.90	54.90	13.60	39.50	0.10	0.30	1.83	5.30
	80-90	1000.00	1000.00	8.49	40.00	1.00	1.00	1.00	4030.00	1730.00	3.00	23.50	1.30	15.00	6.90	0.70	1.20	0.50	0.28	511.00	210.00	1.40	36.90			20.20	54.70	14.40	39.00	0.10	0.30	2.22	6.00
	110-120	1340.00	1340.00	8.68	36.00	1.00	1.00	1.00	3670.00	1740.00	1.00	30.50	1.00	11.00	3.70	2.20	1.40	0.40	0.35	599.00	370.00	1.26	35.60			18.40	51.60	14.50	40.80	0.09	0.30		