LAKE VERMONT MEADOWBROOK PROJECT:

SOIL AND LAND SUITABILITY ASSESSMENT

PREPARED FOR
BOWEN BASIN COAL PTY LTD

December 2021

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Document Control

Project Name:	Lake Vermont Meadowbrook Project
Report Title:	Soil and Land Suitability Assessment
Client:	Bowen Basin Coal Pty Ltd
Project Manager:	Rod Hailstone

Version	Comments	Author	Reviewer	Date
Draft issued for client review		MB	RH	19 March 2020
Revised draft issued		MB	RH	8 April 2020
Final issued		MB	SR	15 July 2022

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List of Abbreviations

AHD	Australian Height Datum
AASS	Actual Acid Sulphate Soil
ASS	Acid Sulphate Soil
BMA	BHP Mitsubishi Alliance
BoM	Bureau of Meteorology
Ca/Mg	Calcium/Magnesium Ratio
CEC	Cation Exchange Capacity
EA	Environmental authority
EC	Electrical Conductivity
ESP	Exchangeable Sodium Percentage
MDL	Mineral Development Lease
MIA	Mine infrastructure area
ML	Mining Lease
MLA	Mining Lease Application
PAA	Priority Agricultural Area
PAWC	Plant Available Water Capacity
PASS	Potential Acid Sulphate Soil
PLA	Priority Living Area
RIDA	Regional Interests Development Approval
RPI Act	Regional Planning Interests Act 2014 (Qld)
SCA	Strategic Cropping Area
SCL	Strategic Cropping Land
SEA	Strategic Environmental Area
SLSA	Soil and Land Suitability Assessment
SMP	Subsidence management plan
SMU	Soil Management Unit
The Project	The Lake Vermont Meadowbrook Project

1 Executive Summary

The Lake Vermont Meadowbrook Project is a proposed extension of the existing Lake Vermont Coal Mine located in the Bowen Basin of central Queensland. AARC Environmental Solutions undertook a soil and land suitability assessment for the Project area. The assessment draws on the findings of a soil survey of the Project area conducted in 2019 and other surveys and SLSAs conducted previously within the Project area (NQSA 2012 and AARC 2013). The SLSA comprised a desktop assessment, soil descriptions, a land suitability assessment, a regional planning interests assessment, soil stripping recommendations, impact assessment and proposed impact mitigation measures. The soil survey was conducted following the Guidelines for Surveying Soil and Land Resources (McKenzie *et al*. 2008). Soil descriptions were made according to the Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain 2009). Land suitability assessments were conducted according to the Technical Guidelines for Environmental Management of Exploration and Mining in Queensland (QDME 1995) and the Regional Land Suitability Frameworks for Queensland (DSITIA and DNRM 2013).

Eight soil management units (SMUs) have been identified within the Project area. SMUs with suitable properties for use in rehabilitation were identified, along with SMUs having management constraints relating to dispersive, saline and alkaline properties. Soil fertility in the Project area is generally poor to moderate with soils typically having moderate cation exchange capacity and low concentrations of several essential nutrients such as nitrate and phosphorous. The concentrations of trace metals are variable across SMUs. The grazing land use suitability assessment determined that the study area is suitable for grazing with 4,131 ha of suitable land with moderate limitations and 4,550 ha of marginal land deemed unsuitable for grazing having severe limitations. The cropping land use suitability assessment identified areas of potentially suitable land with moderate limitations according to a general framework assessment; however, these areas failed suitability according to a regionally specific framework assessment. The study area is therefore determined to be suitable for grazing land use which is consistent with the current land use.

The regional planning interests assessment determined that a 6 ha portion of the study area within the Project footprint is mapped as strategic cropping land (SCL). The land likely does not meet the SCL assessment criteria. Therefore, a regional interests development approval application to demonstrate that the land does not meet the criteria for SCL is recommended. No acid sulphate soils were identified within the study area. Stripping depths for identified SMUs are recommended for topsoil and subsoil for use in rehabilitation works.

Potential impacts of surface activities and subsidence arising from the Project are discussed and mitigation measures to potential impacts are proposed. The post-mine land use suitability is not expected to differ substantially from the pre-mine land suitability. Measures to mitigate potential impacts to soils are proposed. A subsidence management plan is proposed to outline the measures to mitigate subsidence impacts and specify implementation of the measures.

2 Introduction

AARC Environmental Solutions Pty Ltd (AARC) was commissioned by Bowen Basin Coal Pty Ltd to conduct a soil and land suitability assessment (SLSA) for the proposed Lake Vermont Meadowbrook Project (the Project). The Project area is located approximately 25 km north of Dysart and approximately 160 km south-west of Mackay, in the Bowen Basin of central Queensland (Figure 1). The Project is proposed to include the development of a double-seam underground longwall coal mine, and one small-scale 'satellite' open-cut pit targeting metalliferous coal resources.

The Project forms an extension of the existing Lake Vermont Mine, which currently produces up to nine million tonnes per annum (mtpa) of primarily hard coking coal and pulverised coal injection coal. The existing Lake Vermont Mine operates on mining leases (MLs) ML70331, ML70477 and ML70528 (Figure 2) under the approval of environmental authority (EA) EPML00659513.

The Project boundary is defined by a proposed mining lease application (MLA) within mineral development licence (MDL) 303 and MDL 429. The Project also includes construction of an infrastructure corridor within ML70477 and ML70528 to link the Project to the existing Lake Vermont Mine coal handling and processing plant. The study area of this SLSA includes the proposed MLA and portions of ML70477 and ML70528 which are not within the existing and approved mining disturbance footprint of Lake Vermont Mine (Figure 2). This SLSA was based on a survey conducted to describe the soils in the proposed MLA and soil surveys and findings from SLSAs conducted within the approvals process of the Western Extension Lake Vermont Mine in ML70477 (MQSA 2012) and Northern Expansion of Lake Vermont Mine ML70528 (AARC 2013).

This SLSA documents the nature and distribution of major soil types in the Project area and assesses their suitability for the land uses of cattle grazing and dryland cropping. Regional planning interests, acid sulphate soils, and potential impacts are assessed. This assessment also establishes baseline environmental characteristics and values relating to land use and suitability and provides recommendations for the management of soil resources and site rehabilitation.

2.1 Scope of study

This report is a baseline assessment of the soils and land suitability for the study area and includes the following objectives:

- describe the agricultural use of the Project area and its surrounds, including any crop rotations;
- describe, map and illustrate the soil types of the study area;
- describe and map land suitability classes of the Project area in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land suitability Assessment Techniques* (QDME 1995) and the *Regional Land Suitability Frameworks for Queensland* (DSITIA and DNRM 2013);
- describe agricultural land class in accordance with *The Agricultural Land Evaluation in Queensland – Second Edition* (DSITI and DNRM 2015);
- assess areas of regional interest including priority living areas (PLAs), strategic environmental areas (SEAs), priority agricultural areas (PAAs) and strategic cropping areas (SCAs);
- recommend soil stripping depths for topsoil and subsoil reuse in rehabilitation works;
- identify soils that would require particular management due to wetness, erosivity, depth, acidity, salinity or other features, including acid sulphate soils (ASS) in accordance with the *Land-EIS information guideline* (DES 2020);
- for soils that are susceptible to erosion or have other chemical constraints such as salinity or acidity, provide recommendations for particular management strategies (of either topsoil or subsoil) if localised disturbance were to occur; and

- assess the impact of underground mining operations on the soil and land use values of the Project area and recommend mitigation measures that are specific to both the type of soil and the intended post-mine land use of the area, these impacts include subsidence and other secondary impacts associated with this subsidence.

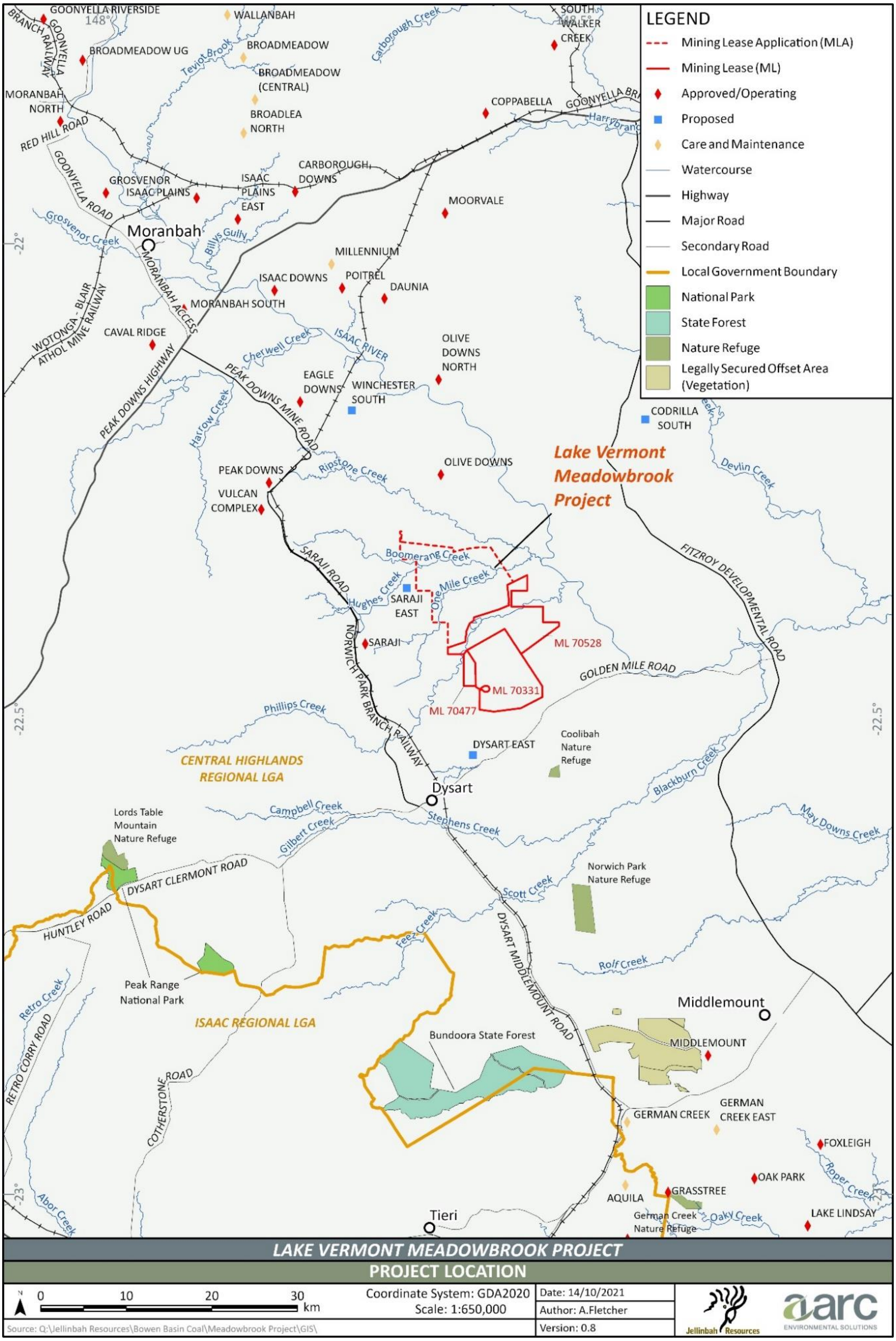


Figure 1: Project location

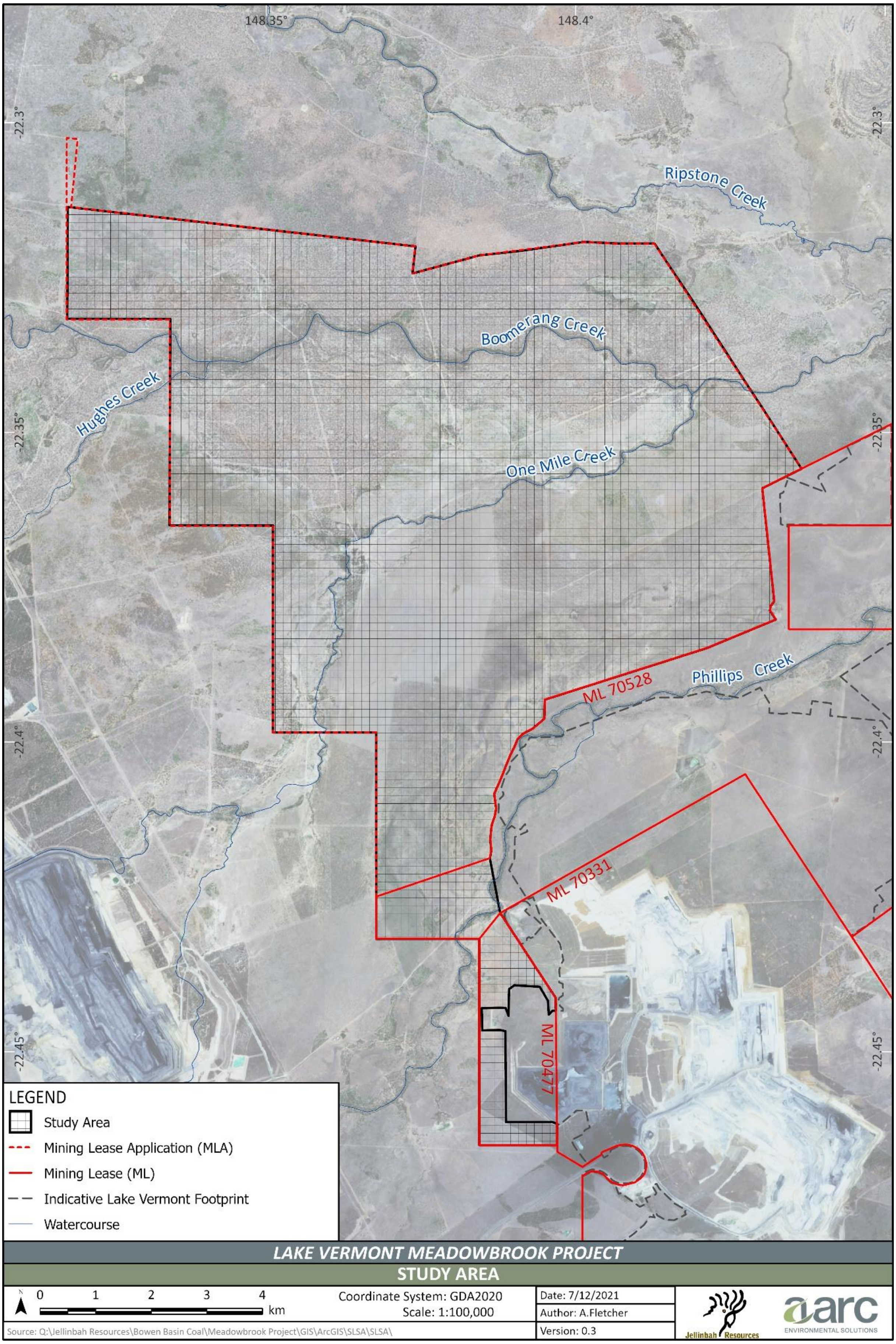


Figure 2: Study area

2.2 Project background

The Project is located in the Bowen Basin of central Queensland on tenure adjoining the northern boundary of the existing Lake Vermont Mine (Figure 2). The Lake Vermont Mine is an operation producing hard coking coal and low volatile pulverised coal injection coal.

The objective of the Project is to extend the life of the existing Lake Vermont Mine by supplementing the future decline in production from the existing open-cut with output from an adjoining underground operation and satellite open-cut pit.

The Project lies approximately 25 km north of Dysart, 160 km south-west of Mackay and is within close proximity to existing rail, road and power infrastructure. Several coal terminals are located within 500 km of the Project site such as the Abbot Point Coal Terminal, RG Tanna Coal Terminal, and the Dalrymple Bay Coal Terminal.

Approximately 3.5 km from the western border of the Project area is the BHP Mitsubishi Alliance (BMA) owned and operated Saraji Mine, which spans approximately 33 km from south to north. Between the existing Saraji Mine and the Project area, is the proposed Saraji East Project. To the north and east of the Project area lies the Olive Downs Coking Coal Project owned by Pembroke Resources, a 15 mtpa operation that was granted approval in May 2019.

2.3 Current land use

The land within the Project area is currently used for low-intensity cattle grazing of native pastures and resource exploration activities. The Isaac Regional Planning Scheme mapping identifies a portion of Class A cropping agricultural land within the study area in the south-east of ML70477 (approximately 6 ha). The remainder of the study area is mapped as Class C pastureland (Figure 3). The Queensland Agricultural Land Audit mapping identifies the Project is partially located on land mapped as the 'Golden Mile Important Agricultural Area' (Figure 3).

No protected areas (nature refuges, national parks), state-controlled roads or rail, or stock routes are within the study area. Queensland land use mapping classifies the study area as 'grazing native vegetation', 'mining' and 'managed resource protection'. The vegetation in the study area is a combination of introduced grasslands, natural bushland and regrowth native bushland.

2.4 Local waterways and topography

The Project site is located within the Isaac Connors sub-catchment, an area encompassing 22,325 km^2 within the greater Fitzroy Basin catchment. The Isaac River is the main watercourse in the Project surrounds and flows in a north-west to south-east direction to the east of the study area boundary.

The main water body associated with the study area is Boomerang Creek; a fifth order stream which traverses the study area in an easterly direction (Figure 2). There are also two third-order streams that cross the study area being Ripstone Creek and One Mile Creek. Ripstone Creek flows in a south-easterly direction before joining Boomerang Creek to the east of the Project area. One Mile Creek is located southwest of the Project area, flows north-easterly and discharges into Boomerang Creek within the study area. Phillips Creek traverses the study area and flows north-east in the vicinity of the study area boundary. Ripstone Creek, Hughes Creek, Phillips Creek and One Mile Creek are defined watercourses under the *Water Act 2000*.

Topography of the study area is flat to gently undulating, with elevation ranging between 160 mAHD and 190 mAHD. The topography of the Project area is representative of the surrounding region.

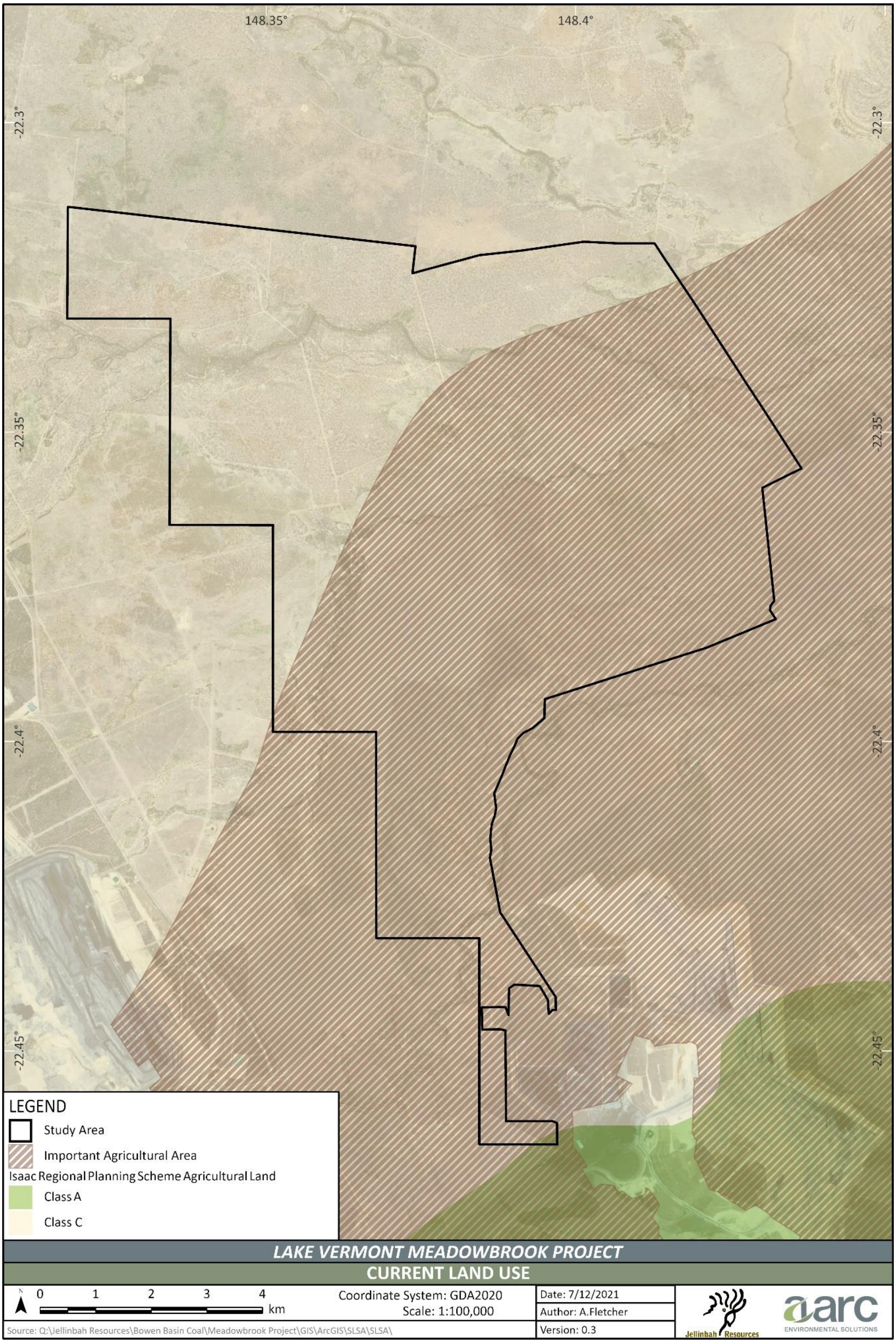


Figure 3: Current land use

2.5 Regional geology

The study area is within the Bowen Basin, one of Queensland's largest depositional zones, formed through a period of rifting and subsidence between the Early Permian to the Mid-Triassic Period. The area surrounding the Project is dominated by clastic sedimentary rocks of marine and lacustrine origin, including sandstones, mudstones, siltstones and coal (Geoscience Australia 2019).

The coal seams found in the eastern-central part of the Bowen Basin are of Permian age and contain higher quality coking coal deposits, with the rank falling below the coking range farther south and west (Hutton 2009, Mutton 2003).

The solid geology of the region is described as including:

- Rewan Group—Early to Mid-Triassic sandstone, mudstone, and conglomerate;
- Fairhill Formation/Fort Cooper Coal Measures—Permian Age sandstones, conglomerates, mudstones, carbonaceous shales, coal, and cherty tuff.

Surface geology includes the following:

- Qa–QLD (Qa)—Quaternary clay, silt, sand, gravel; floodplain alluvium;
- TQa–QLD (TQa)—Late Tertiary to Quaternary poorly consolidated sand, silt, clay, minor gravel and high-level alluvial deposits.

2.6 Regional climate

The climate of the broader Project area is classified as semi-arid, with characteristic hot dry summers and mild to warm winters. Climate statistics for the Clermont Post Office, located approximately 90 km southwest of the Project indicates average rainfall for the region to be approximately 665 mm with the majority falling from November to March. Long term temperature statistics demonstrate that the average maximum daily temperature in summer is 34°C with overnight minimum temperatures averaging 21°C. In winter, the average maximum temperature is 24°C with an average minimum temperature of 8°C (BoM 2019).

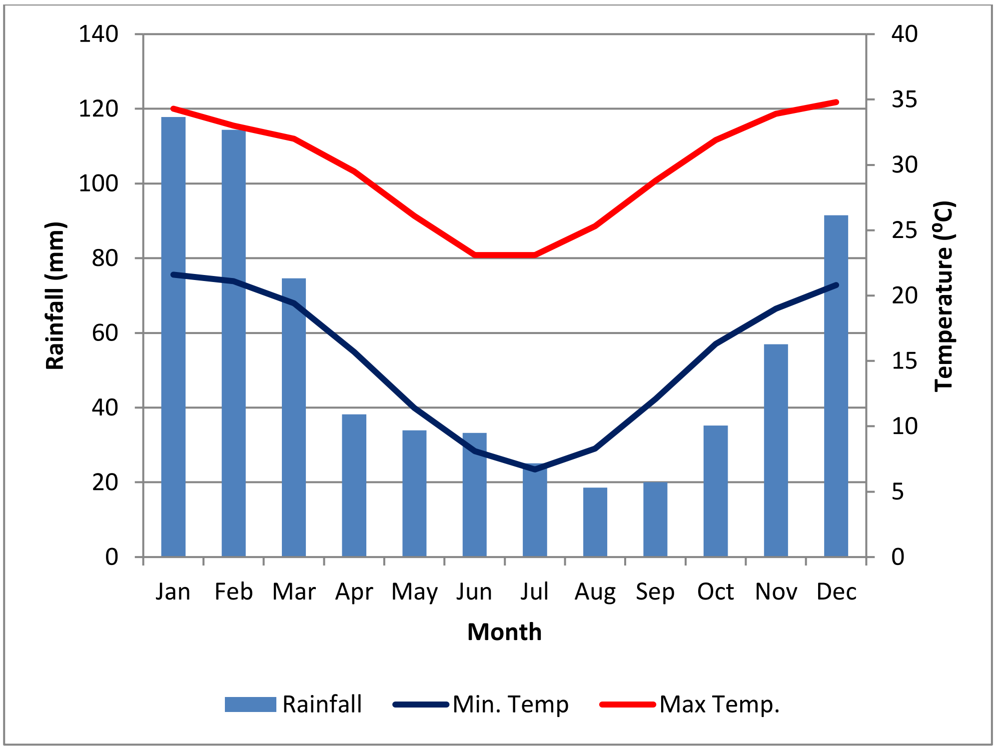


Figure 4: Climate statistics for the Project area

2.7 Land systems

The Report on Lands of The Isaac-Comet Area (Story *et al*. 1967) indicates the study area contains the land system units described in the following sections:

2.7.1 Blackwater land system

The Blackwater land system is predominantly characterised by lowlands and plains with undulating terrain with a local relief between 3–8 m. This land system has developed cracking clays with occasional gilgai on weathered Tertiary-aged clay and Pre-Tertiary rock. Vegetation is described as a mixed shrub woodland dominated by Brigalow *(Acacia harpophylla), Carissa spinarum, Eremophila mitchellii* and *Terminalia oblongata.*

2.7.2 Connors land system

The Connors land system is characterised by alluvial plains composed of terraces and levees up to 3 km wide. Texture-contrast soils have developed in this area and are characterised by thick sandy topsoil and neutral to strongly alkaline subsoil. Vegetation consists of savannah woodlands dominated by Poplar box *(Eucalyptus populnea)* and mixed shrub woodland.

2.7.3 Comet land system

The Comet land system is characterised by alluvial clay plains with back-swamped sites or abandoned flow channels and minor occurrences of weathered clay and gilgai. Soils are predominantly cracking clay soils and vegetation is predominantly Brigalow with other woody associated vegetation *(Eucalyptus microtheca, Terminalia eremophila, Eucalyptus cambageana, Bauhinia spp.)*.

2.7.4 Humboldt land system

The Humboldt land system is characterised by plains and lowlands with slopes of less than 2% gradient. Soils are predominantly texture-contrast soils with thin sandy surface soils and to a lesser extent cracking clays. Surface soil horizons are situated over deeply weathered Tertiary clays and Pre-Tertiary rock. Vegetation associated with this land system is mixed shrub woodland dominated by Brigalow *(Acacia harpophylla)* and Dawson Gum *(Eucalyptus cambageana)* with *Carissa spinarum, Eremophila mitchellii* and *Terminalia oblongata* being less dominant.

2.7.5 Monteagle land system

The Monteagle land system is predominantly characterised by low-lying plains and colluvial foot slopes with local relief generally below 6 m. This land system is associated with texture-contrast soils composed of thick sandy topsoil and neutral to strongly alkaline subsoils. Savannah woodlands consisting largely of Poplar box *(Eucalyptus populnea)* and some Narrow-leaved iron bark *(Eucalyptus crebra)* dominate. Geology in this land system is comprised of undissected Tertiary sandstones and clays.

2.7.6 Somerby land system

The Somerby land system is characterised by plains and very gently undulating hills. Soil types alternate between gilgaied deep cracking clays with alkaline surface horizons becoming acidic at depth to texture-contrast soils with strongly alkaline subsoils. These soils have formed on weathered Tertiary clays and Pre-Tertiary rock. Vegetation associated with this land system predominantly consists of *Brigalow (Acacia harpophylla)* occurring with *Carissa spinarum, Eremophila mitchellii, Terminalia oblongata, Geijera parviflora* and *Bauhinia spp.*

3 Methodology

This SLSA incorporates the results of a soil survey conducted within the Project proposed MLA and the findings of two SLSAs conducted previously within the approval process for Lake Vermont Mine. These prior SLSAs are:

- *Soils, pre-mining land suitability and stripping recommendations for Lake Vermont Coal mining lease, Central Queensland* undertaken in 2012 (NQSA 2012) which characterised the soils of the western extension area (ML70477).
- *Lake Vermont Northern Extension Soil and Land Suitability Assessment* undertaken in 2013 (AARC 2013) which characterised the soils of the northern extension area (ML70528).

The extent of each survey event within the Meadowbrook study area is presented in Figure 5. The previous SLSAs and recent survey work and assessment were conducted in accordance with the same survey guidelines and followed the same soil classification and nomenclature as this SLSA. The findings of all three surveys informed this SLSA.

3.1 Desktop analysis

A desktop analysis was conducted prior to field sampling. This analysis comprised background research and evaluation of information from the following resources:

- the Digital Atlas of Australian Soils (Bureau of Rural Science 1991) which provides broad information of the soils present in the area;
- government mapping of topography, geology, elevation, and watercourses;
- Land Systems of the Isaac-Comet Area, Queensland (Story *et al.* 1967);
- Geology of the Bowen Basin, Queensland (Dickins and Malone 1973);
- Land Resource Assessment of the Windeyers Hill Area, Isaac – Conners and Mackenzie River Catchments, Central Queensland (Burgess 2003); and
- Understanding and Managing Soils in the Central Highlands (DPI 1993).

3.2 Survey methodology

The surveys were conducted in accordance with the *Guidelines for Surveying Soil and Land Resources* (McKenzie *et al.* 2008) and the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain 2009). The surveys for portions of the study area within ML70477 and ML70528 were conducted in 2012 and 2013 respectively using equivalent methodologies which are detailed in NQSA 2012 and AARC (2013).

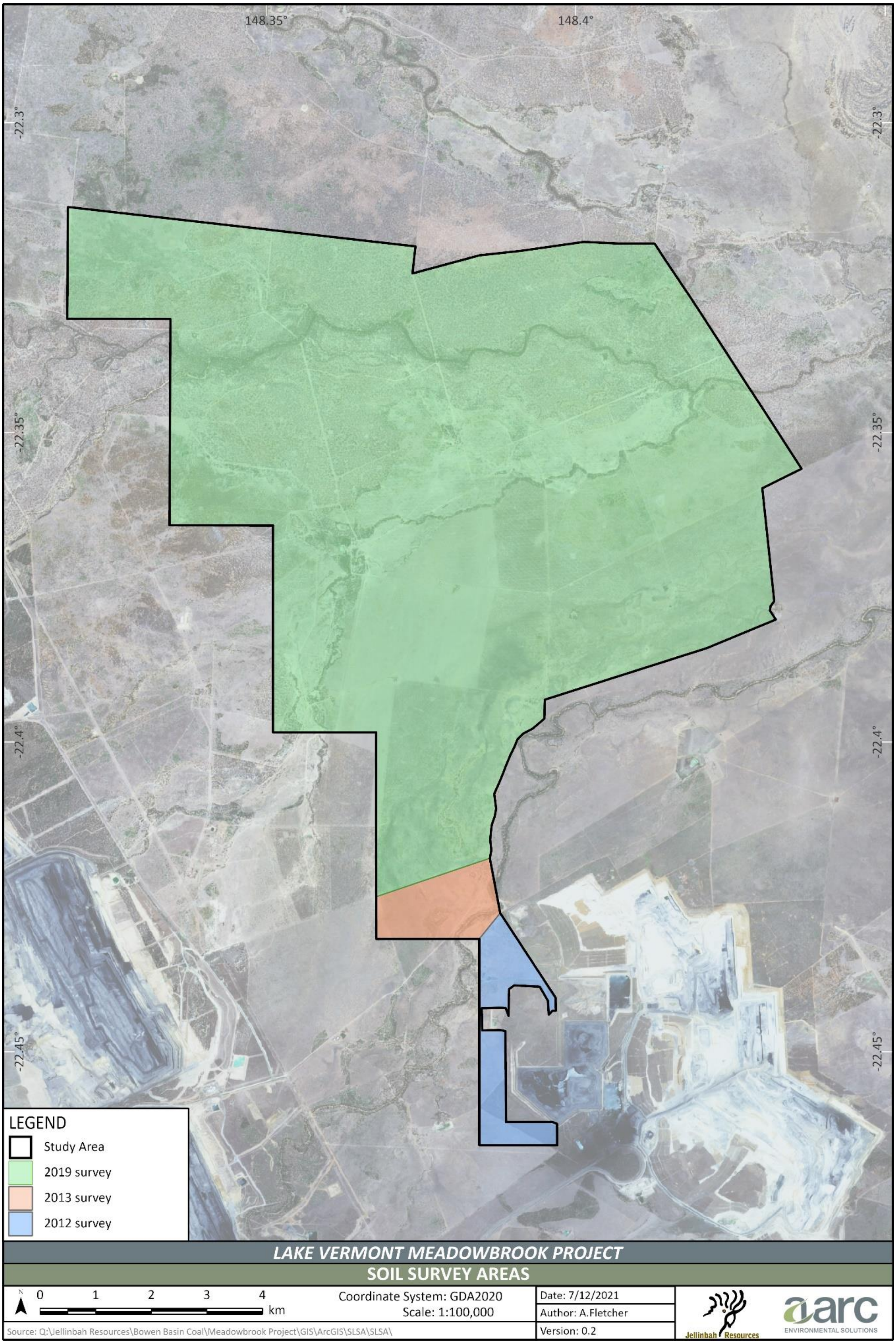


Figure 5: Soil survey areas

3.2.1 Survey design

The soil surveys were based on a free-survey technique with soil profile and observation sites located to best represent the soil types present in the Project area.

The mapping scale of the soil surveys was selected to allow adequate representation of the study area soils. A scale between 1:25,000 and 1:100,000 was determined most appropriate based on Guidelines for Surveying Soil and Land Resources (McKenzie *et al*. 2008). The guideline for this scale requires a sampling density of between one site per 25 ha and one site per 400 ha with data collection comprising detailed soil profile descriptions (15–35% of sites), representative profile sampling for lab analysis (1–5%) and mapping observations sites (55–83%). The soil surveys of the study area were designed to meet these requirements and the number of survey sites across all three surveys exceeded the minimum requirements for this scale (Table 1).

Table 1: Study area survey site density (all survey)

Area	Detailed soil profiles	Representative profiles for analysis	Mapping observations	Total
8681	41	9	47	97

3.2.2 Field investigations

The survey for the study area within the proposed MLA was conducted between 5–10 December 2019 and consisted of detailed sampling sites (profiles) and secondary visual assessments (observations). Sampling site locations were determined based on the desktop analysis, land management units, landform and vehicle access. Visual assessments were conducted while traversing the landscape to confirm major soil types and boundaries between soil units. Each site location was determined with the use of a Global Positioning System device.

Within the proposed MLA boundary, soil profiles were undertaken at 29 detailed sampling sites including five representative profiles for analysis. A soil corer was used to excavate cores to a maximum depth of 120 cm. Soil samples were collected from profiles at standard depths of 0–10 cm, 20–30 cm, 50–60 cm, 80–90 cm, and 110–120 cm for representative sites. Observations recorded included micro-relief, permeability, drainage, substrate, site disturbance, landform (slope percentage, relief, elevation, morphological type, landform element and landform pattern), runoff, erosion, surface coarse fragments, rock outcrops, surface condition and dominant vegetation type. Soil profile morphology was described in the field including description of horizon type, horizon depth, boundary, colour, mottles, texture, coarse fragments, structure, segregations, consistency, and field pH.

Soil stripping recommendations were made based on soil properties. Estimates of topsoil to be recovered were based on preliminary mine plans and disturbance areas. The mine plan and associated disturbance was also used to assess potential impacts to land suitability.

3.2.3 Laboratory analysis

Samples from a total of six representative sites were chosen for analysis through Australian Laboratory Services which holds NATA accreditation. Samples from all standard depths at the chosen sites were analysed to:

- inform the classification of the described soil profile;
- assist in the description of soil characteristics;
- assist in the determination of land suitability classes;
- assist in the determination of topsoil and subsoil as a suitable topdressing media; and

- assist in the identification of soils that would require specialised management.

Physical and chemical parameters analysed for all samples included:

- pH (1:5);
- electrical conductivity (EC) (1:5);
- moisture content;
- chloride (soluble);
- exchangeable cations (Ca, Mg, Na, K);
- cation exchange capacity (CEC); and
- exchangeable sodium percentage (ESP).

Additional physical and chemical parameters analysed for topsoil samples included:

- organic matter;
- particle size analysis;
- extractable trace elements/metals (iron, copper, zinc and manganese);
- boron (CaCl2 extractable);
- N as nitrate;
- SO4 (water soluble S as sulphate);
- phosphorus and potassium (Colwell); and
- Emerson class.

3.2.4 Characterisation of soil management units

Soil classification was undertaken using the methodologies specified in *The Australian Soil Classification* (Isbell 2002). Soil Management Units (SMUs) were then defined based on grouping soils of like soil morphology, parent material, and land attributes in accordance with the *Guidelines for Surveying Soil and Land Resources* (McKenzie *et al.* 2008). SMUs were mapped across the study area at scales between 1:25,000 and 1:100,000. Soil classification and nomenclature follow the 1:100,000 soils mapping from the Windeyers Hill area, surveyed by the Department of Natural Resources and Mines in 2003 (Burgess 2003). Where soils identified did not fit the Burgess (2003) classification, a site-specific classification was used.

3.2.5 Interpretation of chemical data

The following guidelines were used to assist in the interpretation of SMU physical and chemical properties and determine rating categories for pH, EC, ESP and CEC:

- Interpreting Soil Test Results—Third Edition (Hazelton and Murphy 2016)
- Soil Chemical Methods of Australasia (Rayment and Lyons 2011)
- Standard Soil Test Methods and Guidelines for Interpretation of Soil Results (DEW 2013)

Broad descriptions for each soil parameter and rating categories are described as follows.

3.2.5.1 Soil pH

Soil pH influences the solubility and availability of plant available nutrients and toxic elements. At extreme pH, the availability of essential plant nutrients can be severely reduced while toxic elements can become bioavailable. Soil pH ratings were derived from Hazelton and Murphy (2016) as presented in Table 2.

Table 2: Soil pH rating

pH water	Rating	Soil chemistry indications
< 4.0	Very strongly acid	Typical of disturbed ASS
4.0 to < 5.0	Strongly acid	Acidified soils
5.0 to < 6.0	Moderately acid	Range most suitable for plant growth
6.0 to < 7.0	Slightly acid	
7.0	Neutral	
> 7.0 to < 8.0	Slightly alkaline	
8.0 to < 9.0	Moderately alkaline	
9.0 to 10.0	Strongly alkaline	Some nutrients becoming unavailable, indication of sodicity
> 10.0	Very strongly alkaline	Extreme pH, high sodicity and carbonates

3.2.5.2 Electrical conductivity

Electrical conductivity indicates the presence of soluble salts in the soil profile. High salinity interferes with the osmotic capacity of plants. Soil clay content is a determinant of soil salinity rating. Soil salinity ratings were derived from Rayment and Lyons (2011) as presented in Table 3.

Table 3: Soil salinity ratings

Soil salinity rating	EC 1:5 (dS/m)	
	10–20% Clay	20–40% Clay
Very low	< 0.07	< 0.09
Low	0.07–0.15	0.09–0.19
Medium	0.15–0.34	0.19–0.45
High	0.34–0.63	0.45–0.76
Very high	0.63–0.93	0.75–1.21
Extreme	> 0.93	> 1.21

3.2.5.3 Chloride

Chloride is associated with EC. A high chloride concentration can induce chloride toxicity and interfere with the osmotic capacity of plants. Table 4 provides chloride ratings sourced from Rayment and Bruce (1984).

Table 4: Chloride concentration ratings

Chloride rating	Cl Concentration (mg/kg)
Very low	< 100
Low	100–300
Medium	300–600
High	600–2,000
Very high	> 2,000

3.2.5.4 Cation exchange capacity and exchangeable cations

CEC is an indication of the capacity of a soil to adsorb cationic nutrients to the surface of soil particles. This process of adsorption prevents nutrient leaching from the soil and buffers the concentration of plant available nutrients in the soil solution. The ratio of exchangeable cations also indicates the availability cationic nutrients. Table 5 and Table 6 provide ratings for soil CEC and extractable cations sourced from Hazelton and Murphy (2016).

Table 5: Soil CEC ratings

CEC rating	CEC (cmol(+)/kg)
Very low	< 6
Low	6–12
Medium	12–25
High	25–40
Very high	> 40

Table 6: Ratings for exchangeable cations (cmol(+)/kg)

Cation	Very low	Low	Moderate	High	Very high	Ideal range (% of CEC)
Ca	0–2	2–5	5–10	10–20	> 20	65–80
K	0–0.2	0.2–0.3	0.3–0.7	0.7–2	> 2	1–5
Mg	0–0.3	0.3–1	1–3	3–8	> 8	10–15
Na	0–0.1	0.1–0.3	0.3–0.7	0.7–2	> 2	< 1

3.2.5.5 Exchangeable sodium percentage

ESP is defined as the amount of exchangeable sodium as a percentage of the total CEC of the soil. Soils with a high proportion of sodium are susceptible to dispersion. Table 7 provides ESP ratings sourced from the guide Hazelton and Murphy (2016).

Table 7: Soil ESP ratings

ESP (%)	ESP rating
< 6	Non-sodic
6–15	Sodic
> 15	Strongly sodic

3.2.5.6 Organic matter

Soil organic matter contributes to the pH buffering capacity, nutrient holding and soil structural stability of a soil. Table 8 provides soil organic matter ratings sourced from Hazelton and Murphy (2016).

Table 8: Soil organic matter ratings

Organic matter rating	Organic matter content (g/100 g)
Extremely low	< 0.7
Very low	0.7–1
Low	1–1.7
Moderate	1.7–3
High	3–5.15
Very high	> 5.15

3.2.5.7 Particle size analysis

Particle size analysis determines the percentage composition of sand, silt and clay-sized particles which in turn determines soil texture. Soil texture influences the structural stability, water holding capacity, porosity and permeability.

3.2.5.8 Extractable trace elements/metals

Trace elements such as copper, iron, manganese, zinc and boron are essential nutrients required for plant growth, although needed in much smaller quantities than exchangeable cations. Table 9 provides trace element/metal ratings sourced from DEW (2013).

Table 9: Trace elements ratings

Trace element	Rating	Concentration (ppm)
Boron	Low	< 0.5
	High	> 15
Copper	Low	< 0.3
	High	> 1
Iron	Low	< 10
	High	> 70
Manganese	Low	< 1
	High	> 10
Zinc	Low	< 0.5
	High	> 1

3.2.5.9 Nitrate

Nitrate is a plant available form of nitrogen and is an essential nutrient which is often the most limiting to plant growth. Table 10 provides soil nitrate ratings sourced from the guide Hazelton and Murphy (2016).

Table 10: Soil nitrate ratings

Rating	Nitrate concentration (mg/kg)
Very low	0–6
Low	7–15
Moderate	16–22
High	23–30
Very high	> 30

3.2.5.10 Sulphate

Sulphate is an essential plant nutrient. Table 11 provides soil sulphate ratings sourced from DEW (2013).

Table 11: Soil Sulphate Ratings

Rating	Sulphate concentration (mg/kg)
Low	< 5
Marginal	5–10
High	> 10

3.2.5.11 Phosphorous and potassium

Phosphorous and potassium are essential nutrients. Table 12 and Table 13 provide ratings for soil phosphorous and potassium levels sourced from Hazelton and Murphy (2016).

Table 12: Soil phosphorous ratings

Rating	Phosphorous concentration (mg/kg)
Very low	< 5
Low	5–10
Moderate	10–17
High	17–25
Very high	> 25

Table 13: Soil potassium ratings

Soil texture	Critical concentration (mg/kg)*
Sand	126
Sandy loam	129
Sandy clay loam	143
Clay loam	161

* Critical concentration is that concentration where 95% of maximum yield is achieved

3.2.5.12 Emerson class

Emerson class describes soil aggregate stability. Low Emerson class is indicative of dispersive soils which are prone to erosion. Emerson classes derived from Emerson (1967) are presented in Table 14.

Table 14: Emerson class

Emerson aggregate class	Level of dispersion
1	Slaking and complete dispersion
2	Slaking and some dispersion
3	Slaking and no dispersion
4	$CaCO_3$/$CaSO_4$ present. No dispersion at field capacity
5	No $CaCO_3$/$CaSO_4$ present. No dispersion at field capacity, however, dispersion in an aggregate - water suspension.
6	No $CaCO_3$/$CaSO_4$ present. No dispersion at field capacity, however, flocculation in an aggregate-water suspension.
7	No slaking and swelling
8	No slaking and no swelling

3.2.6 Land suitability and agricultural class assessment

Land suitability for cattle grazing and rainfed broadacre cropping was assessed according to the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (QDME 1995). SMUs identified as suitable to rainfed broadacre cropping according to the 1995 guideline were subsequently assessed for cropping suitability according to the regionally specific guideline *Regional Land Suitability Frameworks for Queensland* (DSITIA and DNRM 2013) in conjunction with the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM 2015).

Agricultural land class was assessed according to hierarchical classification scheme *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM 2015)

3.2.7 Regional planning interests assessment

Regional planning interests of the study area were assessed in accordance with *the Regional Planning Interests Act 2014* (RPI Act) and Regional Planning Interests Regulation 2014 (RPI Regulation). The assessment considered PLAs, SEAs, PAAs and SCAs.

3.2.8 Acid sulphate soils assessment

The study area was assessed for risk of ASS through a review of Atlas of Australian Acid Sulphate Soils mapping supported by field observations of ASS indicators according to WQA (2018).

4 Soil Survey Results

Eight SMUs were identified within the study area as presented in Table 15. The soil mapping conducted for ML70477 (NQSA 2012) identified three phases of the Knockane SMU within the study area (Knockane, Knockane shallow phase and Knockane wet phase) which were aggregated into the Knockane SMU for this assessment. The three Knockane phases were assessed as possessing the same suitability for grazing and cropping. The spatial distribution of the SMUs has been mapped across the study area at scales of 1:25,000 and 1:100,000; and is presented in Figure 6 with the survey site locations.

Table 15: Area of soil management units

SMU	Surface area (ha)	Per cent of study area (%)
Booroondarra	144	2
Kirkcaldy	70	1
Knockane	2,908	33
Mayfair	93	1
Mayfair sodic variant	1,248	14
Moreton	1,293	15
Norwich	1,009	12
Parrot	1,917	22
Total area	**8,681**	**100**

Descriptions of SMUs encountered within the proposed MLA 2019 survey are described in sections 4.1 to 4.5. The 2019 survey laboratory analysis results are presented in Appendix A. The 2019 survey soil profile data sheets and soil observation points records are presented in Appendix B and C respectively. Soil descriptions for the Kirkcaldy and Mayfair SMUs, which are mapped in ML70477 and not within the proposed MLA, are presented in Appendix D (NQSA 2012). Soil descriptions for the Booroondarra and Kirkcaldy SMUs, which are mapped in ML70528 and not in the proposed MLA, are presented in Appendix E.

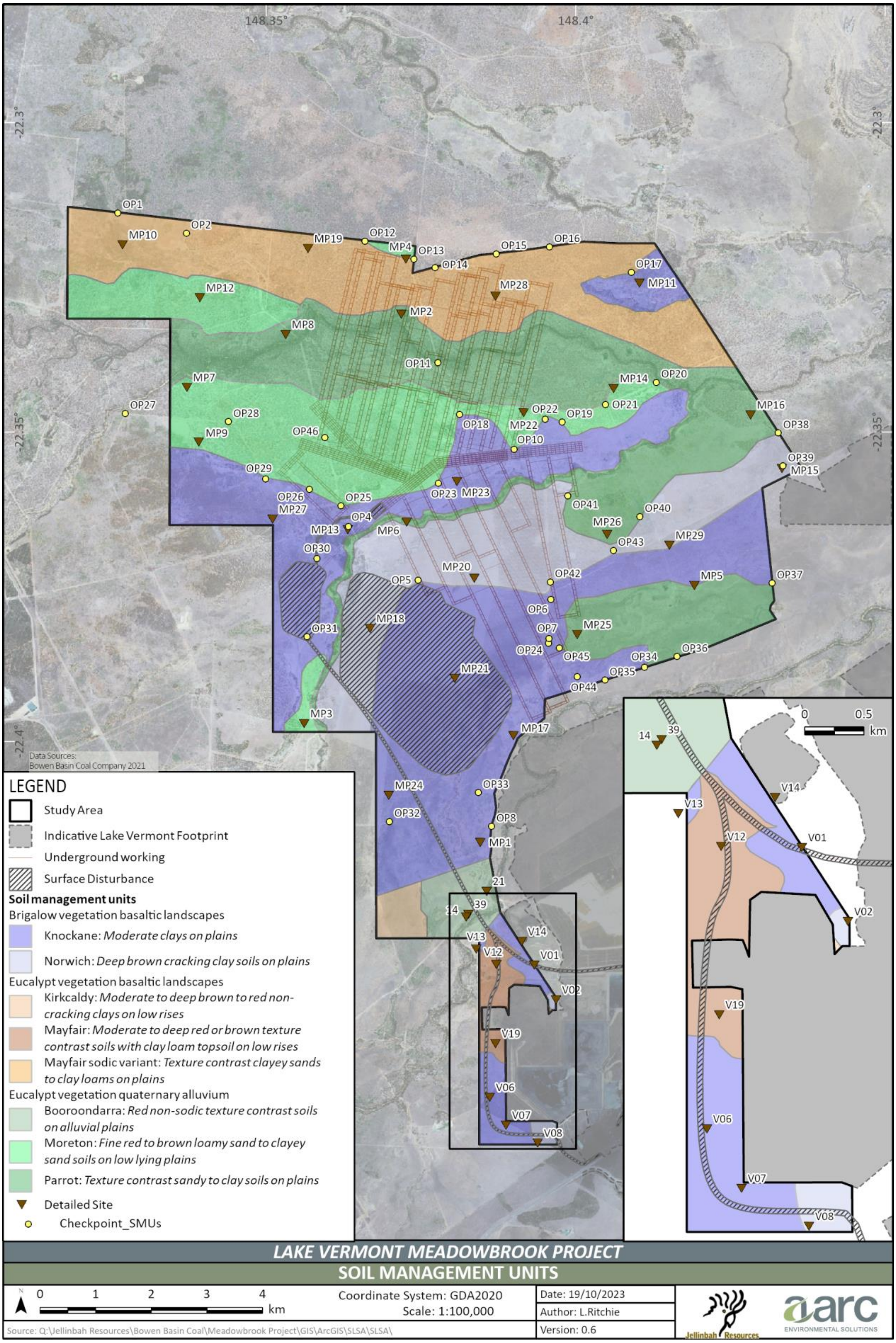


Figure 6: Soil management units

4.1 Knockane soil management unit

4.1.1 Soil unit description

A clay dominated soil unit with minor surface cracking associated with open plains and frequent development of normal gilgai with a depression vertical interval of 0.1 m–0.3 m. Soil textures grade from light-medium clays to medium-heavy clays at depth with many profiles containing calcareous segregations. The vegetation of this soil unit includes a dense shrub layer composed of Warrior bush *(Apophyllum anomalum)* and Conkerberry *(Carissa spinarum)* with less dominant Brigalow *(Acacia harpophylla)*.

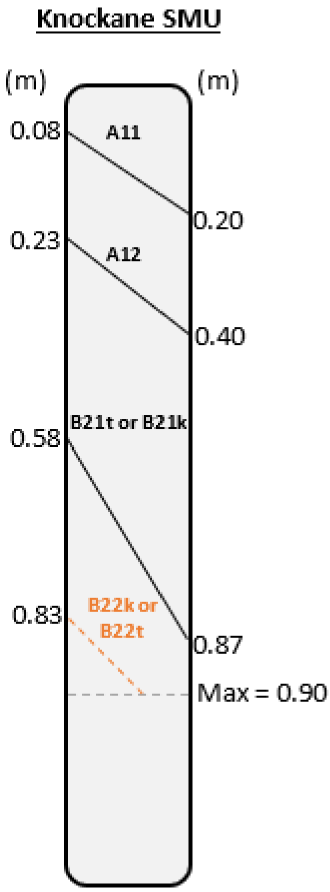
4.1.2 Australian soil classification: Epipedal Brown Vertosol

Figure 7: Knockane SMU vegetation

Table 16: Knockane SMU soil unit description

Parameter	Soil unit description
Landform	Plains
Land System	Humboldt and blackwater land systems
Slope	0 to 2%
Geology	Alluvium (TQa): Stratified unit including volcanic and metamorphic material
Vegetation	*Carissa spinarum, Acacia harpophylla, Apophyllum anomalum*
Runoff	Moderate
Permeability	Very slowly to slowly permeable
Drainage	Moderately well-drained

4.1.3 Profile description—representative sites MP23 and MP25



The **surface soil** (A11/A12) is a very dark grey to very dark greyish brown (10YR3/1, 10YR3/2) light to medium clay with moderate polyhedral to a platy structure. The soil unit has a field pH of 7–8, demonstrating a clear to gradual change to:

The **lower surface soil** (B21t/B21k) is a brown to a dark brown (10YR4/3, 10YR3/3) medium to heavy clay with strong subangular to a polyhedral structure. Some profiles of this SMU comprise of < 2% nodular calcareous segregations. Field pH is alkaline at pH 8–9. Clear change to:

The **subsoil** (B22k/B22t) is a brown to a dark brown (10YR4/3, 10YR3/3) layer and has not been observed in all profiles within this SMU. Soil has medium to heavy clay texture with a strong subangular structure. This horizon has an alkaline field pH of 9.

4.1.4 Chemical and physical analysis

Table 17: Chemical properties of Knockane SMU (representative site MP23)

Depth	pH		EC		Cl	ESP%		Moisture
(m)	-	Rating	dS/m	Rating	(mg/kg)	%	Rating	(%)
0–0.1	7.8	Slightly alkaline	0.071	Very low	20	2.8	Non-sodic	3.5
0.2–0.3	9.0	Strongly alkaline	0.244	Medium	120	9.6	Sodic	6
0.5–0.6	9.2	Strongly alkaline	0.668	High	780	20.7	Strongly sodic	7.5
0.7–0.8	9.2	Strongly alkaline	0.846	Very high	1,000	26.9	Strongly sodic	8
Depth	**CEC**		**Exchangeable cations (meq/100g)**					**Emerson class no.**
(m)	**meq/100g**	**Rating**	**Ca**	**Mg**	**K**	**Na**	**Ca/Mg Ratio**	
0–0.1	13.2	Medium	8.2	4	0.6	0.4	2.1	2
0.2–0.3	18.7	Medium	9.6	7	0.3	1.8	1.4	2
0.5–0.6	8.6	Low	2.6	4.2	< 0.2	1.8	0.6	2
0.7–0.8	14.1	Medium	3.2	6.9	0.2	3.8	0.5	2
Nutrient Distribution in Topsoil (%)			62.1	30.3	4.6	3.0	–	–

The soil pH of the Knockane SMU increases from slightly alkaline (pH 7.8) at the surface to very strongly alkaline (pH 9.2) with depth. Below a depth of 0.2 m, pH is likely to become plant limiting as the solubility of many elemental nutrients decreases with increasing pH; reducing their availability to plants. The Knockane SMU becomes highly saline and highly concentrated in chloride ions with depth which is likely to adversely impact plants with deeper root systems.

Throughout the soil profile, CEC is low to medium suggesting some capacity for soil to retain cationic nutrients and all cations slightly below what is ideal for plant growth. Magnesium and sodium, however, increase with depth which may influence the dispersive potential of soil. Consequently, exchangeable cations are not evenly distributed in topsoil with both magnesium and sodium occupying a much larger than ideal proportion of the soil exchange.

Soil sodicity increases with depth with ESP values ranging from 2.6% at the surface to 26.9% in lower horizons. This indicates that subsoil layers are likely to disperse if disturbed or exposed to the surface. The Emerson Class Number also indicates dispersive properties. Furthermore, with the misbalance of cations on the exchange, the ratio between calcium and magnesium is very low (Ca/Mg ≤ 2.1) which is likely to exacerbate the risk of soil dispersion.

Table 18: Surface Soil (0–10 cm) properties of Knockane SMU

Particle size analysis %				Soil particle density (g/cm³)	Organic matter (%)			
Clay	**Silt**	**Sand**	**Gravel**					
45	27	26	2	2.54	5			
Extractable nutrients (mg/kg)					**Extractable metals (mg/kg)**			
Phosphorous	**Potassium**	**Boron**	**Nitrate**	**Sulphate**	**Cu**	**Fe**	**Mn**	**Zn**
23	600	0.2	3.7	20	1.39	28.2	24.3	< 1

The surface soil of the Knockane SMU is largely composed of clay-sized particles but the range of particle size distribution indicates stability of the soil as particles have the potential to be well-packed. The organic matter content of soil is very high at 5%. This allows for good structural stability of aggregates and good pH and nutrient buffering capacity. Particle density is 2.54 g/cm^3 which is considered highly compact for clay-rich soils, and may stunt the root development of plants.

Of the extractable nutrients, phosphorous (23 mg/kg), potassium (600 mg/kg), and sulphate (20 mg/kg) are all present in soil at adequate concentrations. However, both nitrate (3.7 mg/kg) and boron (0.2 mg/kg) are below ideal concentrations for plant growth and may thus be a limiting factor. Extractable metal concentrations in soil are variable. Iron (28.2 mg/kg) is within an appropriate range for plant growth, although, both manganese (24.3 mg/kg) and copper (1.39 mg/kg) have higher than ideal soil concentrations while zinc (< 1 mg/kg) is lower than ideal.

4.2 Mayfair sodic variant soil management unit

4.2.1 Soil unit description

A texture-contrast soil associated with open plains. The soil surface is firm with very minor undulations across the surface. Soil texture grades from clayey sand in the topsoil to clay loam, sandy in deeper horizons. Some profiles of this SMU contain calcareous segregations and small coarse fragments in deeper horizons. The vegetation associated with this SMU includes Poplar Box *(Eucalyptus populnea)* and Sally Wattle *(Acacia salicina)*.

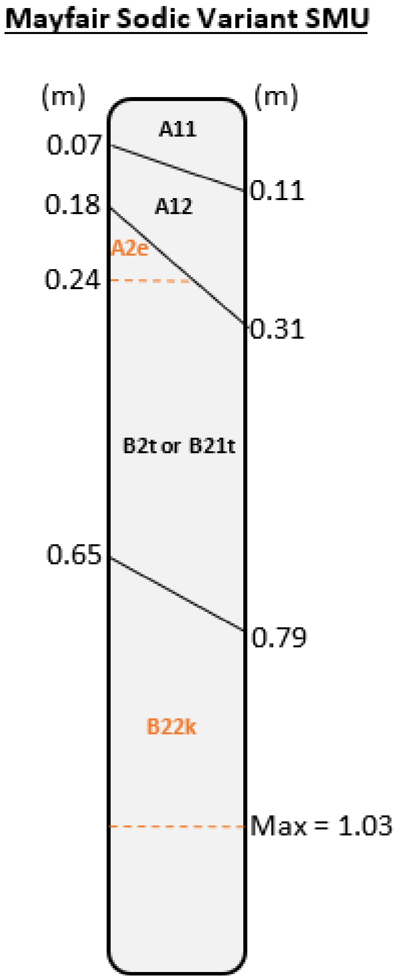
4.2.2 Australian soil classification: Brown Sodosol

Figure 8: Mayfair sodic variant SMU vegetation

Table 19: Mayfair sodic variant SMU soil unit description

Parameter	Soil unit description
Landform	Plains
Land system	Monteagle land system
Slope	0–2%
Geology	Alluvium (TQa): Stratified unit including volcanic and metamorphic material
Vegetation	*Acacia salicina, Cassia brewsteri, Eucalyptus populnea*
Runoff	Slow
Permeability	Slowly permeable
Drainage	Well-drained

4.2.3 Profile description – representative sites MP10 and MP28



The **surface soil** (A11/A12) is a very dark greyish brown to a dark grey (10YR3/2, 7.5YR4/1) clayey sand with single grain loose to weak platy structure. The soil unit has a neutral field pH of 6–7, demonstrating an abrupt change to:

The **lower surface** soil (A2e) is a bleached horizon that is not present in all profiles of this SMU. It is a brown (10YR4/3) loamy sand. It has a single grain loose structure and a neutral field pH of 7. An abrupt change to:

The **upper subsoil** (B2t/B21t) is a yellowish-brown to grey (10YR5/4, 7.5YR5/1) sandy clay loam to clay loam, sandy textured soil with moderate polyhedral to a sub-angular blocky structure. It can contain rounded to angular course fragments which make up < 10% of the horizon. This horizon has a field pH of 7–8.5, with a gradual change to:

The **lower subsoil** (B22k) horizon is not present in all profiles of this SMU. This horizon is a brown (10YR5/4) clay loam, sandy textured soil with moderate sub-angular blocky structure. Nodular calcareous segregations with a diameter of 6–20 mm are present in this horizon. Additionally, this horizon can contain rounded coarse fragments that makeup 10–20% of the horizon. This horizon has a field pH of 8.5.

4.2.4 Chemical and physical analysis

Table 20: Chemical properties of Mayfair sodic variant SMU (representative site MP28)

Depth	pH		EC		Cl	ESP%		Moisture
(m)	-	Rating	dS/m	Rating	(mg/kg)	%	Rating	(%)
0–0.1	6.0	Slightly acid	0.020	Very low	<10	0.6	Non-Sodic	0.8
0.2–0.3	6.5	Slightly acid	0.006	Very low	<10	3.4	Non-Sodic	0.4
0.5–0.6	6.7	Slightly acid	0.126	Low	160	13.6	Sodic	7.4
0.7–0.8	7.2	Slightly alkaline	0.169	Medium	210	17.0	Strongly Sodic	5.9
Depth	**CEC**		**Exchangeable cations (meq/100g)**					**Emerson class no.**
(m)	**meq/100g**	**Rating**	**Ca**	**Mg**	**K**	**Na**	**Ca/Mg Ratio**	
0–0.1	4.0	Very low	2.9	0.8	0.2	< 0.1	3.6	2
0.2–0.3	1.0	Very low	0.6	0.3	< 0.1	< 0.1	2.0	2
0.5–0.6	12.8	Medium	4.4	6.4	0.2	1.7	0.7	2
0.7–0.8	11.5	Low	3.7	5.6	0.2	1.9	0.7	2
Nutrient Distribution in Topsoil (%)			72.5	20.0	5.0	<2.5	–	–

The soil pH of the Mayfair sodic variant SMU ranges from moderately acid at the surface (pH 6) to neutral (pH 7.2) with depth. Soil pH remains within a suitable range for plant growth and nutrient availability is not anticipated to be hindered by pH. While soil EC and chloride concentration increase slightly with depth, both parameters remain within an ideal range for plant growth and are therefore not anticipated to be a constraining factor for plant growth.

Soil CEC is very low in the soil surface (1–4 meq/100g) and increases to what is considered low to moderate in deeper horizons (11.5–12.8 meq/100g). Within the upper 0.3 m, the availability of all exchangeable cations (calcium, magnesium, potassium and sodium) is very low. While availability increases below 0.5 m depth, the presence of the exchangeable cations calcium, potassium and sodium remains low, but the concentration of magnesium increases to what is considered high (5.6–6.4 meq/100g). This large increase in magnesium relative to other cations has allowed for a misbalance in the distribution of cations on the soil's exchange and a very low calcium/magnesium ratio.

Above a depth of 0.3 m, the soil is not sodic according to the low ESP (ESP < 6%). Below this depth, ESP increases from sodic (ESP = 13.6%) to strongly sodic (ESP of 17%). This indicates that soil at this depth may tend to disperse if disturbed or exposed to surface conditions. This is supported by the Emerson Class Number of 2 and the very small calcium/magnesium ratio (Ca/Mg of 0.7).

Table 21: Surface soil (0–10 cm) properties of Mayfair sodic variant SMU

Particle size analysis %				**Soil particle density (g/cm³)**	**Organic matter (%)**
Clay	**Silt**	**Sand**	**Gravel**		
9	27	63	1	2.46	3

Extractable nutrients (mg/kg)					**Extractable metals (mg/kg)**			
Phosphorous	**Potassium**	**Boron**	**Nitrate**	**Sulphate**	**Cu**	**Fe**	**Mn**	**Zn**
< 5	228	< 0.2	1.5	< 10	< 1	49.5	47.3	< 1

Soil particle analysis reveals a topsoil dominated by sand-sized particles although the wide range of particle size observed in the soil will contribute to the stability of the topsoil layer due to the close packing of particles. The organic matter composition of topsoil is considered high to moderate at 3%. This will also contribute to the structural stability of soil. The soil particle density is 2.46 g/cm^3 which is considered compact for sand-dominated soils.

The extractable nutrient content of the topsoil of the Mayfair sodic variant SMU is likely to be limiting. Phosphorous (< 5 mg/kg), boron (< 0.2 mg/kg), nitrate (1.5 mg/kg) and sulphate (< 10 mg/kg) are all below the ideal concentrations necessary for plant growth with only potassium (228 mg/kg) above the critical concentration for sandy soils. Of the extractable metals, both copper (<1 mg/kg) and zinc (< 1 mg/kg) are below ideal concentrations for plant health while manganese is above the ideal soil concentration. This high concentration of manganese in the soil can induce manganese toxicity in plants. Iron, however, is within a suitable range for plant growth.

4.3 Moreton soil management unit

4.3.1 Soil unit description

A soil unit composed of fine red to brown coloured sand associated with low-lying plains. The soil surface is soft-setting with textures ranging from loamy- to clayey-sands. Soil texture remains constant throughout the solum. Vegetation associated with this unit consists of Moreton Bay Ash *(Corymbia tessellaris)* with Conkerberry *(Carissa spinarum)* in the shrub layer.

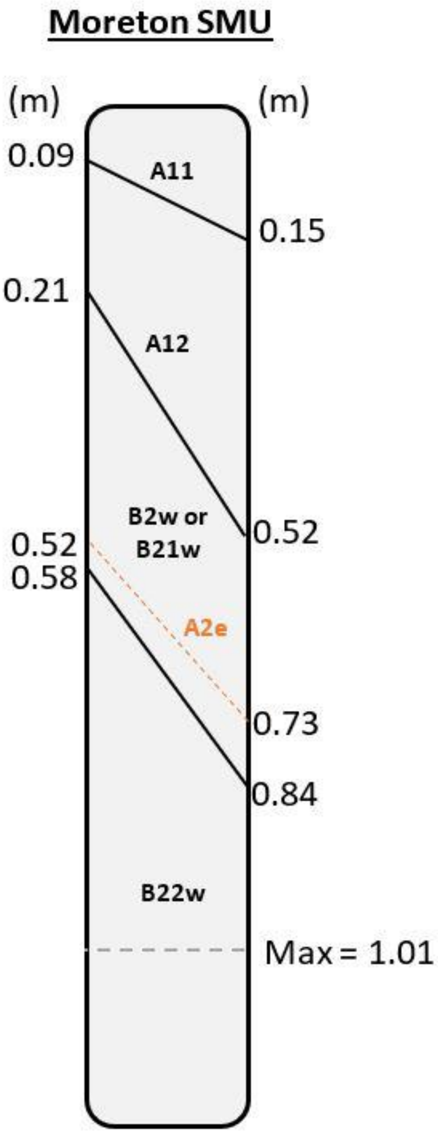
4.3.2 Australian soil classification: Arenosol

Figure 9: Moreton SMU vegetation

Table 22: Moreton SMU soil unit description

Parameter	Soil unit description
Landform	Plains
Land system	Monteagle land system
Slope	0–2%
Geology	Alluvium (TQa): Stratified unit including volcanic and metamorphic material
Vegetation	*Corymbia tessellaris, Carissa spinarum*
Runoff	Slow to very slow
Permeability	Moderately to highly permeable
Drainage	Rapidly drained

4.3.3 Profile description—representative sites MP12 and MP14



The **surface soil** (A11/A12) is a dark brown to very dark brown (10YR3/3, 7.5YR2.5/2) clayey sand to loamy sand with weak platy structure. The soil unit has a field pH of 6–7.5, demonstrating a clear to gradual change to:

The **lower surface soil** (A2e) is not a commonly observed horizon in this SMU. It is a strong brown (7.5YR4/6) clayey sand. It has a single grain, loose structure and a neutral field pH of 7. Clear smooth change to:

The **upper subsoil** (B2w/B21w) is a brown to strong brown (7.5YR4/4, 7.5YR5/6) sand to clayey sand with a single grain, loose structure. This horizon has a neutral field pH of 7– 7.5, with a smooth clear to gradual change to:

The **lower subsoil (**B22w) is a yellowish red to dark yellowish-brown (5YR4/6, 10YR3/4) clayey sand with a single grain, loose structure and a field pH of 7.5.

4.3.4 Chemical and physical analysis

Table 23: Chemical properties of Moreton SMU (representative site MP12)

Depth	pH		EC		Cl	ESP%		Moisture
(m)	-	Rating	dS/m	Rating	(mg/kg)	%	Rating	(%)
0–0.1	6.2	Slightly acid	0.017	Very low	< 10	0.7	Non-sodic	0.1
0.2–0.3	6.4	Slightly acid	0.005	Very low	< 10	< 0.1	Non-sodic	0.1
0.5–0.6	6.6	Slightly acid	0.014	Very low	< 10	1.1	Non-sodic	0.4
0.7–0.8	7.0	Neutral	0.015	Very low	< 10	< 0.1	Non-sodic	0.3
Depth	**CEC**		**Exchangeable cations (meq/100g)**					**Emerson class no.**
(m)	**meq/100g**	**Rating**	**Ca**	**Mg**	**K**	**Na**	**Ca/Mg Ratio**	
0–0.1	2.0	Very low	1.4	0.4	0.2	0.1	3.5	7
0.2–0.3	1.5	Very low	1.1	0.2	0.1	< 0.1	5.5	7
0.5–0.6	1.2	Very low	0.8	0.2	0.2	< 0.1	4	7
0.7–0.8	1.5	Very low	1	0.2	0.2	< 0.1	5	7
Nutrient Distribution in Topsoil (%)			70.0	20.0	10.0	< 5.0	–	–

The Moreton SMU is slightly acid at the surface with a pH of 6.2 and increases to a neutral pH with depth. Throughout the solum, pH is not anticipated to reduce the availability of any nutrients. Soil salinity and chloride concentration remain very low throughout the soil profile with EC < 0.7 dS/m and chloride < 10 mg/kg. Salinity and chloride are therefore not anticipated to be constraints to plant health.

Soil CEC is considered very low at all depths (CEC ≤ 2 meq/100g) indicating the soil has poor nutrient holding capacity. At all depths, the presence of exchangeable cations is well below the ideal concentrations for calcium, magnesium, potassium and sodium respectively. Cations are unevenly distributed on the exchange with magnesium, potassium and sodium all occupying a higher than ideal proportion of the exchange.

Soil ESP remains low throughout the solum indicating that the soil is not dispersive. This is supported by the Emerson Class Number of 7 and the predominantly large calcium/magnesium ratio (Ca/Mg < 4).

Table 24: Surface soil (0–10 cm) properties of Moreton SMU

Particle size analysis (%)					**Soil particle density (g/cm³)**		**Organic matter (%)**	
Clay	**Silt**		**Sand**	**Gravel**				
9	12		78	1	2.59		1.4	
Extractable nutrients (mg/kg)					**Extractable metals (mg/kg)**			
Phosphorous	**Potassium**	**Boron**	**Nitrate**	**Sulphate**	**Cu**	**Fe**	**Mn**	**Zn**
< 5	222	< 0.2	1.6	< 10	< 1	9.14	33.5	< 1

References:
1– Interpreting Soil Test Results (3rd Edition), 2016
2 – Standard Soil Test Methods and Guidelines for the Interpretation of Soil Results, 2013

Particle size analysis reveals the soil is predominantly composed of sand-sized particles which is consistent with the single grain loose structure and suggests the soil may be subject to slumping under certain conditions. Soil organic matter composition in topsoil is low at 1.4% which can be attributed to the large composition of sand-sized particles.

The availability of extractable nutrients in the surface soil of Moreton SMU is predominantly low. Phosphorous (< 5 mg/kg), boron (< 0.2 mg/kg), nitrate (1.6 mg/kg) and sulphate (< 10 mg/kg) are below the ideal soil concentrations for plant growth. Potassium, however, is above the critical concentration for sandy soils (222 mg/kg). The concentration of extractable metals is variable with copper (< 1 mg/kg), iron (9.14 mg/kg) and zinc (< 1 mg/kg) soil concentrations below what is considered adequate for plant health. Soil manganese concentration, however, is very high at 33.5 mg/kg which may induce manganese toxicity in plants.

4.4 Norwich soil management unit

4.4.1 Soil unit description

A heavy clay soil unit situated on plains. The soil surface exhibits deep cracking and development of normal gilgai with depression vertical intervals ranging from 0.1 m to 0.3 m. Soil textures grade from medium clays to medium-heavy clays at depth with many profiles containing calcareous segregations. The vegetation associated this SMU is predominantly Brigalow *(Acacia harpophylla)* regrowth and pastoral grass species.

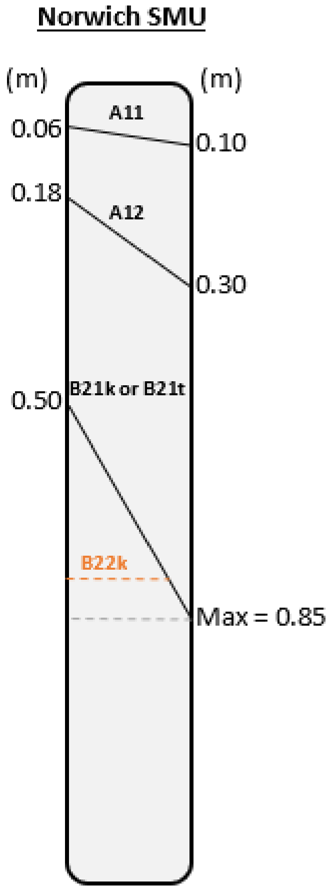
4.4.2 Australian soil classification: Self-mulching Brown Vertosol

Figure 10: Norwich SMU vegetation

Table 25: Norwich SMU soil unit description

Parameter	Soil unit description
Landform	Plains
Land system	Somerby land system
Slope	0–2%
Geology	Alluvium (TQa): Stratified unit including volcanic and metamorphic material
Vegetation	*Acacia harpophylla* dominant in tree layer. Ground cover composed of various pasture grass species.
Runoff	Moderate
Permeability	Very slowly to slowly permeable
Drainage	Imperfectly drained

4.4.3 Profile Description—representative sites MP15 and MP18



The **surface soil** (A11/A12) is a dark brown to very dark brown (10YR3/3, 10YR2/2) light to medium clay with a moderate polyhedral structure. The soil unit has a neutral field pH of 7–7.5, displaying a smooth clear change to:

The **upper subsoil** (B21k/B21t) is a dark yellowish-brown to a very dark greyish brown (10YR3/4, 10YR3/2) medium to heavy clay with moderate to strong polyhedral structure. Nodular calcareous segregations are present throughout the B21 layer. The subsoil has a neutral to slightly alkaline field pH of 7.5–8.5 with a clear to gradual change to:

Some profiles of this soil unit have developed a **lower subsoil** (B22k) layer. This B22k layer is a dark brown (10YR3/3) with moderate polyhedral structure and medium clay texture. Nodular calcareous segregations are present throughout. Field pH is slightly alkaline at pH 8.

4.4.4 Chemical and physical analysis

Table 26: Chemical properties of Norwich SMU (representative site MP15)

Depth	pH		EC		Cl	ESP%		Moisture
(m)	**-**	**Rating**	**dS/m**	**Rating**	**(mg/kg)**	**%**	**Rating**	**(%)**
0–0.1	6.8	Slightly acid	0.060	Very low	10	0.6	Non-sodic	2.8
0.2–0.3	8.2	Moderately alkaline	0.101	Low	100	6.8	Sodic	6.8
0.5–0.6	8.6	Moderately alkaline	0.588	High	870	14.7	Sodic	9.3
0.7–0.8	8.4	Moderately alkaline	1.03	Very high	1590	20.8	Strongly sodic	9.4
Depth	**CEC**		**Exchangeable cations (meq/100g)**					**Emerson class no.**
(m)	**meq/ 100g**	**Rating**	**Ca**	**Mg**	**K**	**Na**	**Ca/Mg Ratio**	
0–0.1	21.6	Medium	16.2	4.6	0.6	0.1	3.5	3
0.2–0.3	6.8	Low	8.0	2.5	< 0.2	0.8	3.2	2
0.5–0.6	14.7	Medium	8.5	5.4	< 0.2	2.4	1.6	2
0.7–0.8	20.8	Medium	5.4	5.2	< 0.2	2.8	1.0	2
Nutrient Distribution in Topsoil (%)			75.0	21.3	2.8	0.5	–	–

Soil pH of the Norwich SMU ranges from slightly acid in the soil surface to moderately alkaline in lower horizons. Below 0.5 m, this pH range has the potential to limit the availability of micronutrients such as iron, manganese, copper and zinc. In the topsoil, EC is very low and thus will not impact plant health, however, soil salinity is very high at depth. Chloride concentration increases from suitable levels in the topsoil (< 100 mg/kg) to highly unsuitable (870–1,590 mg/kg) below a depth of 0.5 m which impedes the availability of soil water to plants.

Soil CEC is predominantly medium (14.7–21.6 meq/100g) with only the lower topsoil horizon demonstrating low soil CEC (6.8 meq/100g). This indicates a moderate nutrient retention capacity. The concentration of exchangeable cations in the topsoil is, for the most part, adequate, however, exchangeable cations decrease with depth to concentrations slightly below suitable ranges for plant growth. The distribution of cations in the topsoil is ideal with only magnesium occupying slightly higher than the ideal proportion of the exchange.

The surface soil of the Norwich SMU is non-sodic, however, below 0.2 m soil ESP increases such that the deeper horizons are sodic and may be subject to dispersion if disturbed or left exposed. This is supported by an Emerson Class Number of 2 throughout the lower horizons. Furthermore, the calcium/magnesium ratio decreases from 3.5 at the surface to 1. This indicates an imbalance between calcium and magnesium and risk of dispersive properties.

Table 27: Surface soil (0–10 cm) properties of Norwich SMU

Particle size analysis (%)					Soil particle density (g/cm³)		Organic matter (%)	
Clay	**Silt**		**Sand**	**Gravel**				
44	17		38	1	2.39		4.5	
Extractable nutrients (mg/kg)					**Extractable metals (mg/kg)**			
Phosphorous	**Potassium**	**Nitrate**	**Sulphate**	**Boron**	**Cu**	**Fe**	**Mn**	**Zn**
68	473	5.4	20	< 0.2	2.09	43.2	148	1.34

The topsoil has a fair particle size distribution indicating a likely good water holding capacity. Organic matter content is considered very high at 4.5% indicating very good structural stability as well as good nutrient and pH buffering capacity. Soil particle density is 2.39 g/cm^3 which is considered excessively compact which may restrict root penetration of growing plants.

According to guidelines (Hazelton and Murphy 2016), the extractable nutrients phosphorous (68 mg/kg), potassium (473 mg/kg), and sulphate (20 mg/kg) are present in the soil at adequate concentrations. Nitrate (5.4 mg/kg) and boron (<0.2 mg/kg), however, are below suitable soil concentrations which may limit plant growth. Extractable metals are very highly concentrated in the soil with copper concentration at 2.09 mg/kg, manganese at 148 mg/kg and zinc at 1.34 mg/kg. Manganese, in particular, has the potential to induce toxicity in plants. Iron, however, is suitably concentrated at 43.2 mg/kg.

4.5 Parrot soil management unit

4.5.1 Soil unit description

A texture-contrast soil associated with the watercourses within the survey area. Soil texture is sandy within the surface layers with an abrupt change to a clay-rich subsoil. The soil surface is soft to firmly set while the subsoil displays mottles developed from alternating wet and dry periods. The vegetation of this soil unit consists predominantly of Poplar Box *(Eucalyptus populnea),* Sally Wattle *(Acacia salicina)* and Leichardt Bean *(Cassia brewsteri)*.

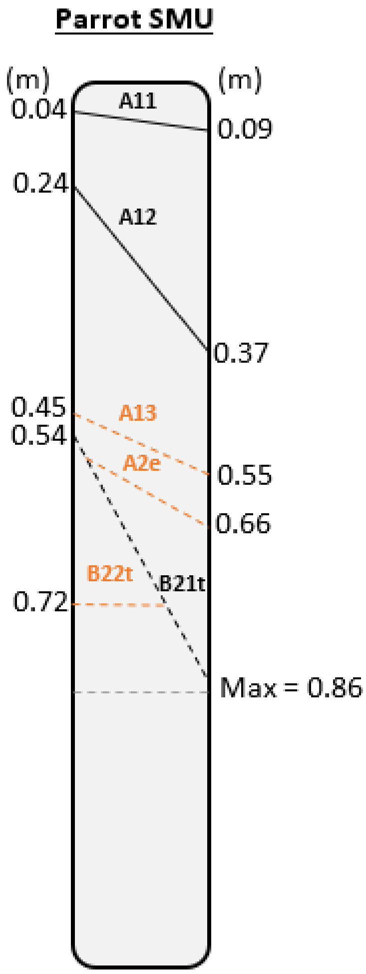
4.5.2 Australian soil classification: Brown Chromosol

Figure 11: Parrot SMU vegetation

Table 28: Parrot SMU soil unit description

Parameter	Soil unit description
Landform	Plains
Land system	Connors land system
Slope	0–2%
Geology	Alluvium (TQa): Stratified unit including volcanic and metamorphic material
Vegetation	*Acacia salicina, Cassia brewsteri, Eucalyptus populnea*
Runoff	Slow to moderate
Permeability	Slowly to moderately permeable
Drainage	Moderately well-drained

4.5.3 Profile description—representative sites MP2 and MP26



The **surface soil** (A11/A12/A13) is a very dark brown to very dark greyish brown (7.5YR2.5/2, 10YR3/2) loamy sand to sandy loam with a single grain loose to weak platy structure. The soil unit has a field pH of 4.5–5.5, demonstrating an abrupt to clear change to:

The **lower surface soil** (A2e) is a bleached horizon only present in some profiles of this SMU. It is a brown (7.5YR4/4, 10YR4/3) loamy sand. It has a single grain loose structure and a field pH of 7–8. Clear to abrupt change to:

The **subsoil** (B21t/B22t) is a yellowish-brown to a dark yellowish-brown (10YR5/4, 10YR4/4) clay loam, sandy textured soil with moderate angular to a subangular structure. Less than 20% of this horizon can contain subangular course fragments with a diameter of 2–6 mm. This horizon has a field pH of 7.5–8.

4.5.4 Chemical and physical analysis

Table 29: Chemical properties of Parrot SMU (representative site MP26)

Depth	pH		EC		Cl	ESP%		Moisture
(m)	-	Rating	dS/m	Rating	(mg/kg)	%	Rating	(%)
0–0.1	7.9	Slightly alkaline	0.101	Low	10	< 0.2	Non-sodic	<0.1
0.2–0.3	7.6	Slightly alkaline	0.020	Very low	< 10	< 0.2	Non-sodic	0.4
0.5–0.6	8.2	Moderately alkaline	0.013	Very low	< 10	< 0.2	Non-sodic	0.3
0.7–0.8	8.5	Moderately alkaline	0.038	Very low	< 10	5.1	Non-sodic	4.8
Depth	**CEC**		**Exchangeable cations (meq/100g)**					**Emerson class no.**
(m)	**meq/ 100g**	**Rating**	**Ca**	**Mg**	**K**	**Na**	**Ca/Mg Ratio**	
0–0.1	2.6	Very low	1.4	< 0.2	1.2	< 0.2	–	3
0.2–0.3	2.4	Very low	2.2	< 0.2	0.2	< 0.2	–	3
0.5–0.6	0.9	Very low	0.9	< 0.2	< 0.2	< 0.2	–	3
0.7–0.8	9.4	Low	5.1	0.5	0.5	0.5	1.5	2
Nutrient Distribution in Topsoil (%)			53.9	< 7.7	46.2	< 7.7	–	–

The Parrot SMU ranges from slightly alkaline to strongly alkaline with depth. The high soil pH in deeper horizons (below 0.5 m) may have the capacity to reduce the availability of nutrients. Salinity and chloride toxicity are not anticipated to be a constraining factor with low EC (EC < 0.15 dS/m) and chloride concentration (Cl < 10 mg/kg) throughout the soil profile.

Soil CEC is considered very low (CEC < 6 meq/100g) in the upper 0.6 m of the profile and increases slightly to 9.4 meq/100g below this depth. Within the surface 0.6 m, calcium, magnesium, sodium and to a lesser extent potassium, are all well below suitable soil concentrations which may limit plant growth. The distribution of exchangeable cations in the topsoil is poor with potassium occupying a much larger than ideal proportion of the exchange while the proportion of both calcium and magnesium is below ideal. This may influence the dispersive potential of soil.

Soil ESP remains below 6% throughout the solum indicating the soil is non-sodic and is therefore not likely to be prone to dispersion. However, the Emerson class number of 3 suggests the soil may be susceptible to slaking under certain conditions. Due to the near negligible quantity of magnesium in soil the calcium/magnesium ratio cannot be accurately estimated. This, however, is not likely to influence the risk of dispersion due to the low ESP values observed in soil.

Table 30: Surface soil (0–10 cm) properties of Parrot SMU

Particle Size Analysis (%)					Soil Particle Density (g/cm^3)		Organic Matter (%)	
Clay	**Silt**		**Sand**	**Gravel**				
15	7		77	1	2.45		3.6	
Extractable Nutrients (mg/kg)					**Extractable Metals (mg/kg)**			
Phosphorous	**Potassium**	**Boron**	**Nitrate**	**Sulphate**	**Cu**	**Fe**	**Mn**	**Zn**
32	1,350	< 0.2	6.2	20	< 1	24	45.9	1.49

The topsoil is dominated by sand. The soil has a high organic matter composition of 3.6% suggesting good structural stability and the capacity to buffer changes to soil pH. Soil particle size density of 2.45 g/cm^3 suggests the soil is very compact which may impede root penetration.

The concentration of extractable nutrients in soil is variable. Phosphorous (32 mg/kg), potassium (1,350 mg/kg) and sulphate (20 mg/kg) are all adequately concentrated. Both boron (< 0.2 mg/kg) and nitrate (6.2 mg/kg) soil concentrations are considered low with the potential to limit plant growth. The concentration of extractable metals within the topsoil is also variable with a low copper concentration of < 1 mg/kg and high to very high zinc (1.49 mg/kg) and manganese (45.9 mg/kg) concentrations. Manganese, in particular has the potential to induce manganese toxicity. Iron is suitably concentrated in soil at 24 mg/kg.

5 Land Suitability Assessment

Land suitability refers to the adequacy of land for a defined use. Land suitability assessment considers environmental factors including climate, soils, geology, geomorphology, erosion, topography and the effects of past land uses. The classification does not always represent the current land use. Rather, it indicates the potential of land to be used for specific agricultural activities. This land suitability assessment aims to evaluate the suitability of the study area for agricultural land uses including cattle grazing and cropping, prior to development of the Project.

A determination of land suitability of the study area was initially conducted using the Technical Guidelines for the *Environmental Management of Exploration and Mining in Queensland—Land suitability Assessment Techniques* (QDME 1995). The land suitability assessment of SMUs mapped only within ML70477 or ML70528 is presented within Appendix D (NQSA 2012) and Appendix E (AARC 2013) respectively. SMUs mapped within the proposed MLA were assessed according to the guideline (QDME 1995) and are presented in sections 5.1 and 5.2. The SMUs identified as suitable for rainfed broadacre cropping were subsequently assessed according to the *Regional Land Suitability Frameworks for Queensland* (DSITIA and DNRM 2013) in section 5.3.

The five land suitability classes used for assessing land are defined in Table 31. Suitability decreases as the severity of limitations for a land use increases. The land suitability class reflects the score of the most limiting attribute for a given SMU. An increase in limitations may reflect either:

- reduced potential for production;
- increased inputs to achieve an acceptable level of production;
- increased inputs to prepare the land for successful production; and/or
- increased inputs required to prevent land degradation.

Table 31: Agricultural and conservation land class descriptions

Class	Agricultural description	Conservation description
Class 1	Suitable land with negligible limitations. This is highly productive land requiring only simple management practices to maintain economic production.	Areas well suited for conservation uses must possess significant conservation benefits in the pre-mining environment and be capable of being returned to that use post-mining
Class 2	Suitable land with minor limitations which either reduce production or require more than the simple management practices of class 1 land to maintain economic production.	Areas suited to conservation use in that a significant component of the pre-mining conservation values can be restored post-mining. There will, however, be some loss in conservation values where soil terrain or hydrological post-mining conditions may inhibit the full replication of the pre-mining values.
Class 3	Suitable land with moderate limitations which either further lower production or require more than those management practices of class 2 land to maintain economic production.	These lands contain significant conservation values pre-mining, however, restoration of all of these values may not be feasible. These areas could, however, be restored to a form of conservation use that provides alternative conservation benefits.
Class 4	Marginal land, which is presently considered unsuitable due to severe limitations. The long term significance of these limitations on the proposed land use is unknown or not quantified. The use of this land is dependent upon undertaking additional studies to determine whether the effect of the limitation(s) can be reduced to achieve sustained economic production.	These lands contain limited conservation value pre-mining and/ or are incapable of being effectively restored post-mining to any alternative conservation use which provides similar benefits. The area could, however, be restored to provide a stable form of use which does not impact on surrounding conservation values.
Class 5	Unsuitable land with extreme limitations that preclude its use.	These lands contain no significant conservation values.

5.1 Cattle grazing

Limitations for grazing land suitability on improved pastures as outlined in the *Land Suitability Assessment Techniques* (QDME 1995) guidelines (Table 2.2) are:

- water availability;
- nutrient deficiency;
- soil physical factors;
- salinity;
- rockiness;
- micro relief;
- pH;
- ESP;
- wetness;
- topography;
- water erosion;
- flooding; and
- vegetation.

Numerous parameters outlined in this assessment require determination of the 'rootzone'. The rootzone is the depth to hard or weathered rock or the depth to a significant salt bulge within the soil profile. Where these limitations are not encountered within the sampling depth, a value of 0.6 m can be assumed as the rootzone as per the guidelines (QDME 1995).

Class 1 and Class 2 land is considered suitable for grazing improved pastures with maximum grazing productivity achieved in most seasons. Class 3 land is considered suitable for grazing improved pastures; however, it is less productive than Classes 1 and 2. Class 4 land is categorised as marginal for grazing improved pastures although it is largely considered suitable for grazing native pastures of variable quality. Class 5 land is unsuitable for any form of pasture improvement and is limited to low productivity grazing of native pastures. Due to poor soil quality, Class 5 land may require destocking in poor seasons.

Each of the limitations listed above is assessed in the following subsections based on Table 2.2 of the guidelines (QDME 1995).

5.1.1 Water availability

The PAWC requirements for land suitability classes for beef cattle grazing are described in Table 2.3 of the 1995 guideline (QDME 1995) and are summarised 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

This classification is not based on specific pasture species, but on pasture as the general land use. The soils are assessed on the depth to weathered rock, or other root inhibiting factors such as a salt bulge or significant sodicity. Table 32 provides the outcomes of the land suitability class assessment based on PAWC.

Table 32: Plant available water capacity suitability class for cattle grazing

Soil management unit	Limiting features	PAWC (mm)	Land suitability class
Knockane	Cracking clays with alkaline to neutral pH throughout and 60–90 cm depth to Cl > 600 ppm or ESP > 15%	100–125	2
Mayfair sodic variant	Rigid soils: Duplex soils with a sodic subsoil (ESP 6–14) within 60 cm of the surface becoming strongly sodic within 60 cm of the surface.	50–75	4
Moreton	Rigid soils: Sands and sandy loams > 90 cm deep	75–100	3
Norwich	Cracking clays with alkaline to neutral pH throughout and 60–90 cm depth to Cl > 600 ppm or ESP > 15%	100–125	2
Parrot	Rigid soils (non-sodic): duplex soils with >125 cm to salt bulge with EC > 0.9 mS/cm or Cl > 900 ppm	125–150	1

5.1.2 Nutrient deficiency

The nutrient status of each SMU identified has been assessed and the results are presented in Table 33.

Table 33: Nutrient status suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	Brigalow and former scrub soils with bicarbonate P > 10 ppm	1
Mayfair sodic variant	Sands and loams at least 75 cm deep or overlying rock at shallow depth, with Bicarbonate P ≤ 4 ppm	4
Moreton	Sands and loams at least 75 cm deep or overlying rock at shallow depth, with Bicarbonate P ≤ 4 ppm	4
Norwich	Brigalow and former scrub soils with bicarbonate P > 10 ppm	1
Parrot	Eucalypt vegetation with bicarbonate P > 10 ppm	2

5.1.3 Soil physical factors

Soil physical factors for each SMU identified have been assessed with results presented in Table 34. Soil physical condition impacts seed germination and emergence. Adverse conditions such as hard-setting or crusting of surface soils reduce plant establishment by creating a barrier, reducing seed-soil contact.

Table 34: Soil physical factors suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	Cracking clays with coarse peds (peds > 10 mm)	3
Mayfair sodic variant	Rigid soils with a firm surface when dry	1
Moreton	Rigid soils with a soft surface when dry	1
Norwich	Cracking clays with fine self-mulch (peds 2–10 mm)	2
Parrot	Rigid soils with a loose, soft or firm surface when dry	1

5.1.4 Salinity

Land suitability class for each SMU based on salinity was assessed with the results provided in Table 35. Given salinity can inhibit plant growth, the highest EC recorded is considered the most limiting factor and dictates the rating given to each SMU. Significant levels of salinity present in the rootzone can negatively impact plant growth and production.

Table 35: Salinity suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	Rootzone EC 0.3–0.9 mS/cm	3
Mayfair sodic variant	Rootzone EC < 0.15 mS/cm	1
Moreton	Rootzone EC < 0.15 mS/cm	1
Norwich	Rootzone EC 0.3–0.9 mS/cm	3
Parrot	Rootzone EC < 0.15 mS/cm	1

5.1.5 Rockiness

The land suitability for each SMU based on rockiness was assessed with results presented in Table 36. The impacts of rockiness are more extreme for cropping than for grazing. With respect to grazing, rock outcrops reduce the area available to grow pasture, indirectly impacting the carrying capacity of the land.

Table 36: Rockiness suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	< 20% coarse surface gravel (< 6 cm diam.) and rock outcrop	1
Mayfair sodic variant	< 20% coarse surface gravel (< 6 cm diam.) and rock outcrop	1
Moreton	< 20% coarse surface gravel (< 6 cm diam.) and rock outcrop	1
Norwich	< 20% coarse surface gravel (< 6 cm diam.) and rock outcrop	1
Parrot	< 20% coarse surface gravel (< 6 cm diam.) and rock outcrop	1

5.1.6 Microrelief

The microrelief for each SMU identified has been assessed with results presented in Table 37. Microrelief refers to local relief (up to several metres) around the plane of the land (National Committee on Soil and Terrain, 2009). Impacts of microrelief on the suitability of land for cattle grazing are only experienced when soil is severely melonholed. Ponding of water in the depressions can reduce pasture yield, indirectly impacting the land's carrying capacity.

Table 37: Microrelief suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	Melonholes cover < 20% surface area	1
Mayfair sodic variant	Melonholes cover < 20% surface area	1
Moreton	Melonholes cover < 20% surface area	1
Norwich	Melonholes cover < 20% surface area	1
Parrot	Melonholes cover < 20% surface area	1

5.1.7 pH

The land suitability class for pH has been assessed with results presented in Table 38. Soil pH determines the availability of nutrients for plant intake. Where a soil material is strongly acidic, aluminium and manganese toxicity may limit root growth and plant productivity.

Table 38: pH suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	8.0 < pH < 9.0	3
Mayfair sodic variant	6.6 < pH < 8.0	2
Moreton	6.6 < pH < 8.0	2
Norwich	8.0 < pH < 9.0	3
Parrot	8.0 < pH < 9.0	3

5.1.8 Exchangeable sodium percentage (ESP)

The ESP of each SMU identified has been assessed with the results presented in Table 39. ESP is used to determine the erosion potential of soils. The land suitability class identified for each SMU based on ESP in the upper 100 mm of soil.

Table 39: ESP suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	ESP (10cm) % = < 5.0	1
Mayfair sodic variant	ESP (10cm) % = < 5.0	1
Moreton	ESP (10cm) % = < 5.0	1
Norwich	ESP (10cm) % = < 5.0	1
Parrot	ESP (10cm) % = < 5.0	1

5.1.9 Wetness

The land suitability class identified for each SMU based on wetness has been assessed with results presented in Table 40. The wetness limitation refers to any excess water both in and on the soil profile. The adverse effects of excess water include reducing plant growth, impeding oxygen supply to plant roots (possibly leading to denitrification) and increased risk of plant disease.

Table 40: Wetness suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	Low-lying level plains	2
Mayfair sodic variant	Rigid soils with strongly sodic subsoil (ESP > 15) within 60 cm of the surface	2
Moreton	Low-lying level plains	2
Norwich	Low-lying level plains	2
Parrot	Low-lying level plains	2

5.1.10 Water erosion

The land suitability class identified for each SMU based on water erosion has been assessed with the results presented in Table 41.

Table 41: Water erosion suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	Slopes < 1 % on sodic soils	1
Mayfair sodic variant	Slopes < 1 % on sodic soils	1
Moreton	Slopes < 3 % on all other soils	2
Norwich	Slopes < 1 % on sodic soils	1
Parrot	Slopes < 3 % on all other soils	2

5.1.11 Flooding

The land suitability class identified for each SMU based on flooding risk has been assessed with results presented in Table 42. Flooding may result in plant death or reduced growth. In severe cases where land is inundated for a prolonged period, stock loss and loss of grazing production may also occur.

Table 42: Flooding suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	Infrequent flooding (inundation occurs < half the times that stream flow increases)	2
Mayfair sodic variant	Infrequent flooding (inundation occurs < half the times that stream flow increases)	2
Moreton	Infrequent flooding (inundation occurs < half the times that stream flow increases)	2
Norwich	Infrequent flooding (inundation occurs < half the times that stream flow increases)	2

Parrot	Infrequent flooding (inundation occurs < half the times that stream flow increases)	2

5.1.12 Vegetation regrowth (management limitation)

The land suitability class identified for each SMU based on vegetation regrowth has been assessed with results presented in Table 43. Vegetation communities may contain poisonous species or woody weeds that will limit the productivity of grazing pastures to varying degrees and increase the need for land management. The density of tree species and presence of a woody shrub layer may also limit the carrying capacity of the land.

Table 43: Vegetation suitability class for cattle grazing

Soil management unit	Limiting features	Land suitability class
Knockane	Box and ironbark woodlands without wattle	2
Mayfair sodic variant	Box and ironbark woodlands without wattle	2
Moreton	Box and ironbark woodlands without wattle	2
Norwich	Brigalow with melonholes	2
Parrot	Eucalypt woodlands with wattle understorey	4

5.1.13 Summary of land suitability for cattle grazing

Table 44 provides a summary of all the assessed land suitability limitations for beef cattle grazing land use.

The land suitability of the study area for cattle grazing is mostly limited by water availability, pH and nutrient availability.

Unsuitable pH conditions can greatly reduce nutrient levels in the soil. This has the potential to impact livestock production through a reduction in pasture growth and nutrient value of pasture species. Additionally, water availability can also compromise pasture growth by inducing water stress in pasture species and preventing the mobilisation of nutrients in the root zone.

While no Class 1 land was identified for the Project area, the examination of the land suitability limitations for cattle grazing (Table 44) indicates 4,131 ha of the Project is suitable for cattle grazing with moderate limitations (Class 3) and 4,550 ha of land considered marginal land (Class 4). Grazing is the current land use of the study area and on this basis, the land is considered sufficiently suitable for grazing. The land suitability framework is used as a guide to determine potential land suitability and should be considered alongside historical land use.

The distribution of land suitability classes for cattle grazing across the study area is presented in Figure 12.

Table 44: Summary of land suitability limitations for cattle grazing

Limitation	Booroondarra	Kirkcaldy	Knockane	Mayfair[1]	Mayfair SV	Moreton	Norwich	Parrot
Water availability	3	1	2	–	4	3	2	1
Nutrient deficiency	2	1	1	4	4	4	1	2
Soil physical factors	2	2	3	–	1	1	2	1
Salinity	2	2	3	–	1	1	3	1
Rockiness	1	1	1	–	1	1	1	1
Microrelief	1	1	1	–	1	1	1	1
pH	3	3	3	–	2	2	3	3
ESP (10cm) %	1	1	1	–	1	1	1	1
Wetness	1	1	2	–	2	2	2	2
Water erosion	1	1	1	–	1	2	1	2
Flooding	2	2	2	–	2	2	2	2
Vegetation regrowth	–	–	2	–	2	2	2	4
Overall land suitability class	3	3	3	4*	4*	4*	3	4*

Note: Green shading = suitable, red shading = unsuitable. Items displayed with an asterisk (*) are considered suitable based on current land use of low-intensity grazing.

[1] Suitability assessment conducted by NQSA (2012), primary limitation identified only.

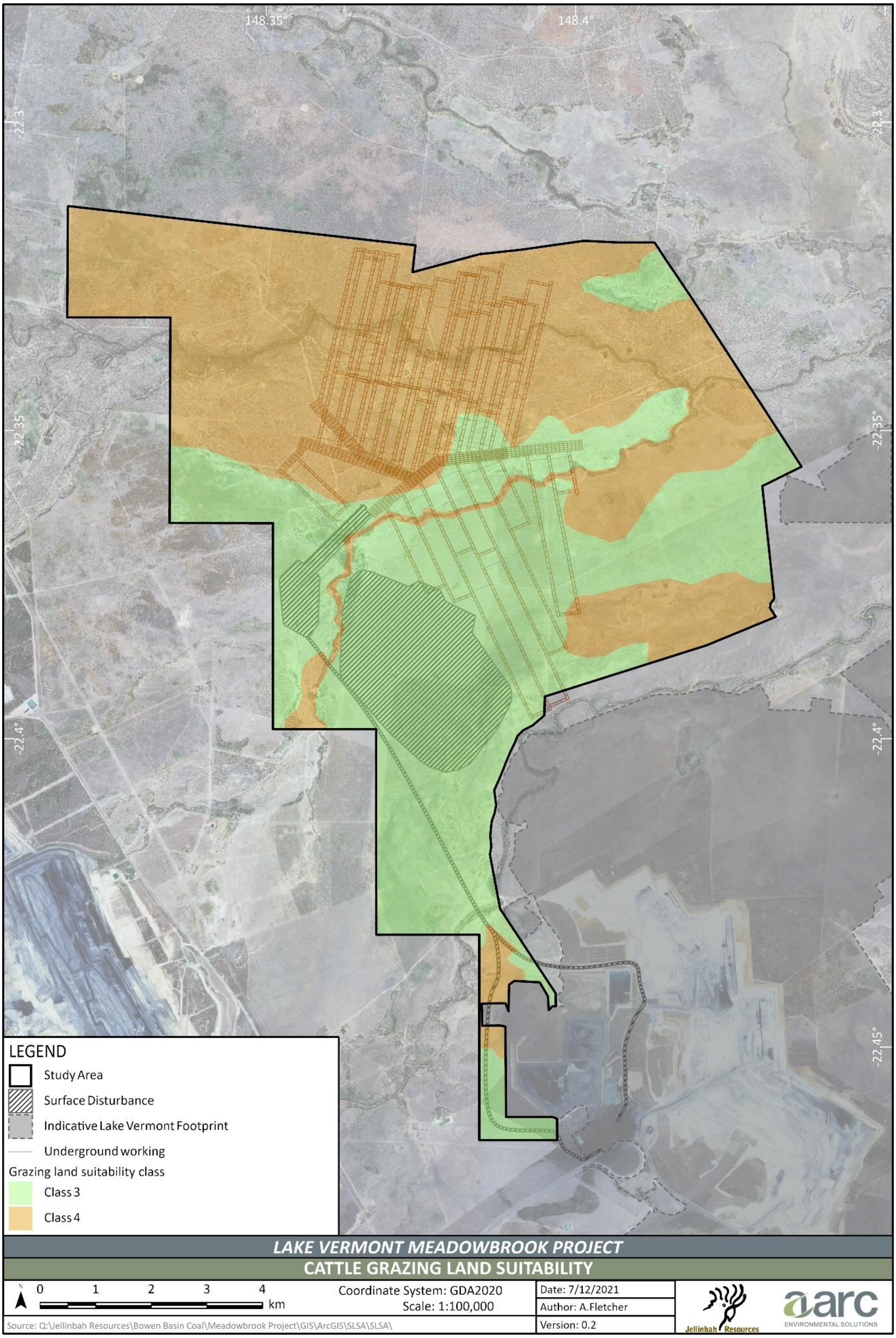


Figure 12: *Cattle grazing land suitability*

5.2 Rainfed broadacre cropping

Limitations for the assessment of land suitability for rainfed broadacre cropping as outlined in *the Land Suitability Assessment Techniques* (QDME 1995) guidelines (Table 2.1) are:

- water availability;
- nutrient deficiency;
- soil physical factors;
- soil workability;
- salinity;
- rockiness;
- microrelief;
- wetness;
- topography;
- water erosion; and
- flooding.

Numerous parameters outlined in this assessment require determination of the 'rootzone'. The rootzone is the depth to hard or weathered rock or the depth to a significant salt bulge within the soil profile. Where these limitations are not encountered within the sampling depth, a rootzone value of 0.6 m can be assumed as described in the guidelines (QDME 1995).

Class 1 and Class 2 land is considered suitable for rainfed broadacre cropping with negligible or minor limitations and limited management requirements to sustain this use. Class 3 land is considered suitable; however, it is likely to be less productive than land of Class 1 or 2. Class 4 land is categorised as marginally suitable for the proposed land use or would require significant inputs to ensure land use sustainability. Class 5 land is unsuitable having extreme limitations and cannot be sustainably used for the rainfed broadacre cropping.

Each of the limitations listed above is assessed below based on Table 2.1 of the guidelines (QDME 1995).

5.2.1 Water availability

The PAWC requirements for each of the land suitability classes are described in Table 2.3 of the 1995 guideline (QDME 1995) and are summarised 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 criteria are not based on a specific crop-type, but on rainfed broadacre cropping as a general land use. The soils are assessed on the depth to weathered rock, or other root inhibiting factors such as a salt bulge or significant sodicity. The availability of water in soils is vital for both plants and soil organisms as they require water to survive. Table 45 provides the outcomes of the land suitability class assessment based on plant available water capacity.

Table 45: Plant available water capacity suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	PAWC (mm)	Land suitability class
Knockane	Cracking clays with alkaline to neutral pH throughout and 60–90 cm depth to Cl > 600 ppm or ESP > 15%	100–125	3
Mayfair sodic variant	Rigid soils: Duplex soils with a sodic subsoil (ESP 6-14) within 60 cm of the surface becoming strongly sodic within 60 cm of the surface.	50–75	5
Moreton	Rigid soils: Sands and sandy loams > 90 cm deep	75–100	4
Norwich	Cracking clays with alkaline to neutral pH throughout and 60–90 cm depth to Cl > 600 ppm or ESP > 15%	100–125	3
Parrot	Rigid soils (non-sodic): duplex soils with > 125 cm to salt bulge with EC > 0.9 mS/cm or Cl > 900 ppm	125–150	2

5.2.2 Nutrient deficiency

The nutrient status of each SMU identified has been assessed and the results are presented in Table 46. Note that bicarbonate phosphorus was only analysed within the topsoil layer (0 – 10 cm). Soil nutrients are vital for plant growth and metabolism.

Table 46: Nutrient status suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Bicarbonate P > 10 ppm	1
Mayfair sodic variant	Bicarbonate P < 10 ppm and exchangeable K < 0.3 meq/100g and exchangeable Ca < 3 meq/100g	4
Moreton	Bicarbonate P < 10 ppm and exchangeable K < 0.3 meq/100g and exchangeable Ca < 3 meq/100g	4
Norwich	Bicarbonate P > 10 ppm	1
Parrot	Bicarbonate P > 10 ppm	1

5.2.3 Soil physical factors

Soil physical factors suitability class for each SMU were assessed with results presented in Table 47. The physical condition of soils plays a direct role in seed germination and emergence. Adverse conditions such as hard-setting or crusting of surface soils reduce plant establishment by creating a barrier, reducing seed-soil contact.

Table 47: Soil physical factors suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Cracking clays with coarse self-mulch (peds 10–20 mm)	3
Mayfair sodic variant	Rigid soils with a loose, soft or firm surface when dry	1
Moreton	Rigid soils with a loose, soft or firm surface when dry	1
Norwich	Cracking clays with fine self-mulch (peds 2–10 mm)	2
Parrot	Rigid soils with a loose, soft or firm surface when dry	1

5.2.4 Soil workability

Soil physical factors for each SMU identified were assessed with results presented in Table 48. The workability of soils refers to the capacity of the soil to support machinery during management practices such as tillage.

Table 48: Soil workability suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Firm cracking clays	2
Mayfair sodic variant	Rigid soils with a loose, soft or firm surface when dry	1
Moreton	Rigid soils with a loose, soft or firm surface when dry	1
Norwich	Stiff cracking clays	3
Parrot	Rigid soils with a loose, soft or firm surface when dry	1

5.2.5 Salinity

The land suitability class for each SMU based on salinity has been assessed with the results provided in Table 49. Given salinity can inhibit plant growth, the highest EC recorded is considered the most limiting factor and dictates the rating given to each SMU. Significant levels of salinity present in the rootzone can negatively impact plant growth and production.

Table 49: Salinity suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Rootzone EC 0.3–0.9 mS/cm	3
Mayfair sodic variant	Rootzone Cl < 300 ppm	1
Moreton	Rootzone Cl < 300 ppm	1
Norwich	Rootzone EC 0.3–0.9 mS/cm	3
Parrot	Rootzone Cl < 300 ppm	1

5.2.6 Rockiness

The land suitability for each SMU based on rockiness was assessed with results presented in Table 50. The impacts of rockiness are more extreme for cropping than for grazing. For cropping, rock outcrops reduce the area available to grow crops, as land cannot be easily traversed or worked.

Table 50: Rockiness suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	Land suitability class
Knockane	< 10 % coarse surface gravel (> 6 cm diam.) and rock outcrop	1
Mayfair sodic variant	< 10 % coarse surface gravel (> 6 cm diam.) and rock outcrop	1
Moreton	< 10 % coarse surface gravel (> 6 cm diam.) and rock outcrop	1
Norwich	< 10 % coarse surface gravel (> 6 cm diam.) and rock outcrop	1
Parrot	< 10 % coarse surface gravel (> 6 cm diam.) and rock outcrop	1

5.2.7 Microrelief

The microrelief for each SMU identified has been assessed with results presented in Table 51. Microrelief refers to local relief (up to several metres) around the plane of the land (National Committee on Soil and Terrain 2009). Impacts of microrelief on the suitability of land for rainfed broadacre cropping are only experienced when soil is severely melonholed. Ponding of water in the depressions can compromise growing conditions directly impacting on crop growth and yield.

Table 51: Microrelief suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Melonholes 30–60 cm deep cover < 20 % surface area	2
Mayfair sodic variant	No melonholes	1
Moreton	No melonholes	1
Norwich	Melonholes 30–60 cm deep cover 20–50% of surface area	3
Parrot	No melonholes	1

5.2.8 Wetness

The land suitability class identified for each SMU based on wetness has been assessed with results presented in Table 52. The wetness limitation refers to any excess water both in and on the soil profile. The adverse effects of excess water include reducing plant growth, impeding oxygen supply to plant roots (possibly leading to denitrification) and increased risk of plant disease.

Table 52: Wetness suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Low-lying level plains with melonholes covering	2
Mayfair sodic variant	Rigid soils with sodic subsoil (ESP 6–14) within 60 cm of the surface	2
Moreton	Non-sodic rigid soils	2
Norwich	Low-lying level plains with melonholes covering	2
Parrot	Non-sodic rigid soils with coarse pale grey and yellow mottles within 75 cm of the surface	2

5.2.9 Topography

The land suitability class identified for each SMU based on wetness has been assessed with results presented in Table 53. The topography limitation refers to the surface features of the land. Substantial variation in slope and elevation of an area can introduce limitations for cropping by reducing the area of land on which cropping is viable.

Table 53: Topography suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	Land suitability class
Knockane	No gully dissection	1
Mayfair sodic variant	No gully dissection	1
Moreton	No gully dissection	1
Norwich	No gully dissection	1
Parrot	No gully dissection	1

5.2.10 Water erosion

The land suitability class identified for each SMU based on water erosion has been assessed with the results presented in Table 54. Erosion of topsoil reduces the productivity of the land through the loss of key nutrients in the soil's upper horizons.

Table 54: Erosion suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Slopes < 1% on non-sodic melon hole clays	1
Mayfair sodic variant	Slopes < 1% on non-sodic rigid soils	1
Moreton	Slopes < 0.5% on sodic rigid soils	1
Norwich	Slopes < 1% on non-sodic rigid soils	1
Parrot	Slopes < 1% on non-sodic melon hole clays	1

5.2.11 Flooding

The land suitability class identified for each SMU based on flooding risk has been assessed with results presented in Table 55. Flooding may result in plant death or reduced growth. In severe cases where land is inundated for a prolonged period, crop failure may occur.

Table 55: Flooding suitability class for rainfed broadacre cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Rare flooding	2
Mayfair sodic variant	Rare flooding	2
Moreton	Rare flooding	2
Norwich	Rare flooding	2
Parrot	Rare flooding	2

5.2.12 Summary of land suitability for rainfed broadacre cropping

Table 56 provides a summary of the assessed land suitability limitations for rainfed broadacre cropping.

Table 56: Summary of land suitability limitations for rainfed broadacre cropping

Limitation	Booroondarra	Kirkcaldy	Knockane	Mayfair[1]	Mayfair SV	Moreton	Norwich	Parrot
Water availability	4	4	3	4	5	4	3	2
Nutrient deficiency	4	4	1	4	4	4	1	1
Soil physical factors	3	3	3	–	1	1	2	1
Soil workability	3	3	2	–	1	1	3	1
Salinity	3	3	3	–	1	1	3	1
Rockiness	1	1	1	–	1	1	1	1
Microrelief	1	1	2	–	1	1	3	1
Wetness	2	1	2	–	2	2	2	2
Topography	2	1	1	–	1	1	1	1
Water erosion	3	2	1	–	1	1	1	1
Flooding	3	2	2	–	2	2	2	3
Overall land suitability class	4	4	3	4	5	4	3	3[x]

Note: Green = suitable, red = unsuitable Items displayed with a superscript X are considered unsuitable based on its association with watercourses in the Project area.

[1] Suitability assessment conducted within NQSA (2012), primary limitations identified only.

In the Project area, the suitability of land for rainfed broadacre cropping is primarily limited by nutrient deficiency and water availability. Fertiliser application could overcome the nutrient deficiency limitation; however, costs are unlikely to warrant the undertaking.

While no Class 1 land was identified for the Project area, the examination of the land suitability limitations for cropping (section 5.2) indicates that 1,917 ha of the Project is suitable for rainfed broadacre cropping with minor limitations (Class 2). A further 3,917 ha is considered suitable with moderate limitations (Class 3). Marginal land which is unsuitable due to severe limitations (Class 4) occupies 1,600 ha of the study area and the remaining 1,248 ha is considered unsuitable with extreme limitations for rainfed broadacre cropping (Class 5).

The land suitability framework should only be used as a guide to determine potential land suitability and should be considered alongside both historical land use and other factors that may limit land suitability. The outcome of this land suitability indicates the Parrot SMU is suitable for rainfed broadacre cropping with moderate limitations however, we have rated this SMU as unsuitable for this use. The Parrot SMU is associated with watercourses within the Project area, and consequently would be inundated on an occasional basis. There is insufficient information to determine whether the rate of inundation would be defined as infrequent or occasional. Regardless, this aspect was considered a limitation, particularly given the lack of suitability for rainfed broadacre cropping of the adjacent SMUs. Parrot SMU was therefore deemed to be not considered suitable for cropping and was not further assessed under the regional specific assessment framework in section 5.3.

The suitability for cropping of the study area is assessed under regionally specific framework in section 5.3.

5.3 Regional frameworks land suitability assessment

The *Regional Land Suitability Frameworks for Queensland* (DSITIA and DNRM 2013) outlines procedures for region specific agricultural land suitability assessments. The Project lies within the Inland Fitzroy and Southern Burdekin area and land deemed suitable for cropping under the *Land Suitability Assessment Technique* (QDME 1995) is a candidate for further assessment of cropping suitability according to Chapter 10 of the *Regional Land Suitability Frameworks for Queensland* (DSITIA and DNRM 2013).

The land suitability assessment detailed in sections 5.1 and 5.2 has determined the overall land suitability of each SMU under the QDME (1995) guideline. From this assessment, all SMUs were considered suitable for beef cattle grazing and the Norwich and Knockane SMUs were considered suitable for use as cropping land (with limitations). Assessment of suitability for dryland cropping under the regionally specific framework guideline (DSITIA and DNRM 2013) was conducted for Norwich and Knockane SMU.

5.4 Dryland cropping

The Project lies within the Inland Fitzroy and Southern Burdekin area. Limitations for the assessment of dryland cropping suitability specific to the Project region include:

- water erosion
- erosion hazard, subsoil erodibility
- soil water availability
- wetness
- surface conditions
- rockiness
- microrelief
- wetness

Several of these limitations contain subclasses based on the crop specific management practices. This suitability assessment will present findings based on the lowest land suitability rating returned across all of the suitability subclasses.

Assessment of the Norwich and Knockane SMUs suitability for dryland cropping has been conducted per the methodology described within the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM 2015) and the *Regional Land Suitability Frameworks for Queensland*, Chapter 10 (DSITIA and DNRM 2013). The suitability framework for the Inland Fitzroy and Southern Burdekin area focuses on assessing the potential for cultivating the following 12 specific crops:

- barley
- chickpea
- maize
- millet
- mungbean
- oats
- safflower
- sorghum
- soybean
- sunflower
- triticale; and
- wheat

The rootzone is defined as the depth to hard or weathered rock or the depth to a significant salt bulge within the soil profile. For the assessed SMUs weathered rock or salt bulges were absent and a rootzone depth of 0.6 m was used as per the guidelines (QDME 1995).

5.4.1 Water erosion

The land suitability class for water erosion was determined using the *Regional Land Suitability Frameworks for Queensland*, Chapter 10, Table E, and is presented in Table 57. Dispersive properties were allocated based on Emerson Class Number and sodicity.

Table 57: Water erosion suitability classes for dryland cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Slopes 0–0.5% with dispersive soil in the surface 200 mm	3
Norwich	Slopes 0–0.5% with dispersive soil in the surface 200 mm	3

5.4.2 Erosion hazard, subsoil erodibility

The land suitability class for erosion hazard and subsoil erodibility was determined using the *Regional Land Suitability Frameworks for Queensland*, Chapter 10, Table Es, and is presented in Table 58.

Table 58: Erosion hazard and subsoil erodibility suitability classes for dryland cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Slopes 0–0.5% with strongly dispersive subsoil (200–1000 mm) and a clay content greater than 20%	2
Norwich	Slopes 0–0.5% with strongly dispersive subsoil (200–1000 mm) and a clay content greater than 20%	2

5.4.3 Soil water availability

The land suitability class for soil water availability was determined using the *Regional Land Suitability Frameworks for Queensland*, Chapter 10, Table M, and is presented in Table 59. PAWC values were determined from Table 2.3 of the Technical Guidelines for the *Environmental Management of Exploration and Mining in Queensland–Land Suitability Assessment Techniques* (QDME 1995).

Table 59: Soil water availability suitability classes for dryland cropping

Soil management unit	PAWC (mm)	Land suitability class (Group A)	Land suitability class (Group B)	Land suitability class (Group C)
Knockane	100–125	3	3	4
Norwich	100–125	3	3	4

5.4.4 Narrow moisture range

The land suitability class for narrow moisture range was determined using the *Regional Land Suitability Frameworks for Queensland*, Chapter 10, Table Pm, and is presented in Table 60. The narrow moisture range of soil plays a role in determining the soil's capacity for cultivation within the restraints of machinery.

Table 60: Narrow moisture range suitability classes for dryland cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Narrow moisture range for cultivation—imperfectly drained to moderately well-drained; hard-setting, firm or weakly self-mulching when dry and not 'spewy' when wet. Hard-setting, firm or weakly self-mulching, pedal clays	3
Norwich	Narrow moisture range for cultivation—imperfectly drained to moderately well-drained; hard-setting, firm or weakly self-mulching when dry and not 'spewy' when wet. Hard-setting, firm or weakly self-mulching, pedal clays	3

5.4.5 Surface condition

The land suitability class for surface condition was determined using the *Regional Land Suitability Frameworks for Queensland*, Chapter 10, Table Ps, and is presented in Table 61. The physical condition of soils plays a direct role in seed germination and emergence. Adverse conditions such as hard-setting, or surface crusting soils impedes plant establishment by creating a barrier between seed-soil contact.

Table 61: Surface condition suitability classes for dryland cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Clay soils with hard-setting, firm pedal, or weakly self-mulching surface horizons	2
Norwich	Coarse self-mulching clays (peds greater than 5–10 mm); poor seed-soil contact due to separation of large peds with drying	2

5.4.6 Rockiness

The land suitability class for rockiness was determined using the *Regional Land Suitability Frameworks for Queensland*, Chapter 10, Table R, and is presented in Table 62. Rocky outcrops and soils containing coarse fragments hinder the cultivation of crops and may damage harvesting machinery.

Table 62: Rockiness suitability classes for dryland cropping

Soil management unit	Limiting features	Land suitability class (Group A)	Land suitability class (Group B)
Knockane	Gravels less than 20 mm and abundance less than 10%	1	1
Norwich	Gravels less than 20 mm and abundance less than 10%	1	1

5.4.7 Microrelief

The land suitability class for microrelief was determined using the *Regional Land Suitability Frameworks for Queensland*, Chapter 10, Table Tm and is presented in Table 63. Suitability classes for microrelief are based on the degree to which land needs to be levelled for dryland cropping.

Table 63: Microrelief suitability classes for dryland cropping

Soil management unit	Limiting features	Land suitability class
Knockane	Very weakly developed microrelief depression (VI less than 0.1m) that occurs across much (30–70%) of the land surface	2
Norwich	Normal, lattice or linear gilgai (depression VI 0.1–0.3m) that occurs across much (30–70%) of the land surface	2

5.4.8 Wetness

The land suitability class identified for each Soil Management Unit based on wetness was determined using the *Regional Land Suitability Frameworks for Queensland*, Chapter 10, Table W, and is presented in Table 64. Soil with poor permeability and drainage are less suitable for crop growth.

Table 64: Wetness suitability class for dryland cropping

Soil management unit	Limiting features	Land suitability class (Group A)	Land suitability class (Group B)	Land suitability class (Group C)
Knockane	Imperfectly drained and moderately permeable	3	3	3
Norwich	Poorly drained	4	4	4

5.4.9 Summary of land suitability for dryland cropping

Land suitability for dryland cropping is mostly limited by soil water availability and soil wetness. Crops require suitable quantities of water to reach optimum production. Poor water availability can induce water stress in plants and prevents the mobilisation of soluble nutrients. Conversely, soil wetness can also constrain plant growth if the soil profile is unable to effectively drain water during heavy rainfall events. This can result in periodic anaerobic conditions within the soil profile which will compromise growing conditions.

The assessment was conducted on SMUs Knockane and Norwich which were identified by the QDME (1995) guideline as suitable for rainfed broadacre cropping. A summary of the limitations to dry land cropping suitability for the two assessed SMUs is presented in Table 65. The Knockane SMU (2,908 ha) and the Norwich SMU (1,009 ha) were assessed to be marginally suitable for cropping (Class 4), due to land and soil limitations. This assessment determined that the SMUs identified as suitable for cropping under the QDME (1995) guideline are not suitable according to the region specific framework guideline (DSITIA and DNRM 2013). Consequently, there is no suitable cropping land within the study area.

Table 65: Summary of land suitability limitations for dryland cropping

Limitation		Knockane	Norwich
Water erosion		3	3
Erosion hazard, subsoil erodibility		2	2
Soil water availability	A	3	3
	B	3	3
	C	4	4
Narrow moisture range		3	3
Surface condition		3	3
Rockiness	A	1	1
	B	1	1
Microrelief		2	2
Wetness	A	3	4
	B	3	4
	C	3	4
Overall suitability rating		4	4

Note: red shading = unsuitable

6 Agricultural Land Class Assessment

Agricultural land class classification follows a hierarchical scheme to identify land that can be used sustainably for a particular land use with minimal land degradation. The land classes are defined by the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM 2015). There are three broad classes of agricultural land; Class A, Class B and Class C with one non-agricultural land class (Class D). Descriptions of agricultural land classes are provided in Table 66 below.

Table 66: Description of agricultural land classes

Class	Description
A	Land that is suitable for a wide range of current and potential crops with nil to moderate limitations to production
A1	Suitable for a wide range of current and potential broadacre and horticultural crops
A2	Suitable for a wide range of current and potential horticulture crops only
B	Limited crop land that is suitable for a narrow range of crops. The land is suitable for sown pastures and may be suitable for a wider range of crops with changes to knowledge, economics, or technology.
C	Pastureland—land that is suitable only for improved or native pastures due to limitations that preclude continuous cultivation for crop production. Some areas may tolerate a short period of ground disturbance for pasture establishment
C1	Suitable for grazing sown pastures requiring ground disturbance for establishment; or native pastures on higher fertility soils
C2	Suitable for grazing native pastures, with or without the introduction of pasture species, and with lower fertility soils than C1
C3	Suitable for light grazing of native pastures in accessible areas, and includes steep land more suited to forestry or catchment protection
D	Land not suitable for agricultural use, including land alienated from agricultural use
A/C A/D B/C C/D	Land that is a complex of class A, B, C or D land where it is not possible to delineate the land class at the map scale. The dominant class is the first code in the sequence and is assumed to be > 50% of the area, but < 70%

Source: Guidelines for Agricultural Land Evaluation in Queensland (DSITI and DNRM 2015)

6.1 Agricultural land class assessment

Agricultural land class was determined using the outcome of the land suitability assessment and SMU descriptions. The determined agricultural land class of the study area SMUs is presented in Table 67.

Table 67: Agricultural land class assessment summary

SMU	Agricultural land class	Area (ha)
Booroondarra	C2	144
Kirkcaldy	C2	70
Knockane	C1	2908
Mayfair	C3	93
Mayfair SV	C3	1248
Moreton	C2	1293
Norwich	C1	1009
Parrot	C3	1917

7 Regional Planning Interests Assessment

The *Regional Planning Interests Act 2014 (Qld)* (RPI Act) aims to identify areas of Queensland that are of regional interest because they contribute, or are likely to contribute, to Queensland's economic, social and environmental prosperity. The RPI Act also aims to give effect to the policies about matters of state interest identified in regional plans; and to effectively manage the impact of resource activities on areas of regional interest.

Areas of regional interest that the RPI Act aims to protect are classified as:

- living areas in regional communities (Priority Living Areas);
- high-quality agricultural areas (Priority Agricultural Areas);
- regionally important environmental areas (Strategic Environmental Areas); and
- strategic cropping areas.

Detailed descriptions of what constitutes each type of area of regional interest are provided in sections 8 to 11 of the RPI Act as well as the Regional Planning Interests Regulation 2014 (RPI Regulation). The RPI Act and RPI Regulation seek to strike an appropriate balance between protecting priority land uses and delivering a diverse and prosperous economic future in Queensland.

7.1 Assessment of priority living areas

Identification of PLAs was conducted using regional interest mapping published by the Queensland government. No PLA is located within the study area. The nearest PLA is the town of Tieri located 60 km south of the Project site.

7.2 Assessment of priority agricultural areas

Identification of PAAs was conducted using regional interest mapping published by the Queensland government. No PAA is located within the study area. The nearest PAA located 100 km south.

7.3 Assessment of strategic environmental areas

Identification of SEAs was conducted using regional interest mapping published by the Queensland government. No SEA is located within the study area. The nearest SEA is the Channel Country SEA located 330 km west of the Project.

7.4 Assessment of strategic cropping areas

The strategic cropping land (SCL) trigger map identifies 6 ha of likely strategic cropping land within the Project area. This land is located within the south-eastern corner of ML70477 and had been previously assessed and surveyed in the SLSA for the 2012 Western Extension of Lake Vermont (NQSA 2012).

The eight criteria for Division 1 Western Cropping Zone used to assess the 6 ha of land identified as a strategic cropping area are as follows:

- Criterion 1: Slope is 3% or less.
- Criterion 2: Rockiness is 20% or less.
- Criterion 3: The average density of gilgai microrelief with depressions of more than 500 mm is less than 50% of the land surface.

- Criterion 4: Soil depth is 600 mm or more.
- Criterion 5: The land has favourable drainage.
- Criterion 6: Soil pH at 300 mm depth and 600mm depth is as follows:
  - for rigid soils—5.1 or more to 8.9;
  - for non-rigid soils—more than 5.0.
- Criterion 7: Soil at 600 mm depth or shallower has a chloride content of less than 800mg/kg.
- Criterion 8: The land's soil water storage is 100 mm or more.

The NQSA (2012) assessment determined that a portion of the likely SCL within the Project area failed the slope criteria. Spatial analysis using a digital elevation model identified an area of 3 ha with a slope greater than 3% (NQSA 2012). The other assessment criteria were not assessed based on the failure of the first criterion. The remaining 3 ha of potential SCL within the Project area met the slope criteria but was discontinuous (trisected into three areas).

The 2012 assessment further determined that the remaining 3 ha, while meeting the SCL criteria, failed soil map unit aggregation rules due to its small size and inability to amalgamate into a larger 100 ha SCL area, as permitted by the original 2011 *Guidelines for applying the proposed strategic cropping land criteria* (DERM 2011). The adjoining land parcel with mapped likely SCL is subject to slope constraints, nor was there evidence of prior cropping being conducted on the mapped SCL within either the Project area or neighbouring mapped SCL. It was therefore concluded that the area should be regarded as non-SCL.

The 2012 assessment did not result in an SCL validation application despite identifying that the area was unlikely to meet SCL criteria; therefore the area currently remains mapped as potential SCL. If the Project results in disturbance that will have a permanent impact on the mapped SCL, an application for a Regional Interest Development Approval (RIDA) will be required before or after applying for an EA for the Project, unless a SCL validation application is made prior.

8 Acid Sulphate Soil Assessment

8.1 Desktop assessment of acid sulphate soils

The study area was reviewed using the Atlas of Australian Acid Sulphate Soils (Fitzpatrick *et al.* 2013). The study area was within low probability and extremely low probability of ASS soil occurrence. The study area was also assessed against the Isaac Regional Council planning scheme (Isaac Regional Council 2021) Acid Sulfate Soils Overlay Map. The study area determined to be outside the ASS trigger area.

8.2 Field assessment of acid sulphate soils

Field observations across all SMUs were conducted for indicators of actual acid sulphate soils (AASS) which include: soil pH values less than 4; jarosite or reddish orange iron mineral staining or sulphurous odour (WQA 2018). Indicators of potential acid sulphate soils (PASS) including waterlogging and sulphurous odours were also recorded. A summary of the AASS and PASS assessment is presented in Table 68.

Table 68: Field AASS and PASS assessment

SMU	Field indicators	AASS assessment	PASS indication
Booroondarra	Neutral to very strongly alkaline pH, no observed mottling, no sulphurous odour, no water logging	No indication	No indication
Kirkcaldy	Moderately alkaline to very strongly alkaline pH, no observed mottling, no sulphurous odour, no water logging	No indication	No indication
Knockane	Slightly alkaline to strongly alkaline pH, low abundance mottling, no sulphurous odour, no water logging	No indication	Very low indication
Mayfair	Moderately alkaline to slightly alkaline pH, no observed mottling, no sulphurous odour, no water logging	No indication	No indication
Mayfair SV	Slightly acid to slightly alkaline pH, low abundance mottling, no sulphurous odour, no water logging	No indication	Very low indication
Moreton	Slightly acid to neutral pH, low abundance mottling, no sulphurous odour, no water logging	No indication	Very low indication
Norwich	Slightly acid to moderately alkaline pH, some mottling, no sulphurous odour, no water logging	No indication	Very low indication
Parrot	Slightly alkaline to moderately alkaline pH, low abundance mottling, no sulphurous odour, no water logging	No indication	Very low indication

No Indication of AASS was observed within the study area. Some very low indicators of PASS were recorded in the study area. It is recommended though that field assessments are occasionally undertaken in association with soil disturbance activities in those SMUs providing a PASS indication.

9 Topsoil Management for Localised Disturbance Area

Site clearing within the proposed footprint for infrastructure development and the open-cut pit will generate stripped topsoil and subsoil which can be used in rehabilitation works. An assessment of SMUs was conducted to determine recommended stripping depths and use for stripped material. Soil stripping, stockpiling and placement should be carried under a ground disturbance permit or similar system and in accordance with a topsoil management plan. The topsoil management plan will describe recommended maximum stripping depths, topsoil volumes required for rehabilitation purposes, and describe the placement and management of stripped soil.

9.1 Study area soil stripping recommendations

The study area SMUs have been assessed for limitations to reuse as topsoil in rehabilitation work. The recommended stripping depths for rehabilitation uses are provided in Table 69.

Table 69: Recommended topsoil stripping depths

SMU	Topsoil recommended rehabilitation use	Topsoil stripping depth (m)	Subsoil recommended rehabilitation use	Subsoil stripping depth
Booroondarra	Suitable for use as seed surface material or root zone material	0.0–0.3	Unsuitable—dispersive, saline and strongly alkaline	0.0
Kirkcaldy	Suitable for use as seed surface material or root zone material	0.0–0.3	Suitable for use as root zone material. Material below 0.5 m has alkalinity, salinity, and dispersive limitations	0.3–0.5
Knockane	Suitable for use as seed surface material or root zone material	0.0–0.2	Unsuitable—dispersive, strongly alkaline and saline	0.0
Mayfair	Suitable for use as seed surface material or root zone material	0.0–0.25	Suitable for use as root zone material to the depth sampled	0.25–0.9
Mayfair sodic variant	Suitable for use as seed surface material or root zone material	0.0–0.2	Unsuitable—dispersive limitations	0.0
Moreton	Suitable for use as seed surface material or root zone material	0.0–0.5	Suitable for use as root zone material to the depth sampled	0.5–0.8
Norwich	Suitable for use as seed surface material or root zone material	0.0–0.2	Unsuitable—alkalinity and dispersive limitations	0.0
Parrot	Suitable for use as seed surface material or root zone material	0.0–0.6	Suitable for use as root zone material to the depth sampled	0.6–0.8

Additional management practice recommendations for the stripping, stockpiling and spreading of soils include:

- soil stripped for reuse should be revegetated as soon as practicable;
- where practicable, topsoil should be directly placed in prepared rehabilitation areas rather than stockpiled;

- soil stockpiles should be less than 2 m high;
- groundcover vegetation should be established on stockpiles to prevent erosion and maintain soil biological function while stockpiled;
- stockpiles are to be monitored for weeds and control measures implemented as appropriate;
- topsoil placement should occur at a minimum thickness of 0.2 m to establish a growth medium conducive to plant growth;
- knowledge of potentially dispersive SMUs should be incorporated into appropriate erosion and sediment control methods;
- gypsum treatment should be used to reduce dispersion where practicable;
- stripped topsoils from SMUs with alkaline pH (Booroondarra, Kirkcaldy, Knockane, Mayfair, Norwich and Parrot) are likely to require fertiliser application to compensate for low pH available nitrogen deficiency;
- SMUs with weak structures such as sands, loamy sands or massive structured soils (Booroondarra, Mayfair, Mayfair sodic variant, Moreton, and Parrot) may pose an erosion risk if material is placed in steeper areas and these materials should preferentially be placed in less steep areas to reduce erosion risk;
- grass and woody vegetation collected from land clearing should be incorporated into the rehabilitation measures at strategic locations to help limit runoff and erosion, retain active biological activity, and provide fauna habitat; and
- topsoils applied to rehabilitation areas should be contour ripped where erosion risk and hard-setting surfaces may impede revegetation success.

9.2 Available stripping volumes

The total estimated available soil reserves useful for rehabilitation purposes are presented in Table 70. Estimates have been based on maximum area of surface development including the open-cut pit, infrastructure corridor and the mine infrastructure area (MIA).

Table 70: Soil reserves available from topsoil stripping of disturbance areas

SMU	Recommended topsoil stripping depth	Recommended subsoil stripping depth	Area likely to be disturbed under open-cut pit and waste rock structures (ha)	Area likely to be disturbed under MIA and infrastructure (ha)	Total topsoil volume available m^3	Total subsoil volume available m^3
Booroondarra	0.0–0.3	0.0	–	5.3	15,900	0
Kirkcaldy	0.0–0.3	0.3–0.5	–	–	0	0
Knockane	0.0–0.2	0.0	528.2	132.2	1,981,200	0
Mayfair	0.0–0.25	0.25–0.9	–	10.6	26,500	68,900
Mayfair sodic variant	0.0–0.2	0.0	–	–	0	0
Moreton	0.0–0.5	0.5–0.	–	0.9	4,500	2,700
Norwich	0.0–0.2	0.0	156.5	7.2	327,400	0
Total			**843**		**2,369,900**	**76,400**

10 Potential Impacts

10.1 Surface activities impacts

The Project has the potential to impact soils and land suitability through the direct surface disturbance required for construction and operation. The potential impacts are:

- change to land use suitability from direct disturbance;
- soil impacts resulting from disturbance and topsoil stripping practices; and
- impacts to SCL.

10.1.1 Direct disturbance impact

The Project surface activities will cause direct disturbance that will cause impacts to land suitability and future land use. Surface activities will occur over approximately 843 ha in the following areas:

- infrastructure corridor area;
- mine infrastructure area;
- open-cut pit; and
- waste rock emplacements.

These areas will require rehabilitation measures to prevent impacts derived from direct disturbances. The potential impacts to post mine land use suitability of these areas are discussed in section 10.3. The land use suitability of the remainder of the Project area will be unaffected, or experience impacts from subsidence resulting from underground mining, and is assessed in section 10.2.

10.1.2 Topsoil and subsoil stripping impacts

Topsoil stripping and management of stripped topsoil may impact the soils or land suitability of the Project. Impacts may occur from stripping soils to incorrect depths, mixing of suitable topsoil with unsuitable soils in stockpiles, erosion of topsoil stockpiles caused by incorrect storage practices and incorrect placement of stripped topsoils in rehabilitation areas.

10.1.3 Strategic cropping area impact

The SCL assessment identified an area of mapped SCL in the southeast corner of ML70477. The proposed infrastructure corridor will intersect with this area. Further consultation and approvals will be required to undertake construction of the infrastructure corridor in the mapped SCL area.

10.2 Subsidence impacts

The Project is primarily an underground mining operation and subsidence will result from the underground operations in the study area. The subsidence footprint will occupy the area above the longwall panel mining area. Subsidence is expected to be a maximum of 5 m in the northern two-seam underground mining area, and 2.9 m in the southern single seam mined area (Gordon Geotechniques 2021). Subsidence and its mitigation will impact land through changes to erosion, surface cracking and alteration of overland flow. Mitigation works to surface drainage will likely be conducted in affected areas. The SMUs present above the underground mining footprint and within the modelled subsidence zones (Gordon Geotechniques 2021) include the Knockane, Mayfair sodic variant, Moreton, Norwich, and Parrot SMUs. Land impacts and the consequences of subsidence to future land use are discussed in sections 10.2.1 to 10.2.3.

10.2.1 Erosion

Changes to surface topography will occur as a result of subsidence and slopes will form between ridges above chain pillars and subsidence troughs above goaf areas. The maximum slope predicted as a result of subsidence is 3.8% while the majority of slopes resulting will be less than approximately 2% (Gordon Geotechniques 2021). Erosion risk will increase in areas of increased slope and SMUs with weak structures such as sands, loamy sands or massive structured soils will be susceptible to erosion of material down slopes between ridges and troughs. SMUs with weak structures particularly susceptible to this erosion include:

- Mayfair sodic variant;
- Moreton; and
- Parrot.

Where erosive processes occur due to a change in topography resulting from subsidence, soils with dispersive properties will be at risk of erosion. SMUs with dispersive properties, particularly in the subsoils include:

- Knockane;
- Mayfair sodic variant; and
- Norwich.

These SMUs will be more prone to rill and gully erosion where subsoils are exposed. Monitoring of subsidence impacts within the areas of these SMUs should be cognisant of the risks posed by exposed subsoils with dispersive properties.

10.2.2 Surface cracking

10.2.2.1 Tension cracking

Subsidence of the ground surface will create areas of tensile strain around the perimeter of the subsidence troughs. Surface cracking may develop where tensile strains occur, with the extent of cracking dependant on the tensile forces generated by subsidence movement.

The severity of surface cracking will be controlled by the properties of the soil. Heavy cracking clay soils are resilient to underground mine-induced surface cracking; the non-rigid soils being capable of self-mulching over cracks which develop. These soils are unlikely to exhibit any surface cracking beyond three wetting and drying cycles (Lechner *et al*. 2016). The SMUs with these properties in the subsidence area are Knockane and Norwich.

Weakly structured soils such as sandy or sandy loam textured soils will retain surface cracks longer than cracking clay soils (Lechner *et al*. 2016). The SMUs with these properties in the subsidence area are the Mayfair sodic variant, Moreton, and Parrot. Surface cracking can potentially expose subsoils with dispersive properties to accelerated erosive processes. Subsidence monitoring in the Mayfair sodic variant SMU should be cognisant of surface cracking potential due to its dispersive subsoil properties.

Tensile strain leading to surface cracks can be transient above the retreating longwall front. A portion of surface cracking created above the retreating longwall will likely resolve within days as tensile strains transfer along the surface.

10.2.2.2 Connective cracking to the surface

Continuous connective cracking from the mined seams to the surface is not anticipated (Gordon Geotechniques 2021).

10.2.3 Alteration of overland flow

Surface subsidence is likely to result in changes to overland flow paths. Areas that undergo subsidence and become steeper may be subjected to increased erosive pressures, while areas becoming less steep may experience less erosive pressures or ponding. The greatest changes to slope will occur at the perimeter of subsided areas. Areas of water ponding are predicted to occur within the surface subsidence footprint areas in all SMUs. Ponded areas are likely to undergo changes to soil characteristics and vegetation and, in some instances transition to function as ephemeral wetlands, some of which are already present within the study area.

Mitigation works are expected to be proposed to reduce surface ponding and redirect flows of surface water into surface water drainage features. The design of flow mitigation works is expected to include drainage channels between ponded areas and subsided areas of stream beds. The construction of any drainage channels should consider any dispersive properties of soils that will be exposed.

10.3 Post mine land use suitability

The development of the Project will disturb land through both the construction and operational phases. Following completion of mining and rehabilitation, changes to landform and land use suitability will have occurred. Pre-mining land use suitability was assessed in section 5 and a summary of the assessment results is presented in Table 71. The rehabilitation strategies likely to be taken and qualitative assessment of impact to land use suitability are presented in Table 72.

Table 71: Pre-mining land use suitability

SMU	Land suitability class (grazing)	Land suitability class (dryland cropping)	Surface area (ha)
Booroondarra	3	Unsuitable^	144
Kirkcaldy	3	Unsuitable^	70
Knockane	3	4	2908
Mayfair	4*	Unsuitable^	93
Mayfair sodic variant	4*	Unsuitable^	1248
Moreton	4*	Unsuitable^	1293
Norwich	3	4	1009
Parrot	4*	Unsuitable^	1917
Total area			**8681**

Note: Green = suitable, red = unsuitable. Items displayed with an asterisk [*] considered suitable based on current land use of low-intensity grazing. [^] Assessed to be unsuitable according to QDME (1995) and therefore not assessed under regionally specific framework guideline.

Table 72: Expected rehabilitation measures and likely post mining land use outcomes

Disturbance area	Anticipated rehabilitation approach	Post-mining additional limitation to land suitability class	
		Grazing guideline (QDME 1995)	**Dryland cropping guideline (DSITIA and DNRM 2013)**
Subsidence affected underground mining footprint area	The final landform will be designed in consideration of appropriate drainage mitigations to minimise ponding. Some subsided areas will be subjected to intermittent ponding, functioning as ephemeral wetlands.	Areas unaffected by ponding limited to class 2 (water erosion limitation) Ponding affected areas limited to class 3 (wetness limitation)	Areas unaffected by ponding limited to class 5 (water erosion limitation) Ponding affected areas limited to class 5 (wetness limitation)
Open-cut pit void	The open-cut pit will be partially backfilled, leaving a depression subject to intermittent periods of ponding. Final landform design will mitigate risk of inundation of the depression from floods not exceeding the 0.1% AEP flood event. The area will undergo surface preparation and revegetation with pasture species.	Limited to class 5 (wetness limitation)	Limited to class 5 (wetness limitation)
Waste rock emplacements	Material from the out-of-pit waste rock emplacements will be used to partially backfill the remaining pit, removing the eastern waste rock emplacement, and reducing the residual footprint of the western waste rock emplacement. Rehabilitated slopes will not exceed 8.1° (14.5%), and have drainage channels to direct concentrated runoff and minimise potential for erosion. The area will undergo surface preparation and revegetation with pasture species.	Areas of up to 10% slope limited to class 3 (water erosion limitation) Areas greater than 10% slope limited to class 4 (water erosion limitation)	Areas of greater than 8% slope limited to class 5 (water erosion limitation), other areas limited to class 2–5 (water erosion limitation)
Mine infrastructure area	Infrastructure will be decommissioned except where subject to a landholder agreement. A contaminated land site investigation will be undertaken, and remediation activities undertaken if required. The MIA dam will be retained as a stock watering dam. Areas not containing retained infrastructure will undergo surface preparation and revegetation with pasture species.	Same classes as pre-mining	Same classes as pre-mining
Infrastructure corridor	The haul road, including the causeways across Phillips Creek and One Mile Creek, and access roads will be retained. Areas not containing retained infrastructure will undergo surface preparation and revegetation with pasture species.	Same classes as pre-mining	Same classes as pre-mining

The pre-mining land use assessment determined that grazing suitability classes ranged between Class 3 (suitable land with moderate limitations) and Class 4 (marginal land considered unsuitable due to severe limitations). The current land use of grazing indicated the entire study area was sufficiently suitable for grazing. Post mining land use is considered to retain grazing suitability except for the following areas:

- the open-cut void highwall areas which will be unsuitable for grazing;
- areas of the waste rock emplacements that exceed 10% slope and develop water erosion limitations that result in Class 4 grazing suitability; and
- the footprint of the mine infrastructure area, which may be subject to characteristics that limit plant growth (i.e. soil compaction and strongly alkaline subsoils), resulting in Class 4 grazing suitability.

The pre-mining land use assessment determined that the cropping suitability classes of Class 4 (marginal land considered unsuitable due to severe limitations) occur within the Project area. Post mining land use is considered to potentially fall to Class 5 in the subsidence affected areas, open-cut pit void and waste rock emplacements. No suitable cropping land was identified in the pre-mining assessment, and none will be created following rehabilitation works.

11 Mitigation Measures and Recommendations

The proposed Project will impact the landform of the study area. However, rehabilitation measures will enable the majority of the Project area to achieve a land use suitability equivalent to the pre-mining conditions. The following mitigation measures are recommended to minimise potential impacts to soils and land suitability.

11.1 Surface disturbance impact mitigation

11.1.1 Surface disturbance and topsoil stripping impact mitigation measures

A ground disturbance permit system is recommended to manage land disturbance from the Project. The ground disturbance permit system should include the following management aspects:

- the location of surface disturbance activities and confirmation that activities are within the approved footprint;
- the presence of existing services and risk of disruption to existing services;
- communication chains between involved parties and consultation process; and
- identification of environmentally sensitive areas and appropriate and relevant measures to be taken.

Topsoil management should include the following management aspects:

- clearing of vegetation in advance of topsoil stripping;
- an inventory of topsoil stockpiles including details of storage and erosion control measures; and
- topsoil placement operational management.

.

11.1.2 Strategic crop land

Prior to determining the requirements for managing SCL, a validation approval should be sought in accordance with the RPI Act Statutory Guideline 08/14 (Queensland Government 2017) to change the mapping status of SCL within the Project footprint.

11.1.3 Acid sulphate soils mitigation measures

As outlined at section 8, no Indication of AASS was observed within the study area while some very low indicators of PASS were recorded. It is recommended though that field assessments are occasionally undertaken in association with soil disturbance activities in those SMUs providing a PASS indication. The following indicators should be used to trigger further investigation:

- waterlogged soils,
- sulphurous smell or hydrogen sulphide gas smell;
- oily bacterial scum on associated waters;
- observation of jarositic horizons or iron oxide mottling; and
- presence of corroded mollusc shells.

Where these indicators are observed, field soil pH should be determined. If field pH is less than 4.5, further investigation should be conducted in accordance with WQA (2018) and the situation assessed according to *Queensland Acid Sulphate Soils Technical Manual: Soil Management Guidelines* (2014).

11.2 Underground mining impact mitigation

Soil and land suitability will be impacted by subsidence from underground mining activities. A subsidence management plan (SMP) should be developed and implemented outlining the subsidence impact mitigation measures and corresponding implementation strategies to be used. The SMP should address areas expected to be affected by underground subsidence and provide measures that address:

- Subsidence impact to surface drainage systems, in particular:
  - areas susceptible to erosion such as watercourse confluences;
  - incision processes;
  - stream widening;
  - tension cracking;
  - lowering of bed and banks and consequent increased overbank flows;
  - creation of in-stream waterholes; and
  - changes to local catchment drainage patterns.
- Subsidence impacts to other areas, in particular:
  - alteration of overland flow patterns;
  - ponding by subsided longwall panels;
  - changes to local catchments;
  - erosion impacts from localised slope steepening;
  - management and rehabilitation of surface cracking; and
  - overall land condition and land use suitability.

The SMP should be developed and implemented in conjunction with a rehabilitation management plan. The SMP should specify a monitoring program as well as indicate linkages to information from other environmental monitoring programs that is relevant n to assess subsidence impacts. The monitoring types to be addressed include:

- landform monitoring (erosion and watercourse state);
- surface water quality monitoring;
- groundwater quality monitoring;
- ecology monitoring; and
- infrastructure monitoring.

The SMP should specify reporting requirements to document the progress of subsidence monitoring and mitigation of impacts, and should address:

- mining progress and activities;
- relevant monitoring results;
- mitigation and rehabilitation measures undertaken; and
- assessment of impacts to landforms, water quality, aquatic and terrestrial ecology.

11.2.1 Rehabilitation

Rehabilitation requirements for the Project will be specified through the progressive rehabilitation and closure plan and will consist of actions to return the land to a self-sustaining condition. The rehabilitation of the Project area will be informed by the characteristics of soils identified in this SLSA. The study area contains soils and soil horizons suited for rehabilitation purposes, noting that some SMUs display limitations relating to dispersive properties, salinity and alkalinity. The soil stripping recommendations presented in section 9 provide recommended rehabilitation uses of the soils of the study area. If topsoil requirements for rehabilitation actions exceed available suitable topsoil, mixing with identified suitable subsoils should be possible, but should be informed by the identified limitations of subsoils.

The effectiveness of soils for use in rehabilitation areas may also be limited by soil chemical and physical properties. Prior to topsoil application and seeding in rehabilitation areas, soil nutrient status should be assessed for those soils exhibiting low nutrient status (refer section 4). Surface preparation methods to address erosional stability and germination should be developed.

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Appendix 1 2019 survey lab results

CERTIFICATE OF ANALYSIS

Work Order	: **EB2000799**	Page	: 1 of 17
Client	: **AARC ENVIRONMENTAL SOLUTIONS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MEGHAN BARNARD	Contact	: Carsten Emrich
Address	:	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61 7 3552 8616
Project	: Meadowbrook Project	Date Samples Received	: 13-Jan-2020 15:14
Order number	: ----	Date Analysis Commenced	: 14-Jan-2020
C-O-C number	: ----	Issue Date	: 24-Jan-2020 16:02
Sampler	: MEGHAN BARNARD		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 24		
No. of samples analysed	: 24		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- **Bulk Density analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911 (Micro site no. 14913).**
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Magnesium/Potassium Ratio result for some samples as required Exchangeable Magnesium and/or Potassium results are less than the limit of reporting.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Calcium/Magnesium Ratio for some samples result as required Calcium & Magnesium results are less than the limit of reporting.
- ED006 (Exchangeable Cations on Alkaline Soils): Sample EB2000739-002 shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- ED006 (Exchangeable Cations on Alkaline Soils): Sample MP23 20-30 (EB2000799-014) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- ED007 (Exchangeable Cations by ICP-AES): Unable to calculate Magnesium/Potassium Ratio for some samples as required Exchangeable Magnesium and/or Potassium results are less than the limit of reporting.
- EA058 Emerson: V. = Very, D. = Dark, L. = Light, VD. = Very Dark
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).
- ALS is not NATA accredited for the analysis of bulk density in a soil matrix.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP2 0-10	MP2 20-30	MP2 48-58	MP2 70-80	MP12 0-10
			Client sampling date / time	07-Dec-2019 08:15	07-Dec-2019 08:15	07-Dec-2019 08:15	07-Dec-2019 08:15	06-Dec-2019 10:00
Compound	CAS Number	LOR	Unit	EB2000799-001	EB2000799-002	EB2000799-003	EB2000799-004	EB2000799-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.5	8.8	8.7	8.7	6.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	87	52	32	47	17
EA051 : Bulk Density								
ø Bulk Density	BULK_DENSITY	1	kg/m3	1740	----	----	----	1660
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	3.5	1.3	1.3	7.0	0.1
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Very Dark Grayish Brown (10YR 3/2)	Dark Brown (7.5YR 3/3)	Dark Olive Brown (2.5Y 3/3)	Grayish Brown (10YR 5/2)	Very Dark Grayish Brown (10YR 3/2)
Texture	----	-	-	Clayey Sand	Clayey Sand	Sand	Clayey Sand	Loamy Sand
Emerson Class Number	EC/TC	-	-	3	3	7	2	7
EA150: Particle Sizing								
+75µm	----	1	%	70	----	----	----	76
+150µm	----	1	%	44	----	----	----	52
+300µm	----	1	%	21	----	----	----	26
+425µm	----	1	%	12	----	----	----	14
+600µm	----	1	%	6	----	----	----	6
+1180µm	----	1	%	3	----	----	----	1
+2.36mm	----	1	%	1	----	----	----	<1
+4.75mm	----	1	%	<1	----	----	----	<1
+9.5mm	----	1	%	<1	----	----	----	<1
+19.0mm	----	1	%	<1	----	----	----	<1
+37.5mm	----	1	%	<1	----	----	----	<1
+75.0mm	----	1	%	<1	----	----	----	<1
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	15	----	----	----	9
Silt (2-60 µm)	----	1	%	13	----	----	----	12
Sand (0.06-2.00 mm)	----	1	%	70	----	----	----	78
Gravel (>2mm)	----	1	%	2	----	----	----	1
Cobbles (>6cm)	----	1	%	<1	----	----	----	<1
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	2.58	----	----	----	2.59
ED006: Exchangeable Cations on Alkaline Soils								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP2 0-10	MP2 20-30	MP2 48-58	MP2 70-80	MP12 0-10
			Client sampling date / time	07-Dec-2019 08:15	07-Dec-2019 08:15	07-Dec-2019 08:15	07-Dec-2019 08:15	06-Dec-2019 10:00
Compound	CAS Number	LOR	Unit	EB2000799-001	EB2000799-002	EB2000799-003	EB2000799-004	EB2000799-005
				Result	Result	Result	Result	Result
ED006: Exchangeable Cations on Alkaline Soils - Continued								
ø Exchangeable Calcium	----	0.2	meq/100g	**1.9**	**1.7**	**0.9**	**2.0**	----
ø Exchangeable Magnesium	----	0.2	meq/100g	<0.2	<0.2	<0.2	**2.0**	----
ø Exchangeable Potassium	----	0.2	meq/100g	<0.2	<0.2	<0.2	**0.4**	----
ø Exchangeable Sodium	----	0.2	meq/100g	<0.2	<0.2	<0.2	**0.5**	----
ø Cation Exchange Capacity	----	0.2	meq/100g	**1.9**	**1.7**	**0.9**	**5.0**	----
ø Exchangeable Sodium Percent	----	0.2	%	<0.2	<0.2	<0.2	**10.0**	----
ø Calcium/Magnesium Ratio	----	0.2	-	----	----	----	**1.0**	----
ø Magnesium/Potassium Ratio	----	0.2	-	----	----	----	**4.8**	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	----	----	**1.4**
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	**0.4**
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	**0.2**
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	----	**2.0**
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	**0.7**
Calcium/Magnesium Ratio	----	0.1	-	----	----	----	----	**3.5**
Magnesium/Potassium Ratio	----	0.1	-	----	----	----	----	**2.1**
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	**223**	**144**	**150**	**593**	**222**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	----	----	----	<10
Sulfur as S	63705-05-5	10	mg/kg	<10	----	----	----	<10
Silica	7631-86-9	1	mg/kg	**26**	----	----	----	**23**
Silicon	7440-21-3	1	mg/kg	**12**	----	----	----	**11**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	**20**	<10
ED091 : Calcium Chloride Extractable Boron								
ø Boron	7440-42-8	0.2	mg/kg	<0.2	----	----	----	<0.2
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	----	----	----	<1.00
ø Iron	7439-89-6	1.00	mg/kg	**4.78**	----	----	----	**9.14**
ø Manganese	7439-96-5	1.00	mg/kg	**23.5**	----	----	----	**33.5**
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	----	----	----	<1.00
EK057G: Nitrite as N by Discrete Analyser								

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	MP2 0-10	MP2 20-30	MP2 48-58	MP2 70-80	MP12 0-10
Client sampling date / time				07-Dec-2019 08:15	07-Dec-2019 08:15	07-Dec-2019 08:15	07-Dec-2019 08:15	06-Dec-2019 10:00
				EB2000799-001	EB2000799-002	EB2000799-003	EB2000799-004	EB2000799-005
				Result	Result	Result	Result	Result
EK057G: Nitrite as N by Discrete Analyser - Continued								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	----	----	----	**0.2**
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**11.2**	----	----	----	**1.6**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**11.2**	----	----	----	**1.8**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	**1.4**	----	----	----	**1.4**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP12 20-30	MP12 50-60	MP12 70-80	MP15 0-10	MP15 20-30
			Client sampling date / time	06-Dec-2019 10:00	06-Dec-2019 10:00	06-Dec-2019 10:00	09-Dec-2019 08:00	09-Dec-2019 08:00
Compound	CAS Number	LOR	Unit	EB2000799-006	EB2000799-007	EB2000799-008	EB2000799-009	EB2000799-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.4	6.6	7.0	6.8	8.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	5	14	15	60	101
EA051 : Bulk Density								
ø Bulk Density	BULK_DENSITY	1	kg/m3	----	----	----	1500	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	0.1	0.4	0.3	2.8	6.8
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Brown (7.5YR 4/3)	Reddish Brown (5YR 4/4)	Yellowish Red (5YR 4/6)	Very Dark Grayish Brown (10YR 3/2)	Dark Gray (7.5YR 4/1)
Texture	----	-	-	Loamy Sand	Loamy Sand	Loamy Sand	Light Clay	Light Clay
Emerson Class Number	EC/TC	-	-	7	7	7	3	2
EA150: Particle Sizing								
+75µm	----	1	%	----	----	----	37	----
+150µm	----	1	%	----	----	----	26	----
+300µm	----	1	%	----	----	----	14	----
+425µm	----	1	%	----	----	----	9	----
+600µm	----	1	%	----	----	----	6	----
+1180µm	----	1	%	----	----	----	2	----
+2.36mm	----	1	%	----	----	----	<1	----
+4.75mm	----	1	%	----	----	----	<1	----
+9.5mm	----	1	%	----	----	----	<1	----
+19.0mm	----	1	%	----	----	----	<1	----
+37.5mm	----	1	%	----	----	----	<1	----
+75.0mm	----	1	%	----	----	----	<1	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	----	----	44	----
Silt (2-60 µm)	----	1	%	----	----	----	17	----
Sand (0.06-2.00 mm)	----	1	%	----	----	----	38	----
Gravel (>2mm)	----	1	%	----	----	----	1	----
Cobbles (>6cm)	----	1	%	----	----	----	<1	----
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	2.39	----
ED006: Exchangeable Cations on Alkaline Soils								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP12 20-30	MP12 50-60	MP12 70-80	MP15 0-10	MP15 20-30
			Client sampling date / time	06-Dec-2019 10:00	06-Dec-2019 10:00	06-Dec-2019 10:00	09-Dec-2019 08:00	09-Dec-2019 08:00
Compound	CAS Number	LOR	Unit	EB2000799-006	EB2000799-007	EB2000799-008	EB2000799-009	EB2000799-010
				Result	Result	Result	Result	Result
ED006: Exchangeable Cations on Alkaline Soils - Continued								
ø Exchangeable Calcium	----	0.2	meq/100g	----	----	----	----	8.0
ø Exchangeable Magnesium	----	0.2	meq/100g	----	----	----	----	2.5
ø Exchangeable Potassium	----	0.2	meq/100g	----	----	----	----	<0.2
ø Exchangeable Sodium	----	0.2	meq/100g	----	----	----	----	0.8
ø Cation Exchange Capacity	----	0.2	meq/100g	----	----	----	----	11.2
ø Exchangeable Sodium Percent	----	0.2	%	----	----	----	----	6.8
ø Calcium/Magnesium Ratio	----	0.2	-	----	----	----	----	3.2
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.1	0.8	1.0	16.2	----
Exchangeable Magnesium	----	0.1	meq/100g	0.2	0.2	0.2	4.6	----
Exchangeable Potassium	----	0.1	meq/100g	0.1	0.2	0.2	0.6	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.1	----
Cation Exchange Capacity	----	0.1	meq/100g	1.5	1.2	1.5	21.6	----
Exchangeable Sodium Percent	----	0.1	%	<0.1	1.1	<0.1	0.6	----
Calcium/Magnesium Ratio	----	0.1	-	5.5	4.0	5.0	3.5	----
Magnesium/Potassium Ratio	----	0.1	-	1.6	1.5	1.2	7.5	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	171	195	219	473	<100
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	----	----	----	20	----
Sulfur as S	63705-05-5	10	mg/kg	----	----	----	<10	----
Silica	7631-86-9	1	mg/kg	----	----	----	84	----
Silicon	7440-21-3	1	mg/kg	----	----	----	39	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	10	100
ED091 : Calcium Chloride Extractable Boron								
ø Boron	7440-42-8	0.2	mg/kg	----	----	----	<0.2	----
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	----	----	----	2.09	----
ø Iron	7439-89-6	1.00	mg/kg	----	----	----	43.2	----
ø Manganese	7439-96-5	1.00	mg/kg	----	----	----	148	----
ø Zinc	7440-66-6	1.00	mg/kg	----	----	----	1.34	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	----	----	0.7	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP12 20-30	MP12 50-60	MP12 70-80	MP15 0-10	MP15 20-30
			Client sampling date / time	06-Dec-2019 10:00	06-Dec-2019 10:00	06-Dec-2019 10:00	09-Dec-2019 08:00	09-Dec-2019 08:00
Compound	CAS Number	LOR	Unit	EB2000799-006	EB2000799-007	EB2000799-008	EB2000799-009	EB2000799-010
				Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	----	----	**5.4**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	----	**6.1**	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	**68**	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	----	**4.5**	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP15 50-60	MP15 70-80	MP23 0-10	MP23 20-30	MP23 50-60
			Client sampling date / time	09-Dec-2019 08:00	09-Dec-2019 08:00	07-Dec-2019 16:00	07-Dec-2019 16:00	07-Dec-2019 16:00
Compound	CAS Number	LOR	Unit	EB2000799-011	EB2000799-012	EB2000799-013	EB2000799-014	EB2000799-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	8.4	7.8	9.0	9.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	588	1030	71	244	668
EA051 : Bulk Density								
ø Bulk Density	BULK_DENSITY	1	kg/m3	----	----	1580	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	9.3	9.4	3.5	6.0	7.5
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Grayish Brown (10YR 5/2)	Grayish Brown (10YR 5/2)	Dark Gray (10YR 4/1)	Dark Grayish Brown (2.5Y 4/2)	Grayish Brown (2.5Y 5/2)
Texture	----	-	-	Clay Loam Sandy	Clay Loam Sandy	Clay Loam Sandy	Light Clay	Clay Loam Sandy
Emerson Class Number	EC/TC	-	-	2	2	2	2	2
EA150: Particle Sizing								
+75µm	----	1	%	----	----	26	----	----
+150µm	----	1	%	----	----	17	----	----
+300µm	----	1	%	----	----	10	----	----
+425µm	----	1	%	----	----	8	----	----
+600µm	----	1	%	----	----	6	----	----
+1180µm	----	1	%	----	----	4	----	----
+2.36mm	----	1	%	----	----	1	----	----
+4.75mm	----	1	%	----	----	<1	----	----
+9.5mm	----	1	%	----	----	<1	----	----
+19.0mm	----	1	%	----	----	<1	----	----
+37.5mm	----	1	%	----	----	<1	----	----
+75.0mm	----	1	%	----	----	<1	----	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	----	45	----	----
Silt (2-60 µm)	----	1	%	----	----	27	----	----
Sand (0.06-2.00 mm)	----	1	%	----	----	26	----	----
Gravel (>2mm)	----	1	%	----	----	2	----	----
Cobbles (>6cm)	----	1	%	----	----	<1	----	----
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	2.54	----	----
ED006: Exchangeable Cations on Alkaline Soils								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP15 50-60	MP15 70-80	MP23 0-10	MP23 20-30	MP23 50-60
			Client sampling date / time	09-Dec-2019 08:00	09-Dec-2019 08:00	07-Dec-2019 16:00	07-Dec-2019 16:00	07-Dec-2019 16:00
Compound	CAS Number	LOR	Unit	EB2000799-011	EB2000799-012	EB2000799-013	EB2000799-014	EB2000799-015
				Result	Result	Result	Result	Result
ED006: Exchangeable Cations on Alkaline Soils - Continued								
ø Exchangeable Calcium	----	0.2	meq/100g	8.5	5.4	8.2	9.6	2.6
ø Exchangeable Magnesium	----	0.2	meq/100g	5.4	5.2	4.0	7.0	4.2
ø Exchangeable Potassium	----	0.2	meq/100g	<0.2	<0.2	0.6	0.3	<0.2
ø Exchangeable Sodium	----	0.2	meq/100g	2.4	2.8	0.4	1.8	1.8
ø Cation Exchange Capacity	----	0.2	meq/100g	16.3	13.4	13.2	18.7	8.6
ø Exchangeable Sodium Percent	----	0.2	%	14.7	20.8	2.8	9.6	20.7
ø Calcium/Magnesium Ratio	----	0.2	-	1.6	1.0	2.1	1.4	0.6
ø Magnesium/Potassium Ratio	----	0.2	-	----	----	6.1	21.0	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	<100	109	600	194	194
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	----	----	20	----	----
Sulfur as S	63705-05-5	10	mg/kg	----	----	<10	----	----
Silica	7631-86-9	1	mg/kg	----	----	59	----	----
Silicon	7440-21-3	1	mg/kg	----	----	28	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	870	1590	20	120	780
ED091 : Calcium Chloride Extractable Boron								
ø Boron	7440-42-8	0.2	mg/kg	----	----	0.2	----	----
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	----	----	1.39	----	----
ø Iron	7439-89-6	1.00	mg/kg	----	----	28.2	----	----
ø Manganese	7439-96-5	1.00	mg/kg	----	----	24.3	----	----
ø Zinc	7440-66-6	1.00	mg/kg	----	----	<1.00	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	----	0.6	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	----	3.7	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	4.3	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	23	<5	<5
EP004: Organic Matter								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP15 50-60	MP15 70-80	MP23 0-10	MP23 20-30	MP23 50-60
			Client sampling date / time	09-Dec-2019 08:00	09-Dec-2019 08:00	07-Dec-2019 16:00	07-Dec-2019 16:00	07-Dec-2019 16:00
Compound	CAS Number	LOR	Unit	EB2000799-011	EB2000799-012	EB2000799-013	EB2000799-014	EB2000799-015
				Result	Result	Result	Result	Result
EP004: Organic Matter - Continued								
Organic Matter	----	0.5	%	----	----	5.0	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP23 70-80	MP26 0-10	MP26 20-30	MP26 50-60	MP26 70-80
			Client sampling date / time	07-Dec-2019 16:00	09-Dec-2019 11:30	09-Dec-2019 11:30	09-Dec-2019 11:30	09-Dec-2019 11:30
Compound	CAS Number	LOR	Unit	EB2000799-016	EB2000799-017	EB2000799-018	EB2000799-019	EB2000799-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.2	7.9	7.6	8.2	8.5
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	846	101	20	13	38
EA051 : Bulk Density								
ø Bulk Density	BULK_DENSITY	1	kg/m3	----	1980	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	8.0	<0.1	0.4	0.3	4.8
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Grayish Brown (2.5Y 5/2)	Very Dark Grayish Brown (10YR 3/2)	Brown (7.5YR 4/2)	Yellowish Brown (10YR 5/4)	Brown (10YR 5/3)
Texture	----	-	-	Clay Loam Sandy	Loamy Sand	Loamy Sand	Loamy Sand	Clay Loam Sandy
Emerson Class Number	EC/TC	-	-	2	3	3	3	2
EA150: Particle Sizing								
+75µm	----	1	%	----	76	----	----	----
+150µm	----	1	%	----	60	----	----	----
+300µm	----	1	%	----	36	----	----	----
+425µm	----	1	%	----	22	----	----	----
+600µm	----	1	%	----	13	----	----	----
+1180µm	----	1	%	----	4	----	----	----
+2.36mm	----	1	%	----	<1	----	----	----
+4.75mm	----	1	%	----	<1	----	----	----
+9.5mm	----	1	%	----	<1	----	----	----
+19.0mm	----	1	%	----	<1	----	----	----
+37.5mm	----	1	%	----	<1	----	----	----
+75.0mm	----	1	%	----	<1	----	----	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	15	----	----	----
Silt (2-60 µm)	----	1	%	----	7	----	----	----
Sand (0.06-2.00 mm)	----	1	%	----	77	----	----	----
Gravel (>2mm)	----	1	%	----	1	----	----	----
Cobbles (>6cm)	----	1	%	----	<1	----	----	----
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	2.45	----	----	----
ED006: Exchangeable Cations on Alkaline Soils								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP23 70-80	MP26 0-10	MP26 20-30	MP26 50-60	MP26 70-80
			Client sampling date / time	07-Dec-2019 16:00	09-Dec-2019 11:30	09-Dec-2019 11:30	09-Dec-2019 11:30	09-Dec-2019 11:30
Compound	CAS Number	LOR	Unit	EB2000799-016	EB2000799-017	EB2000799-018	EB2000799-019	EB2000799-020
				Result	Result	Result	Result	Result
ED006: Exchangeable Cations on Alkaline Soils - Continued								
ø Exchangeable Calcium	----	0.2	meq/100g	**3.2**	**1.4**	**2.2**	**0.9**	**5.1**
ø Exchangeable Magnesium	----	0.2	meq/100g	**6.9**	<0.2	<0.2	<0.2	**3.3**
ø Exchangeable Potassium	----	0.2	meq/100g	**0.2**	**1.2**	**0.2**	<0.2	**0.5**
ø Exchangeable Sodium	----	0.2	meq/100g	**3.8**	<0.2	<0.2	<0.2	**0.5**
ø Cation Exchange Capacity	----	0.2	meq/100g	**14.1**	**2.6**	**2.4**	**0.9**	**9.4**
ø Exchangeable Sodium Percent	----	0.2	%	**26.9**	<0.2	<0.2	<0.2	**5.1**
ø Calcium/Magnesium Ratio	----	0.2	-	**0.5**	----	----	----	**1.5**
ø Magnesium/Potassium Ratio	----	0.2	-	**28.0**	<0.2	<0.2	----	**6.8**
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	**230**	**1350**	**182**	**196**	**402**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	----	**20**	----	----	----
Sulfur as S	63705-05-5	10	mg/kg	----	<10	----	----	----
Silica	7631-86-9	1	mg/kg	----	**52**	----	----	----
Silicon	7440-21-3	1	mg/kg	----	**24**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**1000**	**10**	<10	<10	<10
ED091 : Calcium Chloride Extractable Boron								
ø Boron	7440-42-8	0.2	mg/kg	----	<0.2	----	----	----
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	----	<1.00	----	----	----
ø Iron	7439-89-6	1.00	mg/kg	----	**24.0**	----	----	----
ø Manganese	7439-96-5	1.00	mg/kg	----	**45.9**	----	----	----
ø Zinc	7440-66-6	1.00	mg/kg	----	**1.49**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	**0.4**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	**6.2**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	**6.6**	----	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	**32**	**10**	<5	<5
EP004: Organic Matter								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP23 70-80	MP26 0-10	MP26 20-30	MP26 50-60	MP26 70-80
			Client sampling date / time	07-Dec-2019 16:00	09-Dec-2019 11:30	09-Dec-2019 11:30	09-Dec-2019 11:30	09-Dec-2019 11:30
Compound	CAS Number	LOR	Unit	EB2000799-016	EB2000799-017	EB2000799-018	EB2000799-019	EB2000799-020
				Result	Result	Result	Result	Result
EP004: Organic Matter - Continued								
Organic Matter	----	0.5	%	----	**3.6**	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP28 0-10	MP28 20-30	MP28 50-60	MP28 70-80	----
			Client sampling date / time	07-Dec-2019 12:00	07-Dec-2019 12:00	07-Dec-2019 12:00	07-Dec-2019 12:00	----
Compound	CAS Number	LOR	Unit	EB2000799-021	EB2000799-022	EB2000799-023	EB2000799-024	--------
				Result	Result	Result	Result	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.0	6.5	6.7	7.2	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	20	6	126	169	----
EA051 : Bulk Density								
ø Bulk Density	BULK_DENSITY	1	kg/m3	1800	----	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	0.8	0.4	7.4	5.9	----
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Very Dark Grayish Brown (10YR 3/2)	Brown (7.5YR 4/2)	Brown (10YR 5/3)	Brown (10YR 5/3)	----
Texture	----	-	-	Clayey Sand	Clayey Sand	Clay Loam Sandy	Clay Loam Sandy	----
Emerson Class Number	EC/TC	-	-	2	2	2	2	----
EA150: Particle Sizing								
+75µm	----	1	%	62	----	----	----	----
+150µm	----	1	%	43	----	----	----	----
+300µm	----	1	%	24	----	----	----	----
+425µm	----	1	%	15	----	----	----	----
+600µm	----	1	%	8	----	----	----	----
+1180µm	----	1	%	2	----	----	----	----
+2.36mm	----	1	%	1	----	----	----	----
+4.75mm	----	1	%	<1	----	----	----	----
+9.5mm	----	1	%	<1	----	----	----	----
+19.0mm	----	1	%	<1	----	----	----	----
+37.5mm	----	1	%	<1	----	----	----	----
+75.0mm	----	1	%	<1	----	----	----	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	9	----	----	----	----
Silt (2-60 µm)	----	1	%	27	----	----	----	----
Sand (0.06-2.00 mm)	----	1	%	63	----	----	----	----
Gravel (>2mm)	----	1	%	1	----	----	----	----
Cobbles (>6cm)	----	1	%	<1	----	----	----	----
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	2.46	----	----	----	----
ED005: Exchange Acidity								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP28 0-10	MP28 20-30	MP28 50-60	MP28 70-80	----
			Client sampling date / time	07-Dec-2019 12:00	07-Dec-2019 12:00	07-Dec-2019 12:00	07-Dec-2019 12:00	----
Compound	CAS Number	LOR	Unit	EB2000799-021	EB2000799-022	EB2000799-023	EB2000799-024	--------
				Result	Result	Result	Result	----
ED005: Exchange Acidity - Continued								
ø Exchange Acidity	----	0.1	meq/100g	<0.1	----	----	----	----
ø Exchangeable Aluminium	----	0.1	meq/100g	<0.1	----	----	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	2.9	0.6	4.4	3.7	----
Exchangeable Magnesium	----	0.1	meq/100g	0.8	0.3	6.4	5.6	----
Exchangeable Potassium	----	0.1	meq/100g	0.2	<0.1	0.2	0.2	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	1.7	1.9	----
Cation Exchange Capacity	----	0.1	meq/100g	4.0	1.0	12.8	11.5	----
Exchangeable Sodium Percent	----	0.1	%	0.6	3.4	13.6	17.0	----
Calcium/Magnesium Ratio	----	0.1	-	3.6	2.0	0.7	0.7	----
Magnesium/Potassium Ratio	----	0.1	-	3.1	----	28.2	29.0	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	228	108	141	131	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	----	----	----	----
Sulfur as S	63705-05-5	10	mg/kg	<10	----	----	----	----
Silica	7631-86-9	1	mg/kg	34	----	----	----	----
Silicon	7440-21-3	1	mg/kg	16	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	160	210	----
ED091 : Calcium Chloride Extractable Boron								
ø Boron	7440-42-8	0.2	mg/kg	<0.2	----	----	----	----
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	----	----	----	----
ø Iron	7439-89-6	1.00	mg/kg	49.5	----	----	----	----
ø Manganese	7439-96-5	1.00	mg/kg	47.3	----	----	----	----
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	0.2	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	1.5	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	1.7	----	----	----	----

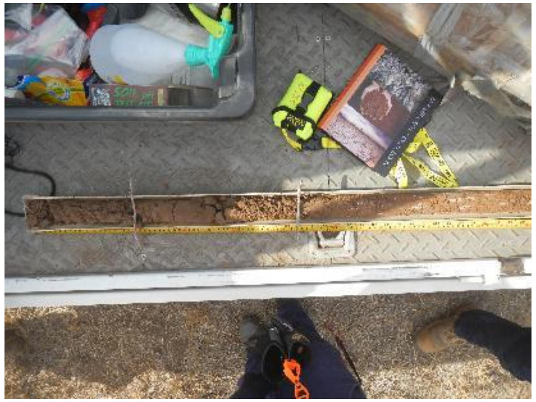
Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	MP28 0-10	MP28 20-30	MP28 50-60	MP28 70-80	----
			Client sampling date / time	07-Dec-2019 12:00	07-Dec-2019 12:00	07-Dec-2019 12:00	07-Dec-2019 12:00	----
Compound	CAS Number	LOR	Unit	EB2000799-021	EB2000799-022	EB2000799-023	EB2000799-024	--------
				Result	Result	Result	Result	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	**3.0**	----	----	----	----

Appendix 2 2019 survey soil profile data

Project Name: Meadowbrook SLSA

Date:	5/12/2019		**Site:**	**MP1**	
Location:	FAR SOUTH		**Coordinates: (55K)**	**E 0642509**	**N 7520462**
Landform Pattern:	PLA		**Micro Relief:**	**N**	
Landform Element:	HCR		**Rock Outcrops:**	**0**	
Morphological Type:	C		**S C Fragments:**	**0**	
Site Disturbance:	1		**Substrate:**	**-**	
Erosion:	001S		**Surface Condition:**	**S**	
Landform	Elevation:	265	**Permeability:**	**3**	
	Slope (%):	0	**Drainage:**	**5**	
	Relief:	-	**Run-off:**	**2**	



[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A1	0-200	-	10YR2/2	-	CL	-	W4PL	-	D30N2	7	10
A2	200-530	GS	7.5YR2.5/2	-	LMC	-	W4PO	-	D30N2	8	31
B2K	530-1080	AS	10YR3/4	-	MC	21S_S	M5PO	2KN2_	T50N3	9	77

Vegetation: Brigalow

Notes:

Project Name: Meadowbrook SLSA

Date:	07/12/2019		Site:	MP2	
Location:	-		Coordinates: (55K)	E 0641292	N 7529952
Landform Pattern:	PLA		Micro Relief:	N	
Landform Element:	HSL		Rock Outcrops:	-	
Morphological Type:	L		S C Fragments:	-	
Site Disturbance:	2		Substrate:	-	
Erosion:	S		Surface Condition:	F	
Landform	Elevation:	217	Permeability:	3	
	Slope (%):	1-2%	Drainage:	4	
	Relief:	-	Run-off:	3	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-90	-	7.5YR2.5/2	-	LS	-	G	-	D00N0	7.5	3
A12	90-280	CS	7.5YR2.5/3	-	LS	-	G	-	D00N0	8	20
A13	280-450	SS	10YR3/4	-	LS	-	G	2FC21	D00N0	8	36
A2E	450-580	AS	10YR4/3	-	LS	-	M3AB	2F*C21	D32N3	8	52
B2T	580-860	SS	10YR5/4	M21DYC	CLS	31S_M	-	-	-	8	73

Vegetation: Some Poplar and pine needly things

Notes:

Project Name: Meadowbrook SLSA

Date:	8/12/2019		Site:	MP3	
Location:	-		Coordinates: (55K)	E 0634551	N 75225914
Landform Pattern:	-		Micro Relief:	-	
Landform Element:	-		Rock Outcrops:	-	
Morphological Type:	-		S C Fragments:	-	
Site Disturbance:	-		Substrate:	-	
Erosion:	-		Surface Condition:	-	
Landform	Elevation:	194	Permeability:	-	
	Slope (%):	-	Drainage:	-	
	Relief:	-	Run-off:	-	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-90	-	10YR3/3	-	LS (very fine)	-	W3PL	-	D10NO	7	2
A12	90-180	CS	10YR3/4	-	LS/fines	-	G	-	DOONO	7	15
B2t	180-820	G5	7.5YR4/4	-	S (very fine)	-	G	-	DOONO	7	50

Vegetation: Moreton Bay Ash, Poplar, *Carrisa Spinatum*

Notes:

Project Name: Meadowbrook SLSA

Date:	7/11/2019		**Site:**	**MP4**
Location:	WHITE TREES		**Coordinates: (55K)**	**E 0641295** / **N 7531049**
Landform Pattern:	PLA		**Micro Relief:**	**N**
Landform Element:	PLA		**Rock Outcrops:**	**--**
Morphological Type:	F		**S C Fragments:**	**11R?S**
Site Disturbance:	2		**Substrate:**	**-**
Erosion:	S		**Surface Condition:**	**F**
Landform	Elevation:	218	**Permeability:**	**4**
	Slope (%):	-	**Drainage:**	**5**
	Relief:	-	**Run-off:**	**1**

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-130	-	7.5YR2.5/3	-	S	-	G	-	D0ON0	6.5	5
A12	130-250	CS	7.5YR2.5/3	-	S	-	G	-	D0ON0	6.5	18
A2E	250-440	CS	5YR5/2	-	S	-	G	1N(?)C11	D0ON0	7	35
C	440	AI	*	-	-	-	-	-	-	-	-

Vegetation: White trees (Gum)

Notes: Shallow sand with rock, attempted sample twice due to rock

Project Name: Meadowbrook SLSA

Date:	09/12/2019	**Site:**	**MP5**	
Location:	-	**Coordinates: (55K)**	**E 0646079**	**N 7525039**
Landform Pattern:	PLA	**Micro Relief:**	**Some N**	
Landform Element:	HSL	**Rock Outcrops:**	**-**	
Morphological Type:	L (towards watercourse)	**S C Fragments:**	**-**	
Site Disturbance:	4	**Substrate:**	**-**	
Erosion:	S	**Surface Condition:**	**G**	
Landform	Elevation: 155	**Permeability:**	**1**	
	Slope (%): 2	**Drainage:**	**2**	
	Relief: -	**Run-off:**	**3**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-90	-	10YR2/2	-	LC	-	M3PO	-	D41N3	7	1
A12	90-190	CS	10YR3/2	-	MC	-	M4PO	-	D41N3	7.5	14
B2K	190-820	AS	10YR3/3	-	MC	-	M4	1KN11_	D51N3	9	45

Vegetation: Some Brigalow, Conkerberry.

Notes: Dark brown, Unknown tall grass species associated with watercourse in Brigalow

Project Name: Meadowbrook SLSA

Date:	7/12/2019	**Site:**	**MP6**	
Location:	Near watercourse	**Coordinates: (55K)**	**E 0441275**	**N 7526229**
Landform Pattern:	PLA	**Micro Relief:**	**N**	
Landform Element:	HSL*	**Rock Outcrops:**	**-**	
Morphological Type:	LS	**S C Fragments:**	**-**	
Site Disturbance:	2	**Substrate:**	**-**	
Erosion:	5	**Surface Condition:**	**F**	
Landform	Elevation: 254	**Permeability:**	**-**	
	Slope (%): -	**Drainage:**	**-**	
	Relief: -	**Run-off:**	**-**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-100	-	7.5YR2.5/2	-	CL/LC`	-	M4PO	-	T3/N3^	6.5	2
A12	100-250	CS	10YR3/2	-	LC	-	M4PO	-	D3/N3	6.5	16
B2K	250-750	AS	10YR4/3	M11DOC	LMC	-	S4PO	1(KF)NC)21_	D5/N3	7	40

Vegetation: Some Brigalow (little) & Moreton Bay Ash, some Conkerberry

Notes: Very spongey, brown

Project Name: Meadowbrook SLSA

Date:	8/12/2019		**Site:**	**MP7**
Location:	NEAR WATERCOURSE		**Coordinates: (55K)**	**E 0637735** **N 7528695**
Landform Pattern:	PLA		**Micro Relief:**	N
Landform Element:	HSL		**Rock Outcrops:**	-
Morphological Type:	L		**S C Fragments:**	-
Site Disturbance:	2		**Substrate:**	-
Erosion:	S		**Surface Condition:**	S
Landform	Elevation:	198	**Permeability:**	**4**
	Slope (%):	-	**Drainage:**	**6**
	Relief:	-	**Run-off:**	**1**

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-240	-	10YR3/3	-	L	-	W5PO	-	D20N2	7.5	1
A2	240-360	CB	7.5YR3/3	-	LS	-	G	-	D00N0	7.5	30
A2	360-630	CS	7.5YR4/4	-	KS	-	G	-	D00N0	7.5	50
B	630-920	AS	10YR3/4	-	CS	-	G	-	D00N0	7.5	75

Vegetation: Poplar Box, Sally Wattle

Notes:

Project Name: Meadowbrook SLSA

Date:	06/12/2019		**Site:**	**MP8**	
Location:	-		**Coordinates: (55K)**	**E 0639317**	**N 7529594**
Landform Pattern:	PLA		**Micro Relief:**	**N**	
Landform Element:	PLA		**Rock Outcrops:**	**-**	
Morphological Type:	F		**S C Fragments:**	**-**	
Site Disturbance:	2		**Substrate:**	**-**	
Erosion:	S		**Surface Condition:**	**F**	
Landform	Elevation:	225	**Permeability:**	**3**	
	Slope (%):	0	**Drainage:**	**5**	
	Relief:	-	**Run-off:**	**2**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-60	-	10YR3/2	-	CL	-	W2PL	-	D10N0	7	3
A12	60-230	CS	7.5YR3/3	-	CL	-	WPL	-	D10N0	7	15
A2E	230-580	GS	7.5YR4/4	-	ZCL	-	V	-	D11N1	7	40
B21	580-800	CS	7.5YR4/6	-	ZCL	-	V	-	D21N1	7	74

Vegetation:

Notes: Close to watercourse, deep sand, Brown

Project Name: Meadowbrook SLSA

Date:	8/12/2019		**Site:**	**MP9**
Location:	Near watercourse		**Coordinates: (55K)**	**E 0637920**	**N 7527659**
Landform Pattern:	PLA		**Micro Relief:**	**N**
Landform Element:	PLA		**Rock Outcrops:**	**-**
Morphological Type:	F		**S C Fragments:**	**-**
Site Disturbance:	2		**Substrate:**	**-**
Erosion:	S		**Surface Condition:**	**S**
Landform	Elevation:	189	**Permeability:**	**-**
	Slope (%):	-	**Drainage:**	**-**
	Relief:	-	**Run-off:**	**-**

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-100	-	7.5YR2.5/2	-	LS(K)	-	W4PL	-	D10N0	7	5
A12	100-380	CB	7.5YR2.5/2	-	LS(K)	-	G	-	D00N0	7	25
A13	380-480	GS	10YR3/4	-	S(K)	-	G	-	D00N0	7	44
A14	480-590	CS	7.5YR2.5/2	-	ZL	-	G	-	D00N0	7	55
B21T	590-720	AB	10YR3/2	-	L	-	M4PO	-	D21N2	7	70

Vegetation: Sally Wattle, Poplar Box, Some Moreton Bay Ash

Notes: Very dark grey brown, Many sandy layers indicating alluvial deposition

Project Name: Meadowbrook SLSA

Date:	06/12/2019		**Site:**	**MP10**	
Location:	Far out back		**Coordinates: (55K)**	**E 0636513**	**N 7531396**
Landform Pattern:	PLA		**Micro Relief:**	**N**	
Landform Element:	HCR		**Rock Outcrops:**	**-**	
Morphological Type:	U		**S C Fragments:**	**-**	
Site Disturbance:	2		**Substrate:**	**-**	
Erosion:	S		**Surface Condition:**	**F**	
Landform	Elevation:	223	**Permeability:**	**2**	
	Slope (%):	1/2	**Drainage:**	**5**	
	Relief:	-	**Run-off:**	**2**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-70	-	10YR3/2	-	SL/L	-	V2PL	-	D00N0	7	3
A12	70-180	CS	10YR3/3	-	SL	-	G	-	D00N0	7	12
A2E	180-240	AS	10YR4/3	-	LS	-	G	-	D00N0	7	21
B21T	240-650	SS	10YR5/4	M11F(RO)D	SCL	21S_S	V7SB	-	TF2N0	8.5	50
B22K	650-1030	GS	10YR5/4	M22DYD	CLS	31R_S	V7SB	3K(F?)/NC/32/11	TF0N0	8.5	90

Vegetation:

Notes:

Project Name: Meadowbrook SLSA

Date:	7/12/2019		**Site:**	**MP11**
Location:	-		**Coordinates: (55K)**	**E 0645183** **N 7530475**
Landform Pattern:	PLA		**Micro Relief:**	**Some N (Gilgai)**
Landform Element:	PLA		**Rock Outcrops:**	**-**
Morphological Type:	F		**S C Fragments:**	**-**
Site Disturbance:	2		**Substrate:**	**G**
Erosion:	S		**Surface Condition:**	**-**
Landform	Elevation:	205	**Permeability:**	**-**
	Slope (%):	0	**Drainage:**	**-**
	Relief:	-	**Run-off:**	**-**

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-100	-	10YR3/2	-	CL	-	M3PO	-	D31N3	8	3
A12	100-270	CS	10YR4/2	-	LMC	-	M4AB	-	D41N3	8.5	20
B21K	270-510	CS	10YR4/3	-	MC	-	M5SB	2KN21_	D41N3	8.5	34
B22K	510-860	AI	10YR4/3	M22DOC	MC	-	M5SB	1KN41_	D41N3	9	63

Vegetation: Brigalow, some Conkerberry where more red/less vertosol, cracking

Notes: Boundary between red and dark vertosol

Project Name: Meadowbrook SLSA

Date:	6/12/2019		**Site:**	**MP12**
Location:	-		**Coordinates: (55K)**	**E 0637780**	**N 7530223**
Landform Pattern:	PLA		**Micro Relief:**	**N**
Landform Element:	PLA		**Rock Outcrops:**	**-**
Morphological Type:	F		**S C Fragments:**	**-**
Site Disturbance:	2		**Substrate:**	**-**
Erosion:	SW1S1		**Surface Condition:**	**S**
Landform	Elevation:	221	**Permeability:**	**4**
	Slope (%):	0	**Drainage:**	**6**
	Relief:	-	**Run-off:**	**1**

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-90	-	5YR2.5/2	-	S	-	G	-	D00N0	5	6.5
A12	90-210	GS	5YR3/3	-	S	-	G	-	D00N0	16	7
B21T	210-580	GS	7.5YR4/4	-	CS	-	G	-	D00N0	35	7
B22T	580-1010	DS	5YR4/6	-	CS	-	G	-	D00N0	90	7.5

Vegetation: Moreton Bay Ash

Notes: Deep sand

Project Name: Meadowbrook SLSA

Date:	06/12/2019		**Site:**	**MP13**	
Location:	-		**Coordinates: (55K)**	**E 0640309**	**N 752695**
Landform Pattern:	PLA		**Micro Relief:**	**N GILGAI**	
Landform Element:	PLA		**Rock Outcrops:**	**-**	
Morphological Type:	PLA		**S C Fragments:**	**-**	
Site Disturbance:	2		**Substrate:**	**-**	
Erosion:	S		**Surface Condition:**	**G**	
Landform	Elevation:	244	**Permeability:**	**2/1**	
	Slope (%):	-	**Drainage:**	**4**	
	Relief:	-	**Run-off:**	**3**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-70	-	10YR3/1	-	MC	-	M3PO	-	D31N3	6.5	2
A12	70-300	AS	7.5YR4/2	-	MC/MLC	-	M5LE	-	D32N3	7	18
A2T	300-610	CS	7.5YR3/1	-	MC/MLC	-	S6LE	-	D62N3	7.5	46

Vegetation: Coolibah

Notes: Fe oxidation Along Peds

Project Name: Meadowbrook SLSA

Date:	7/12/2019		**Site:**	**MP14**
Location:	-		**Coordinates: (55K)**	**E 0644811** **N 7528604**
Landform Pattern:	PLA		**Micro Relief:**	**N**
Landform Element:	PLA		**Rock Outcrops:**	**-**
Morphological Type:	F		**S C Fragments:**	**-**
Site Disturbance:	2		**Substrate:**	**-**
Erosion:	S		**Surface Condition:**	**S**
Landform	Elevation:	231	**Permeability:**	**¾**
	Slope (%):	-	**Drainage:**	**6**
	Relief:	-	**Run-off:**	**1**

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-150	-	10YR3/4	-	CS	-	W4PO	-	D10N0	6.5	8
A12	150-370	CS	10YR4/3	-	CS	-	G	-	D00N0	6.5	28
B2T	370-820	AS	10YR5/6	-	CS	-	G	-	D00N0	7	60

Vegetation: Dominated by Moreton Bay Ash

Notes:

Project Name: Meadowbrook SLSA

Date:	9/12/2019		**Site:**	**MP15**	
Location:	PLA		**Coordinates: (55K)**	**E 0647647**	**N 7527172**
Landform Pattern:	PLA		**Micro Relief:**	**N**	
Landform Element:	F		**Rock Outcrops:**	**-**	
Morphological Type:	-		**S C Fragments:**	**-**	
Site Disturbance:	4		**Substrate:**	**-**	
Erosion:	5		**Surface Condition:**	**G**	
Landform	Elevation:	148	**Permeability:**	**1**	
	Slope (%):	-	**Drainage:**	**2**	
	Relief:	-	**Run-off:**	**3**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-60	-	10YR2/2	-	LC	-	M3PO	-	D51N3	7	2
A12	60-180	CS	10YR3/3	-	MC	-	S4PO	-	D61N3	7	14
B2K	180-850	GS	2.5YR3/3	-	MC	-	S5PO	1KN11_	D71N3	7.5	45

Vegetation: Brigalow regrowth

Notes:

Project Name: Meadowbrook SLSA

Date:	9/12/2019		**Site:**	**MP16**	
Location:	-		**Coordinates: (55K)**	**E 0647098**	**N 7528045**
Landform Pattern:	PLA		**Micro Relief:**	**N**	
Landform Element:	PLA		**Rock Outcrops:**	**-**	
Morphological Type:	Near watercourse		**S C Fragments:**	**-**	
Site Disturbance:	2		**Substrate:**	**-**	
Erosion:	5		**Surface Condition:**	**F**	
Landform	Elevation:	158	**Permeability:**	**3**	
	Slope (%):	-	**Drainage:**	**5**	
	Relief:	-	**Run-off:**	**2**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-40	-	10YR3/2	-	LS	-	W2PL	-	D10NO	6.5	1
A12	40-370	AS	10YR3/4	-	CS	-	G	-	D00N0	7	20
B2T	370-540	CS	10YR4/4	-	CLS	215_M (ironstone)	W2P0	-	D21NO	6.5	44
B22T	540-720	GS	10YR4/6	M22F(RO)C	LC	-	M3PO*	-	T31N3	6.5	70

Vegetation: Poplar, very few Moreton Bay Ash

Notes:

Project Name: Meadowbrook SLSA

Date:	8/12/2019		**Site:**	**MP17**	
Location:	-		**Coordinates: (55K)**	**E 0643050**	**N 7522381**
Landform Pattern:	PLA		**Micro Relief:**	**N**	
Landform Element:	PLA		**Rock Outcrops:**	**-**	
Morphological Type:	F		**S C Fragments:**	**-**	
Site Disturbance:	4		**Substrate:**	**-**	
Erosion:	S		**Surface Condition:**	**F**	
Landform	Elevation:	223	**Permeability:**	**2**	
	Slope (%):	-	**Drainage:**	**3**	
	Relief:	-	**Run-off:**	**2**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-90	-	7.5YR2.5/1	-	L	-	W3PL	-	D31N2	7	4
A12	60-320	AS	7.5YR2.5/2	-	LC	-	M3SB	-	D42N3	7.5	20
B2K	320-730	CI	7.5YR2.5/3	-	LMC/MLC	-	M4PO	1KN11_	T53N3	8	40

Vegetation: Poplar regrowth, Sally Wattle, *Carissa spinarum*

Notes:

Project Name: Meadowbrook SLSA

Date:	8/12/2019		**Site:**	**MP18**	
Location:	-		**Coordinates: (55K)**	**E 0640629**	**N 7524340**
Landform Pattern:	PLA		**Micro Relief:**	**-**	
Landform Element:	PLA		**Rock Outcrops:**	**-**	
Morphological Type:	F		**S C Fragments:**	**-**	
Site Disturbance:	4*		**Substrate:**	**-**	
Erosion:	S		**Surface Condition:**	**G**	
Landform	Elevation:	193	**Permeability:**	**1**	
	Slope (%):	-	**Drainage:**	**3**	
	Relief:	-	**Run-off:**	**3**	

[Soil Description]

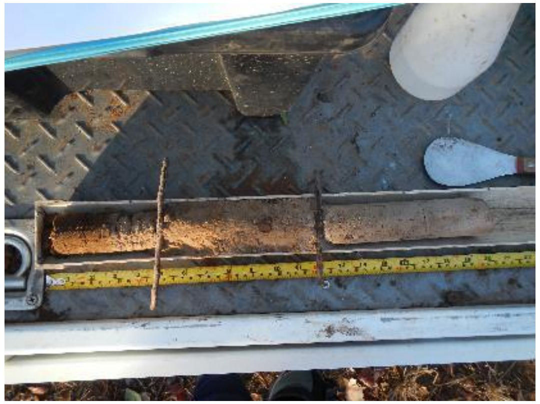
Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-90	-	10YR3/2	-	MHC	-	M2PO	-	D51N3	7	2
A12	90-280	CI	10YR3/2	-	MHC	-	S4PO	-	D51N3	7.5	20
B2t	280-820	AS	10YR3/2	-	HC	-	S4PO	1YC11_	T71N3	8	50

Vegetation: Brigalow regrowth

Notes:

Project Name: Meadowbrook SLSA

Date:	7/12/2019		**Site:**	**MP19**	
Location:	-		**Coordinates: (55K)**	**E 0639691**	**N 7531095**
Landform Pattern:	PLA		**Micro Relief:**	**N**	
Landform Element:	PLA		**Rock Outcrops:**	**-**	
Morphological Type:	F		**S C Fragments:**	**-**	
Site Disturbance:	2		**Substrate:**	**-**	
Erosion:	S		**Surface Condition:**	**S**	
Landform	Elevation:	227	**Permeability:**	**2**	
	Slope (%):	-	**Drainage:**	**4**	
	Relief:	-	**Run-off:**	**1**	



[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-120	-	10YR3/2	-	SL	-	W3PL	-	D20N0	6.5	5
A12	120-300	CS	7.5YR4/2	-	LS	-	G	-	D00N0	6.5	25
B2T	300-500	AS	10YR4/3	M1FOD	CLS	21S_VS	M3SB	-	T41N3	7.5	43

Vegetation: Poplar, Sally Wattle

Notes:

Project Name: Meadowbrook SLSA

Date:	06/12/2019		**Site:**	**MP20**	
Location:	-		**Coordinates: (55K)**	**E 0642383**	**N 7525098**
Landform Pattern:	PLA		**Micro Relief:**	**N**	
Landform Element:	PLA		**Rock Outcrops:**	**-**	
Morphological Type:	F		**S C Fragments:**	**-**	
Site Disturbance:	2		**Substrate:**	**-**	
Erosion:	-		**Surface Condition:**	**G**	
Landform	Elevation:	260	**Permeability:**	**2**	
	Slope (%):	-	**Drainage:**	**4**	
	Relief:	-	**Run-off:**	**3**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-100	-	10YR3/1	-	MC	-	W3PO	-	D20N3	7.5	7
A12	100-300	CS	7.5YR4/1	-	MC/MHC	11S_S	M4PO	-	D20N3	8.5	25
B2K	300-800	AS	10YR4/1	12FRC	MC/MHC	21S_S	M5SB	1KN1W	T40N3	8.5	64

Vegetation: Brigalow regrowth

Notes:

Project Name: Meadowbrook SLSA

Date:	8/12/2019		**Site:**	**MP21**
Location:	-		**Coordinates: (55K)**	**E 0642055** / **N 7523395**
Landform Pattern:	PLA		**Micro Relief:**	**N**
Landform Element:	PLA		**Rock Outcrops:**	**-**
Morphological Type:	F		**S C Fragments:**	**-**
Site Disturbance:	4		**Substrate:**	**-**
Erosion:	S		**Surface Condition:**	**G**
Landform	Elevation:	206	**Permeability:**	**1**
	Slope (%):	0	**Drainage:**	**4**
	Relief:	-	**Run-off:**	**3**

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-110	-	2.5YR3/2	-	MHC	-	M2PO	-	D51N3	8	4
A12	110-360	AS	2.5YR4/2	-	MHC	-	S5PO	-	D51N3	8.5	30
B2t	360-830	CB	10YR4/3	-	HC	-	S5PO*	-	T71N3	9	50

Vegetation: Brigalow regrowth

Notes: Unable to clearly see structure, cracks

Project Name: Meadowbrook SLSA

Date:	7/12/2019		**Site:**	**MP22**
Location:	-		**Coordinates: (55K)**	**E 0643271**	**N 7528162**
Landform Pattern:	PLA		**Micro Relief:**	**N**
Landform Element:	PLA		**Rock Outcrops:**	**-**
Morphological Type:	F		**S C Fragments:**	**-**
Site Disturbance:	2		**Substrate:**	**-**
Erosion:	5		**Surface Condition:**	**S**
Landform	Elevation:	242	**Permeability:**	**4**
	Slope (%):	0	**Drainage:**	**6**
	Relief:	-	**Run-off:**	**2**

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-120	-	7.5YR2.5/3	-	CS	-	W2PL	-	D10N0	6	2
A12	120-520	CS	7.5YR3/3	-	CS	-	G	-	D00N0	7	30
A2e	520-730	CS	7.5YR4/6	-	CS	-	G	-	D00N0	7	64
B2t	730-840	AI	5YR4/6	M22DRD	ZCL	-	W5AB	-	D21N1	7	83

Vegetation: Moreton Bay Ash

Notes:

Project Name: Meadowbrook SLSA

Date:	7/12/2019		**Site:**	**MP23**
Location:	-		**Coordinates: (55K)**	**E 0642149**	**N 7526934**
Landform Pattern:	PLA		**Micro Relief:**	**N**
Landform Element:	PLA		**Rock Outcrops:**	**-**
Morphological Type:	F		**S C Fragments:**	**-**
Site Disturbance:	2		**Substrate:**	**-**
Erosion:	S		**Surface Condition:**	**G**
Landform	Elevation:	249	**Permeability:**	**1**
	Slope (%):	-	**Drainage:**	**3**
	Relief:	-	**Run-off:**	**3**

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-90	-	10YR3/2	-	LMC	-	M3SB	-	D42N3	7.5	4
A12	90-240	CS	10YR3/4	-	LMC/MC	-	M5SB	-	D42N3	8	20
B2t	240-870	CS	10YR4/3	-	MC	11S_S	S5PO	1KN1L	D52NB	9	45

Vegetation: Brigalow

Notes:

Project Name: Meadowbrook SLSA

Date:	8/12/2019	**Site:**	**MP24**	
Location:	-	**Coordinates: (55K)**	**E 0640955**	**N 7521335**
Landform Pattern:	PLA	**Micro Relief:**	**N (but less)**	
Landform Element:	PLA	**Rock Outcrops:**	**-**	
Morphological Type:	F	**S C Fragments:**	**-**	
Site Disturbance:	4	**Substrate:**	**-**	
Erosion:	S	**Surface Condition:**	**G less / F**	
Landform	Elevation: 218	**Permeability:**	**1**	
	Slope (%): -	**Drainage:**	**4**	
	Relief: -	**Run-off:**	**3**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-80	-	10YR3/2	-	MC	-	M3SB	-	D51N3	7	2
A12	80-230	CS	10YR3/3	-	MC	-	M4AB	-	D51N3	8	16
B21K	230-580	CS	10YR3/3	-	MC	-	S4SB	1KN21_	D71N3	9	34
B22T	580-830	CB	7.5YR3/4	-	MC*	-	M3SB	-	D71N3	9	66

Vegetation: Brigalow regrowth, Conkerberry, Warrior Bush

Notes: Some sand in patches

Project Name: Meadowbrook SLSA

Date:	8/12/2019		**Site:**	**MP25**	
Location:	-		**Coordinates: (55K)**	**E 0643887**	**N 7524104**
Landform Pattern:	PLA		**Micro Relief:**	**Some N, not many**	
Landform Element:	PLA		**Rock Outcrops:**	**-**	
Morphological Type:	F		**S C Fragments:**	**-**	
Site Disturbance:	4		**Substrate:**	**-**	
Erosion:	5		**Surface Condition:**	**Some G, F**	
Landform	Elevation:	178	**Permeability:**	**1**	
	Slope (%):	-	**Drainage:**	**4**	
	Relief:	-	**Run-off:**	**2**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A	0.400	-	10YR3/3	-	LC	-	M4PC	-	D21N3	7	14
B21b	400.696	GS	2.5YR3/3	-	LMC	-	M6AB	-	D32N3	8.3	54
B22K	690.900	CS	10YR3/4	-	MC	11U_S	S6SB	1KM11_	D42N3	9	80

Vegetation: Some Brigalow, *Carissa spinarum*, some Warrior Bush

Notes:

Project Name: Meadowbrook SLSA

Date:	8/12/2019		**Site:**	**MP26**
Location:	-		**Coordinates: (55K)**	**E 0644671**	**N 7525809**
Landform Pattern:	PLA		**Micro Relief:**	**N**
Landform Element:	HSL		**Rock Outcrops:**	**-**
Morphological Type:	R		**S C Fragments:**	**-**
Site Disturbance:	4		**Substrate:**	**-**
Erosion:	S		**Surface Condition:**	**F**
Landform	Elevation:	164	**Permeability:**	**3**
	Slope (%):	2.3	**Drainage:**	**4**
	Relief:	-	**Run-off:**	**2**

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-90	I	7.5YR2.5/2	-	SCL	-	W4PL	-	D/ON0	7	4
A12	90-240	AS	10YR3/3	-	SL	-	G	-	D/ON0	7	16
A13	240-550	CS	10YR3/4	-	CL	-	G	-	D/ON0	7.5	38
A2e	550-660	CS	10YR4/4	-	S	11Y_M	G	-	D/ON0	7.5	62
B2t	-830	SS	10YR4/6	M32FOD	MC	-	M5PO	-	D33N3	8	73

Vegetation: A lot of *Carissa spinarum*.

Notes:

Project Name: Meadowbrook SLSA

Date:	8/12/2019		**Site:**	**MP27**	
Location:	-		**Coordinates: (55K)**	**E 0639162**	**N 7526202**
Landform Pattern:	PLA		**Micro Relief:**	**N**	
Landform Element:	PLA		**Rock Outcrops:**	**-**	
Morphological Type:	F		**S C Fragments:**	**-**	
Site Disturbance:	2		**Substrate:**	**-**	
Erosion:	5		**Surface Condition:**	**G**	
Landform	Elevation:	182	**Permeability:**	**-**	
	Slope (%):	0	**Drainage:**	**-**	
	Relief:	-	**Run-off:**	**-**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0.260	-	2.5Y4/2	-	-	-	S2PO	-	D4/N3	8	5
A12	200-380	GS	2.5Y5/3	-	-	-	S3PO	-	D4/N3	9	20
B21	300-830	CS	2.5Y5/3	-	YC	-	S4PO	-	T7/N3	8	40
										8	60

Vegetation: Brigalow regrowth

Notes: Brown, vertosol

Project Name: Meadowbrook SLSA

Date:	7/12/2019		**Site:**	**MP28**	
Location:	-		**Coordinates: (55K)**	**E 0642817**	**N 7530237**
Landform Pattern:	PLA		**Micro Relief:**	**N**	
Landform Element:	PLA		**Rock Outcrops:**	**-**	
Morphological Type:	F		**S C Fragments:**	**-**	
Site Disturbance:	2		**Substrate:**	**-**	
Erosion:	-		**Surface Condition:**	**F**	
Landform	Elevation:	231	**Permeability:**	**-**	
	Slope (%):	0	**Drainage:**	**-**	
	Relief:	-	**Run-off:**	**-**	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-110	-	7.5YR4/1	-	CS	-	W3PL	-	D10N0	6	5
A12*	110-310	CS	7.5YR4/3	-	CS	-	G	-	D00N0	6.5	20
B2t	310-770	AS	7.5YR5/1	M2DYC	MHC/MC	-	M4PO	-	D62N3	7	52

Vegetation: Poplar, Sally Wattle

Notes:

Project Name: Meadowbrook SLSA

Date:	8/12/2019		Site:	MP29	
Location:	-		Coordinates: (55K)	E 0645630	N 7525769
Landform Pattern:	PLA		Micro Relief:	N	
Landform Element:	PLA		Rock Outcrops:	-	
Morphological Type:	F		S C Fragments:	-	
Site Disturbance:	4		Substrate:	-	
Erosion:	S		Surface Condition:	G	
Landform	Elevation:	154	Permeability:	1	
	Slope (%):	-	Drainage:	2	
	Relief:	-	Run-off:	3	

[Soil Description]

Horizon	Depth (mm)	Boundary	Colour	Mottles	Texture	Coarse Fragments	Structure	Segregations	Consistency	Field pH/sample depth (cm)	
A11	0-100	-	10Y3/3	-	MC	-	M3PO	-	D3/N3	7	3
A12	100-190	CS	10Y3/3	-	MC	-	M4PO	-	D3/N3	7.5	13
B21K	190-500	AS	10Y3/4	-	MC	-	M3PO	1KN11_	T4/N3	7.5	35
B22K	500-800	GS	10Y3/3	-	MC	-	M4PO	1KN11_	T4/N3	8	60

Vegetation: Brigalow Regrowth

Notes:

Appendix 3 2019 survey soil observation data

Project Name: Meadowbrook SLSA

Soil Survey Visual Observations

Observation	Date	Site ID	Vegetation	Soil description/unit	Notes/Direction	Easting (GDA2020/MGA Zone 55)	Northing (GDA2020/MGA Zone 55)	SMU
1	06/12	OP1	Poplar, less Conkerberry	Red sandy/dusty	-	636578	7531750	Mayfair sodic variant
2	06/12	OP2	-	Ground becomes darker	South	637715	7531376	Mayfair sodic variant
3	06/12	OP3	Poplar, She oak	Ground becomes lighter	Moving east from MP12	-	-	-
4	06/12	OP4	Brigalow to Coolibah	Red/brown dusty to vertosol	west	640366	7526105	Knockane
5	06/12	OP5	Open grassland, Brigalow regrowth	Change from dark vertosol to lighter red/brown	East	641515	7525140	Norwich
6	06/12	OP6	Brigalow	Red/brown vertosol looking	South	643719	7524772	Knockane
7	06/12	OP7	Less Brigalow, more Warrior Bush	Ground becomes less cracked	South	643681	7524070	Knockane
8	07/12	OP8	-	Changes from vertosol (MP1) to red/brown, less cracked	North	642696	7520720	Knockane
9	07/12	OP9	Brigalow at creek and shrubby ahead	Dark up until creek then becomes light brown dusty	North crossing creek	-	-	-
10	07/12	OP10	Poplar Box, wattle	Brown dusty	North	643131	7527465	Moreton

Project Name: Meadowbrook SLSA

Observation	Date	Site ID	Vegetation	Soil description/unit	Notes/Direction	Easting (GDA2020/MGA Zone 55)	Northing (GDA2020/MGA Zone 55)	SMU
11	07/12	OP11	Moreton Bay Ash	Creek – sandy red brown	North across creek	641879	7529020	Parrot
12	07/12	OP12	Start to see Poplar Gum	NO OBVIOUS CHANGE	East	640684	7531212	Moreton
13	07/12	OP13	End of Poplar Gum zone	NO OBVIOUS CHANGE	South	641494	7530883	Mayfair sodic variant
14	07/12	OP14	Poplar Box, Moreton Bay Ash, few Poplar Gum	NO OBVIOUS CHANGE	East	641852	7530728	Mayfair sodic variant
15	07/12	OP15	Dominant Poplar Gum	NO OBVIOUS CHANGE	East	642868	7530964	Mayfair sodic variant
16	07/12	OP16	No more Poplar Gum, only Poplar Box	NO OBVIOUS CHANGE	East	643755	7531077	Mayfair sodic variant
17	07/12	OP17	Conkerberry	Change from red/brown bull dust to vertosol	South	645112	7530610	Mayfair sodic variant
18	07/12	OP18	Dominant Conkerberry	Ground hard-setting, light brown dusty	South-east	642233	7528090	Moreton
19	07/12	OP19	End of Conkerberry, Poplar Box woodland starts	Soil changes from light brown to red/orangey sandy	East	643935	7527942	Moreton
20	07/12	OP20	Moreton Bay Ash and	Sandy red/brown	Heading west	645514	7528640	Moreton

Project Name: Meadowbrook SLSA

Observation	Date	Site ID	Vegetation	Soil description/unit	Notes/Direction	Easting (GDA2020/MGA Zone 55)	Northing (GDA2020/MGA Zone 55)	SMU
			Poplar Box, not many Poplar Gum					
21	07/12	OP21	Thick Moreton Bay Ash	-	East	644660	7528250	Moreton
22	07/12	OP22	Changes from Conkerberry to dense Moreton Bay Ash	NO OBVIOUS CHANGE	North	643653	7527993	Knockane
23	07/12	OP23	Heading to Brigalow, some Poplar Box to west	Becoming cracked, gilgai	East	641871	7526869	Knockane
24	08/12	OP24	Brigalow changes to Warrior Bush	Change from vertosol to red/brown dusty	North	643675	7523992	Knockane
25	08/12	OP25	No Brigalow, some Poplar	Orangey red/brown dusty	North	640241	7526477	Moreton
26	08/12	OP26	Poplar to east, thick Brigalow to west	-	North-west	639719	7526778	Moreton
27	08/12	OP27	Poplar Box, no Brigalow in close proximity	Firm red/brown	-	636669	7528161	-
28	08/12	OP28	Some Poplar Gum, Moreton Bay Ash	Soft brown-red/sandy	East	638387	7528000	Moreton

Project Name: Meadowbrook SLSA

Observation	Date	Site ID	Vegetation	Soil description/unit	Notes/Direction	Easting (GDA2020/MGA Zone 55)	Northing (GDA2020/MGA Zone 55)	SMU
29	08/12	OP29	Sally Wattle and Poplar Box to east, Brigalow to west	NO OBVIOUS CHANGE	South-east	638993	7526973	Knockane
30	08/12	OP30	Thick Brigalow regrowth	Same as MP27	South	639838	7525535	Knockane
31	08/12	OP31	Still Brigalow	Same as OP30	South-west	639658	7524140	Knockane
32	08/12	OP32	Becomes thick Brigalow	Soil turns from MP24 unit to vertosol	East	641001	7520825	Knockane
33	08/12	OP33	Brigalow less dense, Warrior Bush, Conkerberry	Firm brown/red	East	642480	7521326	Knockane
34	09/12	OP34	Same Brigalow regrowth, Warrior Bush, Conkerberry	From light brown/red	East	645264	7523547	Knockane
35	09/12	OP35	Thicker Brigalow	Soil becomes darker and appears as vertosol	East	644605	7523320	Knockane
36	09/12	OP36	Back to OP34	-	Eastwards	645812	7523729	Parrot
37	09/12	OP37	Cleared Brigalow	Vertosol dark cracking gilgai	North	647404	7525028	Knockane

Project Name: Meadowbrook SLSA

Observation	Date	Site ID	Vegetation	Soil description/unit	Notes/Direction	Easting (GDA2020/MGA Zone 55)	Northing (GDA2020/MGA Zone 55)	SMU
38	09/12	OP38	Disappearance of Brigalow, heading to Eucalyptus woodland with Sally Wattle and Poplar	Goes from vert to red/brown dusty	North	647535	7527714	Parrot
39	09/12	OP39	Brigalow regrowth to open shrubby	Gilgai/cracking dark. Disappears to MP16 stuff	West	647603	7527125	Norwich
40	09/12	OP40	Open, mainly Conkerberry	Dark to brown/reddish, no cracking/gilgai	North	645218	7526239	Parrot
41	09/12	OP41	Conkerberry on left hand side, dense Brigalow regrowth on right	Brown reddish on left, vertosol on right	South-west	644019	7526620	Parrot
42	09/12	OP42	Brigalow regrowth all over	Gilgai	South	643718	7525080	Norwich
43	09/12	OP43	Dense Brigalow to open Conkerberry	Change from vertosol to duplex red/brown sandy	North to MP26	644768	7525637	Norwich
44	09/12	OP44	Brigalow regrowth	Gilgai/ vertosol	North	644149	7523384	Knockane

Project Name: Meadowbrook SLSA

Observation	Date	Site ID	Vegetation	Soil description/unit	Notes/Direction	Easting (GDA2020/MGA Zone 55)	Northing (GDA2020/MGA Zone 55)	SMU
45	09/12	OP45	Less Brigalow, Conkerberry, Warrior Bush	Red/brown firm, no vertosol	North	643850	7523903	Knockane
46	09/12	OP46	Poplar Box, Moreton Bay Ash	Dusty red/brown sandy	North	639984	7527702	Moreton
47	09/12	OP47	Poplar, Broad Leaf Iron Bark, Moreton Bay Ash	Quite sandy brown	East	-	-	-

Appendix 4 Soils, pre-mining land suitability and stripping recommendations for Lake Vermont Coal Mining Lease (NQSA 2012)

Soils, pre-mining Land Suitability and stripping recommendations for Lake Vermont Coal mining lease, Central Queensland.

J McClurg

North Queensland Soil Assessment (NQSA)

17th April 2012

Summary

The soils within most of the Lake Vermont Mining Lease (ML) and all of the Mining Lease Application (MLA) areas were mapped at an approximate scale of 1: 30 000 to determine their distribution and characteristics. The area mapped totals 3097 ha.

Soils were defined and named consistent with previous adjoining soil and land surveys. Sixteen soils, including phases and variants, were identified within the mapped area. Cracking clays with hard setting to weakly self-mulching surface (Knockane soil) occupy the largest area, while other soils mapped include cracking clays with self-mulching surfaces, non-cracking and weakly cracking clays as well as minor areas of sodic and non-sodic duplex soils.

Native vegetation over nearly all of the area has been cleared, with Brigalow regrowth common, often with currant bush and sometimes Belah. Patches of Parthenium weed also occur. Regrowth of Eucalypts such as Bloodwoods, often with currant bush, also occurs. Minor areas of Eucalypts and in some places almost pure stands of Belah have been left relatively untouched. Generally good stands of Buffel grass, Blue grasses and occasionally Rhodes grass occur.

Topsoil stripping recommendations are provided for all soils mapped within the ML and MLA.

Land suitability assessment of the ML and MLA for both rainfed cropping and grazing was undertaken using a combination of an older classification system for the Central Highlands and parts of a draft updated version. This assessment concluded that within the area of the ML mapped, 195 ha are suitable for rainfed cropping and 223 ha suitable for the production of 2-3 year old, grass-fed, export quality cattle in most seasons. Within the MLA, 30 ha are suitable for rainfed cropping, with the same area also suitable for production of 2- 3 year old, grass-fed, export quality cattle.

Good Quality Agricultural Land (GQAL) status was assessed over the area of ML mapped and the MLA. This assessment concluded the area of GQAL is approximately 250 ha within the total area surveyed.

The 452 ha MLA was assessed for Strategic Cropping Land (SCL) status according to the recently released State Planning Policy (SPP) and associated guidelines. This assessment concluded that there is no SCL within the MLA.

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Acknowledgments

- Matthew Esdaile and Tony Bambrick are acknowledged for assistance with logistics – site accommodation, access and on-site work approvals – your assistance is gratefully appreciated.
- Paul Stewart from Minserve for wonderful computer GIS skills to provide maps and tabulated data of areas etc. – your skill and patience in producing the GIS results and willingness to make last minute changes enabled this report to be completed.
- Adam Osten for assistance with on-site field work – your help with excavating soil cores is gratefully appreciated.

1. Background

1.1 General

Lake Vermont Coal mine proposes to expand their mining operation to include further areas within the existing Mining Lease (ML) area than the initial area within the EIS (dated 2004).

Further expansion is also proposed to the west of the existing ML, which will be subject to a new EIS, and include Strategic Cropping Land (SCL) assessment under the recent introduced *State Planning Policy 1/12 : Protection of Queensland's strategic cropping land* (DERM 2012) (referred to as SPP1/12 in this report) and associated Guidelines dated September 2011 (DERM 2011) (referred to as Sept 11 Guidelines). This area is termed as the Mining Lease Application Area or MLA in this report.

Information on soils is required for operational purposes and to satisfy legislative requirements for the proposed expansion of mining activities. A soil and land resource assessment is required:

- To classify and map soil distribution,
- Assess the suitability of topsoil and subsoil material for rehabilitation,
- Assess the suitability of the land for uses other than mining; and
- Identify potential management limitations associated with particular soil characteristics.

From this assessment, a land suitability map is to be provided of the ML and MLA. Land classified as good quality agricultural land in the DERM's land classification system is to be shown in accordance with the planning guideline, *The Identification of Good Quality Agricultural Land*, which supports *State Planning Policy 1/92*.

A topsoil management plan is also required over the ML and MLA areas.

Within the MLA area an SCL assessment according to the recently introduced State Government Legislation is required.

NQSA was contracted by Lake Vermont Coal Mine on 28th October 2011 to provide the information listed above. On-site field work did not commence until 21st November due to site accommodation and personal induction requirements. Field work for 2011 was completed on 7th December due to weather (rainfall) interruption and other work and private (Christmas holiday) commitments. Soil mapping covering approximately 85 % of the existing ML is and all of the MLA area was completed in 2011, with the balance completed in early 2012 when the land was dry enough for adequate access.

A small area of existing cropping in the south west corner of the ML was outside of the area surveyed and therefore not included in this report.

This report details the methodology and results of the soil survey to provide the information requested above.

The mining lease is located approximately 15 kms north east of Dysart, 20 kms east of the Saraji rail loop and approximately 4 kms north of the Golden Mile Road.

1.2 Previous Soil and Land Information

The Land System map at a scale of 1 inch equals 8 miles or approximately 1 : 500 000 within the CSIRO report, *Lands of Isaac-Comet area* (Story *et al* 1967), shows two Land Systems within the Lake Vermont ML. These are:

- Blackwater (Bl) described as Plains on acid clay, frequently gravelly; cracking clay soils (Rolleston) with Brigalow scrubs.
- Girrah (Gi) described as Plains and lowlands on shale; cracking clay soils (Teviot) on downs and Brigalow

A soils map at a scale of 1 inch equals 4 miles or approximately 1:250 000 is included within the CSIRO report (Story *et al* 1967). This map (titled Land Systems grouped according to their dominant soil families by R.H. Gunn) also shows two units of cracking clay soils within the Lake Vermont ML :

- Mainly on weathered zone : Rolleston. Glenora with minor Taurus, Gindie and Cheshire.
- On sedimentary rocks : Teviot, minor Southernwood, Taurus and Bruce.

The northern boundary of soils mapping from the Windeyers Hill area (Burgess 2003) is located 5 kilometers to the south-west of the ML. This low intensity survey identified 56 soil profile classes (termed soils in this report), 10 soil phases and 3 soil variants based on geology, landscape position, native vegetation and soil morphology.

Emmerton (2004) mapped the soils and land suitability for rainfed cropping and grazing over the initial mining disturbance area of Lake Vermont Mining Area.

Existing surface Geology maps of the area are at a broad scale, such Olgers (1969), and were not helpful in identifying geology changes that were reflected in soil changes on the ground observed and mapped at the scale of this survey. Soils identified within the nearby Windeyers Hill area (Burgess 2003) were assume to continue north into the survey area with good correlation between landform, geology and vegetation changes reflected on the ground. Field work completed in this survey did confirm this very good correlation and the validity of using this as the basis for soils mapping.

2. Land resource assessment methodology

The earlier report covering part of the Lake Vermont Mining Area (Emmerton 2004) mapped soils based on the soil profile classes described within Burgess (2003). This report adopts a similar convention, with most soil profiles described correlating well with soil profile classes of Burgess (2003). Where there were significant differences, these are discussed in the relevant sections below.

Black and white aerial photographs were flown on 17th November 2003 by Australasian Mapping Services for Lake Vermont Coal at a scale of approximately 1:15 000. Stereoscopic photo interpretation on these aerial photos using landscape features and soil–vegetation photo patterns delineated initial soil type changes across the survey area. Proposed field sampling locations were selected during this process. These initial soil change boundaries were the basis for soil mapping, checked in the field and modified where field features dictated. Some soil changes were also identified that were not identified during the stereoscopic photo interpretation. These soil changes were also included on the soil map.

Coloured GIS maps at an approximated scale of 1: 30 000 were produced by the Minserve Group and used in the field to locate ground observations sites, soil changes and map boundaries on the ground based on geology, soil surface, vegetation and landform changes. Soil boundaries and ground observation sites were directly marked on these coloured maps.

The Minserve Group produced a coloured GIS map at 1: 10 000 scale of the ML and MLA areas with 0.1 m contour overlays based on recently collected LIDAR data (based on 1 meter grid). Location of ground observation sites and soil boundaries from the field work were then superimposed over this map to produce a final soils map. The final soils map was reproduced at a scale of 1: 25000 and is presented as Map 1 at the back of this report.

Location of ground observation sites was generally restricted to existing access tracks and fence lines as well as lines pushed for drilling rig access. Some ground observation sites were located by traverses across the landscape with cross references to fence gates or major bends in the access tracks (which were recorded as way points on a hand held GPS).

Soil cores were excavated generally to a depth of 1.5 – 1.9 m or depth to underlying rock or calcareous decomposing rock layer and described at all ground observation sites. Check holes were also used where necessary to check the soil boundaries accurately in the field. No detailed descriptions of soil cores were completed at check hole sites.

Most soil profiles were excavated in the field from trailer mounted soil-coring equipment, which provided a fresh, generally undisturbed soil core for examination. This equipment allowed an undisturbed 50 mm diameter soil core to be examined at each ground observation site. Figure 1 on the next page shows the soil-coring equipment.

Ninety ground observation sites where the soil profile was excavated and described over the ML and MLA areas were completed during the field work phase. Locations of these ground observations are shown on the accompanying soils map located at the back of the report.

Detailed field descriptions of the soil profiles and land features described and recorded at the 90 ground observation sites are included in **Appendix I**. In these descriptions, the terminology and codes are as per National Committee on Soil and Terrain (2009) (commonly referred to as the Yellow field book 3rd edition), and soil classifications recorded as per Australian Soil Classification (ASC, Isbell 2002) and World Reference Soil Group (IUSS Working Group WRB. 2007).

Figure 11 Coring equipment for soil sampling, Lake Vermont MLA

AMG co-ordinates were taken from field readings of a hand held GPS system (accurate to within 5–10 m), recorded on Australian Datum 1994 and added to the detailed field descriptions.

Data from two check holes and from 14 soil sites within the previous soil survey (Emmerton 2004) was also incorporated into the base data for this survey, giving a total of 104 soil profiles that were assessed during this survey. This equates to a site intensity of one site per 29 Ha, which is just less than the standards for a high intensity (1:25 000) scale soil survey (Reid 1988).

3. Vegetation and land use

The survey area comprises 3097 hectares immediately adjacent to the existing mining operation (see Map 1). Most of the area has been completely cleared, and regrowth of Brigalow, Eucalypts and some currant bush evident. Small areas of uncleared Eucalypt and Belah have been left probably as shade areas for cattle. Generally, there is good grass cover of Buffel grass, some Rhodes grass and thick patches of Parthenium weed. Figures 2 – 6 on the following pages show some photos of the vegetation recorded in this survey.

Figure 2 2 Brigalow regrowth with buffel grass and some currant bush, Lake Vermont ML.

Figure 3 3 Uncleared Eucalypt vegetation, Lake Vermont ML.

Figure 44 Good cover of Buffel grass, Lake Vermont MLA Area.

Figure 5 5 Cattle grazing on Buffel grass, Lake Vermont ML.

Figure 66 Stand of uncleared Belah, Lake Vermont ML.

The area north and west of the creek line with 2 dams shows no evidence of previous cultivation, whereas most of the area to the south of the creek line has been cultivated in the past, with evidence such as contour banks and little or no gilgai which is likely to be the result of past land leveling operations. However, at the time of survey the land had been sown to improved pasture grass such as Buffel grass. It did not appear to have been cropped for a number of years, if at all, as the pasture appeared to have been sown a number of years ago.

There is an area of existing cropping in the south west corner of the ML. This area was outside of the area surveyed and therefore not included in this report.

4. Soils

4.1 General

Soil profile descriptions were grouped into 16 soils (including phases and variants) within the Vermont Coal ML and MLA, based on geology, landform, native vegetation and soil profile morphology features. Native vegetation usually reflects surface fertility and subsoil salinity and sodicitiy levels (Burgess 2003).

The physical extent of the soils is depicted on the soil map at the back of this report. Brief description of the soils including Geology, Vegetation, Soil Morphology and Australian Soil Classification is presented in Table 1 staring on the next page. Areas of each soil mapped within the ML and MLA and the number of soil profiles examined and described in this survey are given below in Table 2**.**

Table 11 Brief description of soils mapped over Lake Vermont Mining Lease and Mining Lease Application Areas

Soils developed on calcareous unconsolidated sediments sourced from Basaltic Landscapes (TQab)

	Vegetation	ASC **
Hazelbrae (Hb) Deep to very deep, alkaline, brown or grey texture contrast soil with thick, clay loamy topsoil; non-sodic in the upper subsoil.	Brigalow	Hypercalcic Brown or Grey Chromosol
Knockane (Kk) Moderately to very deep, alkaline, grey or brown cracking clay with hard setting surface.	Brigalow	Epipedal Grey or Brown Vertosol
Knockane (KkWp) Moderately to very deep, alkaline, mottled grey cracking clay with hard setting surface.	Brigalow	Aquic Grey Vertosol
Knockane (KkSp) Shallow to moderately deep, gravelly, alkaline, grey or brown cracking clay with hard setting surface.	Brigalow	Epipedal Grey or Brown Vertosol
Norwich (Nw) Deep to very deep, alkaline grey or brown cracking clay with moderately to strongly self-mulching surface.	Brigalow	Self-mulching Grey or Brown Vertosol
Picardy (Pc) Deep to very deep, alkaline, black cracking clay with strongly self-mulching surface.	Brigalow	Self-mulching Black Vertosol
Picardy Surface Seal Phase (PcXp) Deep to very deep, alkaline, black cracking clay with strongly self-mulching surface; weak surface seal may form after rainfall.	Brigalow	Self-mulching Black Vertosol
Picardy Rocky Phase (PcR) Very shallow, gravelly, black cracking clay with strongly self-mulching surface.	Brigalow	Self-mulching Black Vertosol
Kirkcaldy (Kc) Moderately to very deep, neutral to alkaline, brown or red non-cracking to weakly cracking clay.	Eucalypts	Hypercalcic Brown Dermosol or Epipedal Brown Vertosol

Soils developed on calcareous unconsolidated sediments sourced from Basaltic Landscapes (TQab) (cont'd)

Soil	Description	Vegetation	ASC *
Mayfair (Mf)	Moderately to very deep, alkaline, brown or red non-sodic texture contrast soil with thick, clay loamy topsoil.	Eucalypts	Hypercalcic Red or Brown Chromosol
Mayfair Sodic Variant (MfSv)	Deep to very deep, alkaline, grey or brown sodic texture contrast soil with thick, clay loamy topsoil.	Eucalypts	Grey or Brown Mottled-Subnatric Sodosol
	Soils developed on unconsolidated sediments sourced from Sedimentary Landscapes (TQa)		
Pomegranate (Pg)	Very deep, alkaline, brown non-cracking to weakly cracking clay.	Brigalow	Epipedal, Brown Vertosol or Hypercalcic Brown Dermosol
Pomegranate Melonhole Phase (PgMp)	Similar soil profile to Pg soil but with melonhole gilgai to 1.00 m deep.	Brigalow	Epipedal Aquic Vertosol or Hypercalcic Brown Dermosol
Pomegranate Shallow Variant (PgMp)	Moderately deep, alkaline, brown non-cracking to weakly cracking clay.	Brigalow	Epipedal, Brown Vertosol or Hypercalcic Brown Dermosol
	Soils developed on recent alluvium (Qa)		
Langley (Lg)	Very deep, alkaline, black cracking clay with strongly self-mulching surface.	Brigalow	Self-mulching Black Vertosol
Parrot (Pr)	Deep to very deep, alkaline, brown non-sodic texture contrast soil with very thick, sandy topsoil.	Eucalypts	Eutrophic Brown Chromosol

* Soil depth and texture terminology from family criteria within the ASC.
** Australian Soil Classification (Isbell 2002) Classification given only to most common Great Group Level.

Table 22 Areas of each soil and number of soil profiles described within Lake Vermont Mining Lease and Mining Lease Application Areas

Soil	Area mapped (ha)	Number of soil profiles described in this survey	Number of soil profiles described from previous survey *
Hazelbrae (Hb)	28	1	
Knockane (Kk)	1342	32	1
Knockane Wet Phase (KkWp)	9	1**	
Knockane Shallow Phase (KkSp)	21	1**	
Norwich (Nw)	93	6	1
Picardy (Pc)	198	9	
Picardy Surface Seal Phase (PcXp)	27	1	1
Picardy Rocky Phase (PcR)	6	1	
Kirkcaldy (Kc)	710	20	2
Mayfair (Mf)	183	5	1
Mayfair Sodic Variant (MfSv)	115	8	
Pomegranate (Pg)	11	0	1
Pomegranate Melonhole Phase (PgMp)	11	1	
Pomegranate Shallow Variant (PgSp)	27	0	2
Langley (Lg)	256	5	1
Parrot (Pr)	1	1	
Dam	59	0	
Totals	**3097**	**92**	**12**

* Sites from Emmerton (2004)
** Check sites only – no detailed profile descriptions available.

Most soils are formed on calcareous sediments with basaltic influence (Geology unit TQab) or sourced from sedimentary landscapes (Geology unit TQa) except for areas of alluvium (Geology unit Qa) in the southeast of the survey area and minor areas in the MLA.

Soil profile morphology such as topsoil (A horizon) texture, subsoil (B Horizon) colour and structure, soil depth and surface features such as melonhole gilgai were used to delineate and classify the soils within similar landforms, geology and native vegetation. Where possible the soils were defined and named using the soil profile classes, phases and variants previously defined in Burgess (2003).

One new soil phase, PcR is included in this survey that was not previously identified in Burgess (2003). This soil phase depicts a small area of Pc soil (6 ha) with significant surface gravel to cobble and shallower soil.

In this survey, soil MfSv is termed Mayfair Sodic Variant which is based on the earlier soil phase Mayfair Sandy Variant of Burgess (2003). This was a very minor soil in terms of area within the earlier survey. Data from more soil cores collected in this survey provides a more detailed soil description for this soil variant that in the earlier report. The main difference is the surface or A horizon texture and depth and wider variation in upper subsoil colour and structure and soil depth to underlying substrate.

The ML and MLA areas are dominated in terms of area mapped by cracking clays with hard setting to weakly self-mulching surface, (Knockane soil and minor Tralee soil). Self-mulching clays (Norwich, Picardy, Picardy surface seal variant, Picardy rocky phase and Langley soils) were also mapped. Non-cracking to weakly cracking clays (Kirkcaldy and Pomegranate soils and Pomegranate melonhole and Pomegranate shallow phases) and texture contrast soils (Hazelbrae, Mayfair, Mayfair sodic variant and Parrot) are mapped as minor soils.

127 soil samples from 13 soil profiles were collected for chemical analyses. These samples were analysed by an ASPAC accredited Laboratory for chemical properties that are important in assessing agricultural suitability and topsoil stripping suitability. Full results are given in **Appendix II.** The results are assumed to represent the chemical properties of each soil analysed.

4.2 Detailed soil descriptions including geology, vegetation, landform, grazing suitability and topsoil stripping recommendations

Detailed descriptions of each soil, variant and phase including geology, landform, vegetation, Australian Soil Classification and suitability start on the next page. Chemical and physical data including fertility from analyzed profiles are included where appropriate as well as a summary of soil properties including Plant Available Water Capacity (PAWC) and management issues for topsoil stripping and soil reuse. Results of the Agricultural Suitability Analysis (which is discussed in Section 6 below) are also included for each soil, phase and variant.

Soil Hb Deep to very deep, alkaline, brown or grey texture contrast soil with thick, clay loamy topsoil. Non-sodic upper subsoil.

Australian Soil Classification : Hypercalcic Brown or Grey Chromosol
World Reference Base Reference Soil Group : ha LV, ap, ca, sow **Area mapped** 28 ha

Landform : Low Rises **Geology** : Unconsolidated calcareous sediments (TQab)

Vegetation : Brigalow

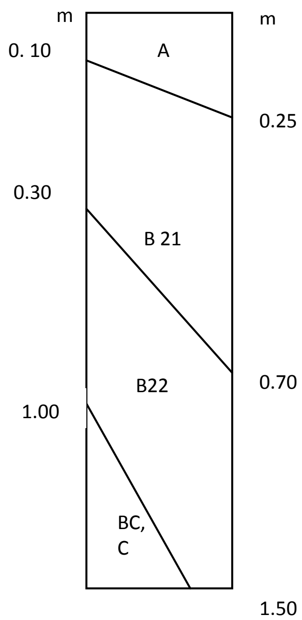
Run-off, Perm. & Drainage : Slowly permeable and moderately well-drained

Surface features : Hard setting

Surface Fertility : Moderate Phosphorus with high Nitrogen and Calcium levels

Estimated PAWC : 84 - 123 mm

Investigation sites : one **Sample sites** : Nil - data from WDH 9119



Soil profile description

A – Sandy clay loam to clay loam, massive to weakly structured. pH 6.0 – 8.5. Usually thin bleach at A / B boundary.

B21 – Brown or grey, light medium to medium clay (sandy), blocky or lenticular structure. pH 8.0 – 9.0

B22 – Brown, light to medium clay (sandy), blocky or lenticular structure. pH 8.5 – 9.5 Moderately to highly calcareous

BC or C – Unconsolidated, very highly calcareous fine grained sediments , pH > 8.5.

Soil chemical and physical data (from site WDH 9119)

- pH is alkaline from the surface
- EC and chloride levels are low to 0.90 m, but increase to moderate levels below this.
- ESP levels are low at the surface increasing in the subsoil to moderate to high levels from 0.60 m which corresponds with high dispersion values.
- Moderate to high CEC levels correspond with high clay content of the subsoil.

- Clay content increases significantly between the top soil and subsoil, reflecting the duplex nature of the soil profile.
- This soil has high fine sand content with low silt content and moderate clay content corresponding to the subsoil field textures. However, the high fine sand content and lower clay content of the surface compared to the subsoil suggests it will be hard setting, which agrees with the field descriptions and indicates it will be subject to water erosion on all slopes where appropriate runoff control structures are not constructed. The surface may tend to become bulldust when disturbed due to the massive surface structure.
- Measured dispersion index (R1) and moderate to high ESP suggests the subsoil below 0.60 m is dispersive and unstable once disturbed.

Summary

This surface soil may become bulldust upon disturbance. Any salvaged material is likely to be subject to slaking, sealing and have poor physical properties due to the high fine sand content and is therefore susceptible to water erosion. Appropriate runoff control structures should be constructed where this soil is placed on slopes. The material below 0.50 m is not recommended for salvage due to high ESP and dispersion levels.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0.15 m	Strip surface to 0.15 m for seed surface material and root zone media
	Subsoil	0.50 m	Strip subsoil to 0.50 m depth from original surface for root zone media.
Single stage stripping	Combined	0.50 m	Do not strip combined surface/subsoil beyond 0.50 m to avoid sodic and dispersive material.

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 Unsuitable	m5
Grazing	Class 2 – Land suitable for the production of 2-3 year old, grass-fed, export quality cattle in most seasons	nd2

Soil Kk Moderately to very deep, alkaline, grey or brown cracking clay with hard setting surface.

Australian Soil Classification : Epipedal Grey or Brown Vertosol
World Reference Base Reference Soil Group : mz, so VR, ca **Area mapped** 1342 ha

Landform : Low Rises **Geology** : Unconsolidated calcareous sediments (TQab)

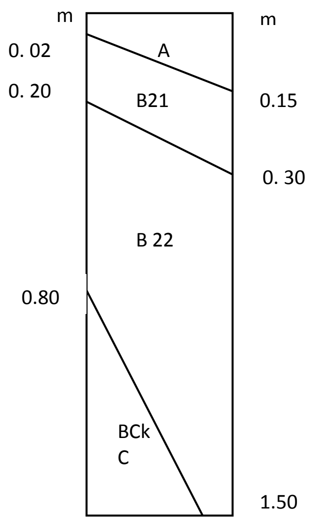
Vegetation : Brigalow

Run-off, Perm. & Drainage : Slowly permeable and moderately well-drained

Surface features : Hard setting, occasionally weak patchy self-mulch. Often gilgai to 0.30 m deep

Surface Fertility : Low Phosphorus but high Calcium and Total Nitrogen levels.
Estimated PAWC : 81 - 126 mm

Investigation sites : thirty two **Sample sites** : 10, 64 plus WDH 9111 & 9116



Soil profile description

A – Black, light to light medium clay (sandy), moderate to strongly blocky structure. pH 6.5 – 8.0

B21 – Grey or brown, light medium to medium clay, blocky or lenticular structure. Moderately to highly calcareous pH 8.0 – 9.0

B22 – Grey or brown, light to medium clay, lenticular structure. Moderately to highly calcareous. pH > 8.5

BCk or C – Unconsolidated, very highly calcareous fine grained sediments , pH > 8.5.

Soil chemical properties – data from site 64

Sample depth (m)	pH (water)	EC (dS/m)	Cl (mg/kg)	CEC or/ECEC (meq/100g)	Exchangeable cations (meq/100 g)				Calculated ratios	
					Ca	Mg	Na	K	ESP	Ca:Mg
0.10	8.5	0.10	<6	29	24.1	6.7	0.2	0.4	0.6	3.6
0.30	8.8	0.14	<6	38	25.4	13.1	1.4	0.1	3.7	1.9
0.60	9.3	0.27	20	38	18.7	16.9	4.8	0.1	12.7	1.1
0.90	9.3	0.42	183	34	13.1	16.0	6.3	0.1	18.6	0.8

- pH is alkaline from the surface increasing to very high values below 0.40 m.

- EC and chloride levels are low to 0.30 m, but increase to moderate levels from 0.60 m.
- ESP levels are low at the surface increasing in the subsoil to moderate to high levels by 0.60 m which corresponds with high dispersion values.
- High CEC levels correspond with high clay content of the soil profile.
- Other sampled sites show similar trends. 37 % of observation sites where field EC (1:5) was measured had high to very values from 0.90 m while 18 % had high to very high values from 0.60 m. 25 % had low values to 1.20 m. 32% of Emerton (2004) sites had moderate to high EC by 0.60 m, and a further 32% by 0.90 m.

Soil physical properties – data from site 64

Sample depth (m)	Particle size analysis (%)				Calculated ratios and ratings				
	C sand	F sand	Silt	Clay	R1 Dispersion	CEC/Clay	Sodicity rating	Salinity rating	Ca : Mg rating
0.10	30	30	9	31	0.43	0.94	Low	Low	High
0.30	29	20	11	43	0.45	0.88	Low	Low	High
0.60	33	18	11	41	0.75	0.93	High	Low	High
0.90	38	17	10	40	0.92	0.85	V high	Mod	Mod

- This soil has high clay content with low silt content. However, the high fine sand content and lower clay content of the surface compared to the subsoil suggests it will be hard setting, which agrees with the field descriptions and indicates it will be subject to water erosion on all slopes where appropriate runoff control structures are not constructed.
- High CEC/clay ratios as well as lenticular structure in the subsoil suggest the clay fraction is reactive, has shrink/swell properties and contains significant proportion of montmorillonite.
- Measured dispersion index (R1) are low in the surface to 0.30 m, but high from 0.60m. These levels combined with the moderate to high ESP suggests the subsoil below 0.60 m is dispersive and unstable once disturbed.
- Other sampled sites show similar trends.

Summary

Any salvaged material from the soil surface is likely to be subject to slaking, sealing and have poor physical properties due to the high fine sand content and is therefore susceptible to water erosion. Appropriate runoff control structures should be constructed where this soil is placed on slopes. Soil material below 0.40 m should not be reused to avoid material with variable salt levels and likely corresponding high sodicitiy and dispersion levels.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0 30 m	Strip surface to 0.30 m for seed surface material and root zone media
	Subsoil	0.40 m	Strip subsoil to 0.40 m depth from original surface for root zone media.
Single stage stripping	Combined	0.40 m	Do not strip combined surface/subsoil beyond 0.40 m to avoid contamination with strongly alkaline material and possible high salinity and sodicitiy levels.

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 Unsuitable	m5
Grazing	Class 3 – Suitable land for the production of 2-3 year old, grass-fed, export quality cattle, but only in good seasons	nd3

Soil KkWp Moderately to very deep, alkaline, mottled grey cracking clay with hard setting surface

Australian Soil Classification : Aquic Grey Vertosol
World Reference Base Reference Soil Group : mz, ct, so VR, ca **Area mapped** 9 ha

Landform : Open depression **Geology** : Unconsolidated calcareous sediments (TQab)

Vegetation : Brigalow

Run-off, Perm. & Drainage : Slowly permeable and poorly drained

Surface features : Hard setting

Surface Fertility and **Estimated PAWC** : expected to be similar to Kk soil.

Investigation sites : one (check site only) **Sample sites** : Nil

Soil chemical and physical data : expected to be similar to Kk soil.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil		Not recommended for reuse due to significant soil wetness issues
	Subsoil		
Single stage stripping	Combined		

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 Unsuitable	m5
Grazing	Class 3 – Suitable land for the production of 2-3 year old, grass-fed, export quality cattle, but only in good seasons	nd3, w3

Soil KkSp Shallow to moderately deep, gravelly, alkaline grey or brown cracking clay with hard setting surface

Australian Soil Classification : Epipedal Grey or Brown Vertosol

World Reference Base Reference Soil Group : mz, nl, so VR ca **Area mapped** 21 ha

Landform : Existing gullies and significant slopes on edge of rises down to Philips Creek

Geology : Unconsolidated calcareous sediments (TQab)

Vegetation : Brigalow and Eucalypts.

Run-off, Perm. & Drainage : Slowly permeable and imperfectly to moderately well-drained

Surface features : Hard setting. Calcareous gravel to cobbles or underlying substrate often exposed

Surface Fertility : expected to be similar to Kk soil.

Estimated PAWC : 53 - 81 mm

Investigation sites : one (check site only) **Sample sites** : Nil

Soil chemical and physical data : expected to be similar to Kk soil.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	m	Not recommended for reuse due to surface "rocks" and significant erosion potential due to surface slope and shallow depth to underlying substrate
	Subsoil	m	
Single stage stripping	Combined	m	

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 Unsuitable	m5
Grazing	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	nd3, w3, e3, r2-3, often t4

Soil Nw Deep to very deep, alkaline, grey or brown, cracking clay with moderately to strongly self-mulching surface.

Australian Soil Classification : Self-mulching, Grey or Brown Vertosol
World Reference Base Reference Soil Group : gm, so VR, ca **Area mapped** 93 ha

Landform : Low Rises **Geology** : Unconsolidated calcareous sediments (TQab)

Vegetation : Brigalow

Run-off, Perm. & Drainage : Slowly permeable and moderately well-drained

Surface features : Moderately to strongly self-mulching Often gilgai to 0.30 m deep.

Surface Fertility : Low to moderate Phosphorus and Nitrogen; very high Calcium levels.
Estimated PAWC : 126 mm

Investigation sites : six **Sample sites** : 8, 9 plus WDH 9112

Soil profile description

A – Black to grey, medium to medium heavy clay, pH 6.5 – 8.0. Surface 2 – 4 mm is moderate to strong medium granular self-mulch, but in some localaties it may be patchy.

B21 – Grey to brown, medium to medium heavy clay, blocky or lenticular structure. Moderately to highly calcareous pH 8.0 – 9.0

B22 – Grey or brown, medium to medium heavy clay, lenticular structure. Moderately to highly calcareous. pH 9.0 – 5.0

BCk – Unconsolidated, fine grained sediments usually very highly calcareous, pH 9.0 – 5.0.

Soil chemical and physical data – data from site 8.

Sample depth (m)	pH (water)	EC (dS/m)	Cl (mg/kg)	CEC or/ECEC (meq/100g)	Exchangeable cations (meq/100 g)				Calculated ratios	
					Ca	Mg	Na	K	ESP	Ca:Mg
0.10	7.2	0.12	55	22	14.6	5.5	0.50	0.22	2.3	2.7
0.30	9.0	0.21	21	33	15.7	15.2	2.45	0.08	7.4	1.0
0.60	9.5	0.39	80	30	9.0	16.6	5.9	0.04	19.7	0.5
0.90	9.4	0.80	535	30	8.6	16.4	7.5	0.04	25.1	0.5
1.20	9.0	1.36	1525	34	9.0	18.9	7.8	0.04	23.0	0.5
1.50	7.8	1.38	1900	36	8.2	19.5	7.9	0.04	22.0	0.4
1.80	5.6	1.18	1700	29	6.2	15.6	6.1	0.04	20.9	0.4

- pH is neutral at the surface increasing to strongly alkaline in the upper subsoil but decreasing to acid in the lower subsoil and substrate
- EC and chloride levels are low to 0.30 m, but increase to moderate levels from 0.40 m and extreme levels from 1.20 m.
- ESP levels are low at the surface increasing in the subsoil to very high levels by 0.60 m which corresponds with high dispersion values.
- High CEC levels correspond with high clay content of the soil profile.

Soil physical properties – data from site 8

Sample depth (m)	Particle size analysis (%)				Calculated ratios and ratings				
	C sand	F sand	Silt	Clay	R1 Dispersion	CEC/Clay	Sodicity rating	Salinity rating	Ca : Mg rating
0.10	37	29	8	26	0.43	0.85	Low	Low	High
0.30	32	17	5	48	0.49	0.68	Moderate	Low	High
0.60	37	19	6	40	0.98	0.75	Very high	Moderate	Moderate
0.90	35	20	8	41	0.92	0.83	Very high	High	Low

- This soil has high clay content with low silt content. However, the high sand content and lower clay content of the surface compared to the subsoil suggests it may be hard setting, but the field description indicates it is strongly self-mulching. The other analyzed soil profiles have much higher surface clay content.
- High CEC/clay ratios as well as lenticular structure in the subsoil suggest the clay fraction is reactive, has shrink/swell properties and contains significant proportion of montmorillonite.
- Measured dispersion index (R1) are low in the surface to 0.30 m, but very high from 0.60m. This level combined with very high ESP suggests the subsoil below 0.60 m is dispersive and unstable once disturbed. Subsoil chemistry dominated by Magnesium may further compound soil instability.

Summary

The surface soil/upper subsoil to 0.2m is characterised by high clay content, strong structure, significant shrink-swell behaviour and limited dispersion (R1<0.65), sodicitiy (ESP <6) and salinity (<0.3dS/m). Such attributes suggest that material to this depth will be relatively stable and resilient following disturbance. Subsoil material below 0.30 m should be avoided because of rapidly increasing salinity, sodicitiy and dispersion.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0 20 m	Strip surface to 0.20 m for seed surface material and root zone media
	Subsoil	0.30 m	Strip subsoil to 0.30 m depth from original surface for root zone media.
Single stage stripping	Combined	0.30 m	Do not strip combined surface/subsoil beyond 0.30 m to avoid material with high salinity, sodicitiy and dispersion levels.

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 4 Marginal	m3, nd3, sa4
Grazing	Class 3 – Suitable land for the production of 2-3 year old, grass-fed, export quality cattle, but only in good seasons	nd3

Soil Pc. Deep to very deep, alkaline, black cracking clay with strongly self-mulching surface.

Australian Soil Classification : Self-mulching Black Vertosol
World Reference Base Reference Soil Group : gm, so VR, ca, pe **Area mapped** 198 ha

Landform : Low Rises **Geology** : Unconsolidated calcareous sediments (TQab)

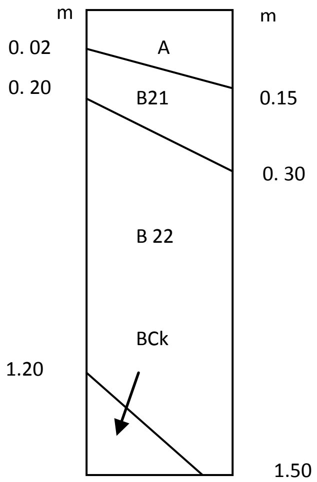
Vegetation : Brigalow and Belah

Run-off, Perm. & Drainage : Slowly permeable and moderately well-drained

Surface features : Strong medium self-mulch, often weak linear gilgai < 0.1m deep.

Surface Fertility : Moderate to high Phosphorous, High Nitrogen and Very High Calcium levels.
Estimated PAWC : 210 mm

Investigation sites : Nine **Sample sites** : 4, 89 & 90 plus WDH 9030, 9032



Soil profile description

A – Black, medium to medium heavy clay, pH 6.5 – 8.0. Surface 2 - 5 mm is strong medium granular self-mulch.

B21 – Black, medium to medium heavy clay, blocky or lenticular structure. Moderately to highly calcareous pH 8.0 – 9.0

B22 – Black to grey, medium to heavy clay, lenticular structure. Moderately to highly calcareous. pH 8.0 – 9.0

BCk – Unconsolidated, fine grained sediments usually very highly calcareous, pH 8.0 – 9.0

Soil chemical and physical data from site 4.

Sample depth (m)	pH (water)	EC (dS/m)	Cl (mg/kg)	CEC or/ECEC (meq/100g)	Exchangeable cations (meq/100 g)				Calculated ratios	
					Ca	Mg	Na	K	ESP	Ca: Mg
0.10	7.9	0.18	15	33	22.0	8.5	0.34	0.29	1.0	2.6
0.30	8.6	0.06	< 6	34	20.7	11.1	1.1	0.07	3.3	1.9
0.60	8.9	0.24	83	40	18.8	17.9	3.56	0.08	8.9	1.1
0.90	8.4	0.67	540	41	17.4	20.1	4.75	0.06	11.6	0.9
1.20	8.6	1.16	1200	44	17.7	22.4	5.45	0.08	12.4	0.8

- pH is alkaline from the surface
- EC and chloride levels are low to 0.60 m, but increase to moderate to very high levels from 0.70m.

- ESP levels are low at the surface increasing in the subsoil to moderate by 0.60 m which corresponds with low to moderate dispersion values.
- Chemistry is dominated by calcium.
- High CEC levels correspond with high clay content of the soil profile.

Soil physical properties – data from site 4

Sample depth (m)	Particle size analysis (%)				Calculated ratios and ratings				
	C sand	F sand	Silt	Clay	R1 Dispersion	CEC/Clay	Sodicity rating	Salinity rating	Ca : Mg rating
0.10	23	24	13	39	0.39	0.86	Low	Low	High
0.30	22	23	11	45	0.51	0.76	Low	Low	High
0.60	17	19	14	53	0.59	0.76	Moderate	Low	High
0.90	17	18	15	54	0.49	0.76	Moderate	Moderate	High
1.20	17	15	12	60	0.39	0.73	Moderate	High	Moderate

- This soil has high clay content with low fine sand and silt content.
- High CEC/clay ratios as well as lenticular structure in the subsoil suggest the clay fraction is reactive, has shrink/swell properties and contains significant proportion of montmorillonite.
- Moderate sodicitiy levels occur from 0.60 m, with salinity levels moderate to high from 0.90 m.
- Measured dispersion levels (R1) are low to moderate throughout – suggesting the calcium dominated chemistry negates to some extent the physical effects of the moderate subsoil sodicitiy levels.

Summary

The surface soil/upper subsoil to 0.6m is characterised by high clay content, strong structure, significant shrink-swell behaviour and limited dispersion (R1<0.65), sodicitiy (ESP mostly <6) and salinity (<0.3dS/m). Such attributes suggest that material to this depth will be relatively stable and resilient following disturbance. Subsoil material below 0.60 m should be avoided because of rapidly increasing salinity levels and courser structured subsoil.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0 30 m	Strip surface to 0.30 m for seed surface material and root zone media
	Subsoil	0.60 m	Strip subsoil to 0.60 m depth from original surface for root zone media.
Single stage stripping	Combined	0.60 m	Do not strip combined surface/subsoil beyond 0.60 m to avoid material with moderate to high salinity

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 2 Suitable with slight limitations	nd2
Grazing	Class 2 – Land suitable for the production of 2-3 year old, grass-fed, export quality cattle in most seasons	nd2

Soil PcXp Deep to very deep, alkaline, black cracking clay with strongly self-mulching surface. Weak to moderate surface seal may form after rainfall.

Australian Soil Classification : Self-mulching Black Vertosol
World Reference Base Reference Soil Group : gm, so VR, ca, pe **Area mapped** 27 ha

Landform : Low Rises **Geology** : Unconsolidated calcareous sediments (TQab)

Vegetation : Brigalow

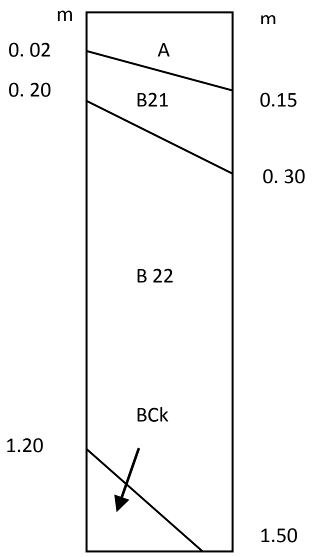
Run-off, Perm. & Drainage : Slowly permeable and moderately well-drained

Surface features : Strong medium self-mulch Gilgai to 0.30 m deep present.

Surface Fertility : Moderate Phosphorous and Nitrogen; Very High Calcium levels.

Estimated PAWC : 210 mm

Investigation sites : One **Sample sites** Nil – data from WDH 9026, 9027



Soil profile description

A – Black, medium to medium heavy clay, pH 6.5 – 8.0. Surface 2 - 5 mm is strong medium granular self-mulch.

B21 – Black, medium to medium heavy clay, blocky or lenticular structure. Moderately to highly calcareous pH 8.0 – 9.0

B22 – Black to grey, medium to heavy clay, lenticular structure. Moderately to highly calcareous. pH 8.0 – 9.0

BCk – Unconsolidated, fine grained sediments usually very highly calcareous, pH 8.0 – 9.0

Soil chemical and physical - data from WDH sites 9026, 9027

- pH is neutral to alkaline from the surface increasing to alkaline in the subsoil
- EC and chloride levels are low to 0.40 m, but increase to moderate below this depth. 86 % of Emmerton (2004) sites had moderate EC levels at 0.60 m increasing to high at 0.90 m.
- ESP levels are low at the surface increasing in the subsoil to moderate by 0.60 m which corresponds with moderate dispersion values.
- Chemistry is dominated by calcium.
- High CEC levels correspond with high clay content of the soil profile.

Soil physical properties – data from site WDH sites 9026, 9027

- This soil has high clay content with low fine sand and silt content.
- However the surface has higher fine sand content which may help explain the tendency to form a surface seal after rainfall.
- High CEC/clay ratios as well as lenticular structure in the subsoil suggest the clay fraction is reactive, has shrink/swell properties and contains significant proportion of montmorillonite.
- Moderate sodicitiy levels occur from 0.60 m, with salinity levels moderate from 0.40 m.
- Measured dispersion index (R1) is moderate throughout – suggesting the calcium dominated chemistry negates to some extent the physical effects of the moderate subsoil sodicitiy levels.

Summary

The surface soil/upper subsoil to 0.4m is characterised by high clay content, strong structure, significant shrink-swell behaviour and limited dispersion (R1<0.65), sodicitiy (ESP mostly <6) and salinity (<0.3dS/m). Such attributes suggest that material to this depth will be relatively stable and resilient following disturbance. Subsoil material below 0.40 m should be avoided because of moderate salinity levels and coarser structured subsoil.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0 20 m	Strip surface to 0.20 m for seed surface material and root zone media
	Subsoil	0.40 m	Strip subsoil to 0.40 m depth from original surface for root zone media.
Single stage stripping	Combined	0.40 m	Do not strip combined surface/subsoil beyond 0.40 m to avoid material with moderate salinity

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 2 Suitable with slight limitations	nd2
Grazing	Class 2 – Land suitable for the production of 2-3 year old, grass-fed, export quality cattle in most seasons	nd2

Soil PcR Very shallow, gravelly, black cracking clay with strongly self-mulching surface.

Australian Soil Classification : Self-Mulching Black Vertosol
World Reference Base Reference Soil Group : gm VR, ca, pe, nl **Area mapped** 6 ha

Landform : Low Hill **Geology** : Unconsolidated calcareous sediments (TQab)

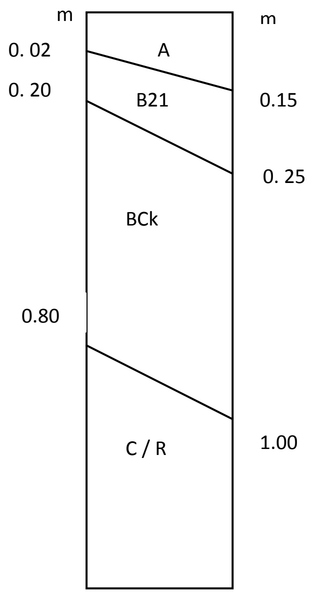
Vegetation : Brigalow

Run-off, Perm. & Drainage : Slowly permeable and moderately well to well-drained

Surface features : Moderate to strong medium self-mulch. Coarse gravel, cobbles and stones – variable geology including basalt and sediments.

Surface Fertility : Expected to be moderate to high
Estimated PAWC : 53 mm

Investigation sites : one **Sample sites** : Nil



Soil profile description

A – Black, medium to medium heavy clay, pH 6.5 – 8.0. Surface 2 - 5 mm is strong medium granular self-mulch. Siginificant gravel to cobble content.

B21 – Black, medium to medium heavy clay, blocky or lenticular structure. Moderately to highly calcareous pH 8.0 – 9.0. Siginificant coarse gravel to cobble content.

BCk – Unconsolidated, fine grained sediments very highly calcareous, pH 8.0 – 9.0 Siginificant coarse gravel to cobble content.

C / R Hard rock

Soil chemical and physical data

- Expected to have low to moderate salinity and sodicitiy in the substrate (BCk horizon).
- Expected to have high clay content and CEC.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil		Not recommended for reuse due to significant “rock” content
	Subsoil		
Single stage stripping	Combined		

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 – Unsuitable	m5, r4
Grazing	Class 3 – Suitable land for the production of 2-3 year old, grass-fed, export quality cattle, but only in good seasons	m3

Soil Kc Moderately to very deep, neutral to alkaline, brown or red non-cracking to weakly cracking clay.

Australian Soil Classification : Hypercalcic Brown Dermosol or Epipedal Brown Vertosol
World Reference Base Reference Soil Group : vr KS, ca, so **Area mapped** 710 ha

Landform : Low Rises **Geology** : Unconsolidated calcareous sediments (TQab)

Vegetation : Eucalypts

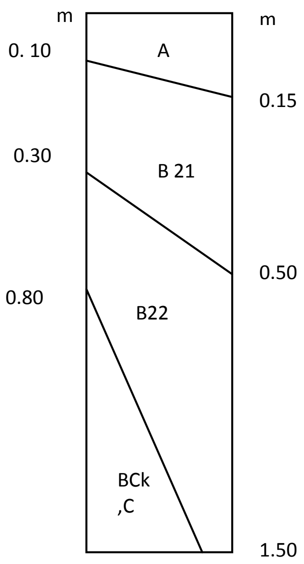
Run-off, Perm. & Drainage : Slowly permeable and moderately well to well-drained

Surface features : Hard setting, occasionally weak linear gilgai < 0.10 m deep.

Surface Fertility : Low Phosphorus with moderate Nitrogen and high Calcium levels.

Estimated PAWC : 108 - 168

Investigation sites : twenty **Sample sites** : 3, 71 plus WDH 9072



Soil profile description

A – Black, light to medium clay (sandy), moderately to strongly structured. pH 6.5 – 7.5

B21 – Brown or red, light medium to medium heavy clay (sandy), blocky or lenticular structure. pH 7.0 – 9.5

B22 – Brown or red, medium to heavy clay (sandy), blocky or lenticular structure. pH 8.5 – 9.5 Moderately to highly calcareous

BCk or C – Uconsolidated, very highly calcareous fine grained sediments , pH > 8.5.

Soil chemical and physical data from site 71.

Sample depth (m)	pH (water)	EC (dS/m)	Cl (mg/kg)	CEC or/ECEC (meq/100g)	Exchangeable cations (meq/100 g)				Calculated ratios	
					Ca	Mg	Na	K	ESP	Ca:Mg
0.10	7.9	0.04	<6	17	12.0	4.1	0.1	0.32	0.3	2.9
0.30	7.8	0.03	<6	16	12.3	3.9	0.2	0.19	1.4	3.2
0.60	8.7	0.11	<6	22	9.9	11.1	1.53	0.08	7.0	0.9
0.90	9.4	0.30	50	26	8.7	15.8	3.75	0.11	14.4	0.5
1.20	9.5	0.54	300	33	8.9	19.8	6.04	0.11	18.3	0.4
1.50	9.2	0.86	710							

- pH is neutral at the surface quickly becoming strongly alkaline in the subsoil.
- EC and chloride levels are low to 0.60 m, but increase to moderate to high levels from 0.70 m.
- ESP levels are low at the surface increasing in the subsoil to moderate to high levels by 0.60 m which corresponds with high dispersion values.
- High CEC levels correspond with high clay content of the subsoil.

Soil physical properties – data from site 71

Sample depth (m)	Particle size analysis (%)				Calculated ratios and ratings				
	C sand	F sand	Silt	Clay	R1 Dispersion	CEC/Clay	Sodicity rating	Salinity rating	Ca : Mg rating
0.10	44	29	7	22	0.55	0.77	Low	Low	High
0.30	42	31	7	23	0.56	0.69	Low	Low	High
0.60	38	22	5	36	0.74	0.61	Moderate	Low	High
0.90	33	20	12	37	0.85	0.70	High	Moderate	Moderate

- This soil has high clay content with low silt content. However, the high fine sand content and lower clay content of the surface compared to the subsoil suggests it will be hard setting, which agrees with the field descriptions and indicates it will be subject to water erosion on all slopes where appropriate runoff control structures are not constructed.
- The data from the other sampled profiles indicate high fine sand content throughout the soil profile.
- Coarse sand content is high throughout; field textures are often recorded as fine sandy.
- High CEC/clay ratios as well as lenticular structure in the subsoil suggest the clay fraction is reactive, has shrink/swell properties and contains high proportion of montmorillonite. Normally such attributes would suggest this material will be relatively stable and resilient following disturbance, but high fine sand content is likely to significantly affect physical behavior.
- Measured dispersion levels (R1) are low in the surface to 0.30 m, but high from 0.60m. These levels combined with the moderate to high ESP suggests the subsoil below 0.60 m is dispersive and unstable once disturbed. Data from site 3 has lower ESP and dispersion levels.

Summary

Any salvaged material from this soil is likely to be subject to slaking, sealing and have poor physical properties due to the high fine sand content and is therefore susceptible to water erosion. Appropriate runoff control structures should be constructed where this soil is placed on slopes. The material below 0.60 m is not recommended for salvage due to high ESP and dispersion levels.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0 40 m	Strip surface to 0.40 m for seed surface material and root zone media
	Subsoil	0.60 m	Strip subsoil to 0.60 m depth from original surface for root zone media.
Single stage stripping	Combined	0.60 m	Do not strip combined surface/subsoil beyond 0.60 m to avoid sodic and dispersive material.

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 4 Marginal	m4
Grazing	Class 3 – Suitable land for the production of 2-3 year old, grass-fed, export quality cattle, but only in good seasons	nd3

Soil Mf Moderately to very deep, alkaline, red or brown non-sodic texture contrast soil with thick, clay loamy topsoil.

Australian Soil Classification : Hypercalcic Red or Brown Chromosol
World Reference Base Reference Soil Group : ha LV, ap, ca, cr **Area mapped** 183 ha

Landform : Low Rises **Geology** : Unconsolidated calcareous sediments (TQab)

Vegetation : Eucalypts

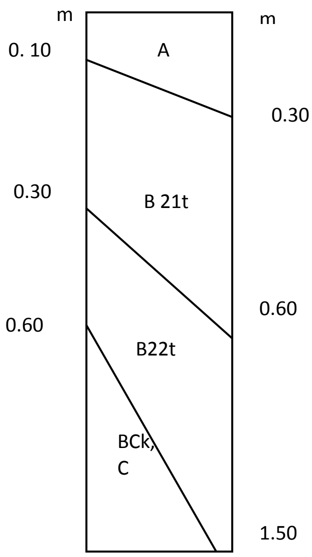
Run-off, Perm. & Drainage : Slowly permeable and moderately well to well-drained

Surface features : Hard setting Usually some silcrete or chert gravels.

Surface Fertility : Very low to low Phosphorus with low Nitrogen and high Calcium levels.

Estimated PAWC : 93 - 130

Investigation sites : Five **Sample sites** : 12 plus WDH 9058



Soil profile description

A – Grey, sandy clay loam to clay loam (fine sandy), massive to weakly structured. pH 6.0 – 7.0 Thin sporadic bleach may be present immediately above the subsoil

B21t – Red or brown, light medium to medium clay (sandy), blocky structure. pH 7.0 – 9.0

B22t – Red or brown, light to medium clay (sandy), blocky structure. pH 7.0 – 9.5 Moderately to highly calcareous.

BCk or C – Unconsolidated, very highly calcareous fine grained sediments , pH > 8.5.

Soil chemical and physical data from site 12

Sample depth (m)	pH (water)	EC (dS/m)	Cl (mg/kg)	CEC or/ECEC (meq/100g)	Exchangeable cations (meq/100 g)				Calculated ratios	
					Ca	Mg	Na	K	ESP	Ca:Mg
0.10	8.0	0.17	15	8	4.5	3.2	0.11	0.19	1.4	1.4
0.30	6.6	0.02	<6	6	3.2	2.2	0.1	0.07	0.6	1.5
0.60	6.8	0.06	<6	15	7.4	7.5	0.3	0.09	2.2	1.0
0.90	7.4	0.04	<6	19	8.7	9.4	0.6	0.09	3.0	0.9

- pH is neutral to alkaline throughout
- EC and chloride levels as well as ESP levels are low throughout. Both of the Emmerton (2004) Mf sites had moderate to high EC levels at and below 0.60 m.
- High Ca:Mg ratios throughout
- CEC is low in the topsoil but moderate in the subsoil.

Soil physical properties – data from site 12

Sample depth (m)	Particle size analysis (%)				Calculated ratios and ratings				
	C sand	F sand	Silt	Clay	R1 Dispersion	CEC/Clay	Sodicity rating	Salinity rating	Ca : Mg rating
0.10	34	47	6	13	0.72	0.61	Low	Low	High
0.30	42	41	7	12	0.69	0.50	Low	Low	High
0.60	29	29	4	40	0.43	0.37	Low	Low	High
0.90	28	35	4	33	0.51	0.57	Low	Low	High

- Clay content increases significantly between the top soil and subsoil, reflecting the duplex nature of the soil profile.
- Fine sand content is high throughout, which is generally reflected in the field texture and indicates the soil material may readily slake.
- Dispersion index is moderate throughout.
- Lower clay content of the topsoil (to 0.30 m) and high fine sand content combined with moderate dispersion index (0.72 at 0.10 m depth) suggests it will be hard setting, which agrees with the field descriptions and indicates it will be subject to water erosion on all slopes where appropriate runoff control structures are not constructed.
- Low dispersion index, low salinity and sodicitiy normally indicate the subsoil is stable after disturbance. However, the high fine sand and silt content to 0.30 m (50 % combined) will lead to poor physical behaviour such as slaking.

Summary

The soil surface may become bulldust upon disturbance. Any salvaged material from this soil is likely to be subject to slaking, sealing and have poor physical properties due to the high fine sand content and silt content and is therefore susceptible to water erosion. Appropriate runoff control structures should be constructed where this soil is placed on slopes. . Topsoil stripping below 0.25 m is not recommended to avoid mixing with subsoil material. The material below 0.60 m is not recommended for salvage to avoid possible contamination with underlying substrate material and / or material with moderate to high salinity.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0 25 m	Strip surface to 0.25 m for seed surface material and root zone media
	Subsoil	0.60 m	Strip subsoil to 0.60 m depth from original surface for root zone media.
Single stage stripping	Combined	0.60 m	Do not strip combined surface/subsoil beyond 0.60 m to avoid possible contamination with underlying substrate.

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 Unsuitable	m4, nd4
Grazing	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	nd4

Soil MfSv Deep to very deep, alkaline, grey or brown sodic texture contrast soil with thick, clay loamy topsoil.

Australian Soil Classification : Grey or Brown, Mottled-Subnatric Sodosol
World Reference Base Reference Soil Group : ca, so SN, ab, ap, ca **Area mapped** 115 ha

Landform : Low Rises **Geology** : Unconsolidated calcareous sediments (TQab)

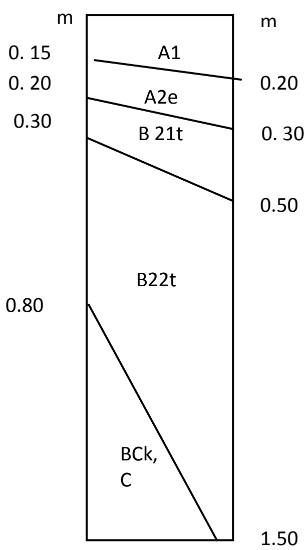
Vegetation : Eucalypts

Run-off, Perm. & Drainage : Slowly permeable and imperfectly drained

Surface features : Hard setting

Surface Fertility : High Phosphorus, Nitrogen and Calcium levels.
Estimated PAWC : 25 mm

Investigation sites : eight **Sample sites** : 22 & 83



Soil profile description

A1 – Clay loam fine sandy, massive. pH 6.0 – 8.5

A2e – As above but conspicuously bleached

B 21t – Grey or brown, often mottled, medium to medium heavy clay, strong coarse columnar or prismatic structure. pH 8.0 – 9.9

B 22 – Brown medium to medium heavy clay, strong coarse prismatic to blocky structure. pH 8.0 – 9.9. Often moderate amounts of carbonate.

BCk or C – Unconsolidated, very highly calcareous fine grained sediments , pH > 8.5.

Soil chemical and physical data – data from site 22

Sample depth (m)	pH (water)	EC (dS/m)	Cl (mg/kg)	CEC or/ECEC (meq/100g)	Exchangeable cations (meq/100 g)				Calculated ratios	
					Ca	Mg	Na	K	ESP	Ca:Mg
0.10	6.9	0.01	10	8	5.5	1.8	<0.1	0.17	1.3	3.1
0.40	8.5	0.07	10	12	5.5	6.0	0.74	0.05	6.1	0.9
0.60	9.0	0.08	5	12	4.1	6.7	1.27	0.03	10.5	0.6
0.90	9.6	0.16	5	13	1.8	7.5	3.37	0.05	26.5	0.2
1.20	10.0	0.37	30	15	1.4	7.6	5.63	0.05	38.4	0.2
1.50	10.0	0.45	150	9.3	1.7	9.7	7.9	0.05	41.1	0.2

- pH is acid in the surface quickly increasing to strongly alkaline in the subsoil.
- EC and Cl levels are low in the topsoil and upper subsoil increasing to moderate by 1.20 m
- Sodicitiy levels are low in the surface increasing to moderate to extreme by 0.60 m.
- CEC is moderate throughout with high Ca:Mg ratio in the surface decreasing to low below 0.60m.

Soil physical properties – data from site 12

Sample depth (m)	Particle size analysis (%)				Calculated ratios and ratings				
	C sand	F sand	Silt	Clay	R1 Dispersion	CEC/Clay	Sodicity rating	Salinity rating	Ca : Mg rating
0.10	55	29	4	12	0.72	0.66	Low	Low	High
0.40	46	26	6	25	0.86	0.48	Moderate	Low	High
0.60	48	25	9	20	0.93	0.60	Moderate	Low	Moderate
0.90							Very High	Low	Low

- Clay content increases significantly between the top soil and subsoil, reflecting the duplex nature of the soil profile.
- Fine sand content is high throughout, which is generally reflected in the field texture and indicates the soil material may readily slake.
- Dispersion index is high throughout suggesting the surface will be hard setting, which agrees with the field descriptions and indicates it will be subject to water erosion on all slopes where appropriate runoff control structures are not constructed. This also correlates with the coarse structure of the subsoil which is evident in field descriptions.
- High measured dispersion index and moderate to extreme sodicitiy levels in the subsoil indicate it will be unstable once disturbed.

Summary

The soil surface may become bulldust upon disturbance. Any salvaged material from this soil is likely to be subject to slaking, sealing and have poor physical properties due to the high fine sand content and is therefore susceptible to water erosion. Appropriate runoff control structures should be constructed where this soil is placed on slopes. Any stripping below 0.20 m should be avoided to minimise inclusion of coarsely structured subsoil with strongly alkaline pH and high dispersion levels.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0 20 m	Strip surface to 0.20 m for seed surface material and root zone media
	Subsoil	0	Subsoil material is not suitable for root zone media.
Single stage stripping	Combined	0.20 m	Do not strip soil below 0.20 m to avoid sodic, dispersive, and coarsely-structured subsoil material.

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 Unsuitable	m5
Grazing	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	m4

Soil Pg. Very deep, alkaline, brown non-cracking to weakly cracking clay.

Australian Soil Classification : Epipedal Brown Vertosol or Hypercalcic Brown Dermosol.
World Reference Base Reference Soil Group : mz, so VR, ca, cr **Area mapped** 11 ha

Landform : Low Rises **Geology** : Unconsolidated sediments (TQa)

Vegetation : Brigalow

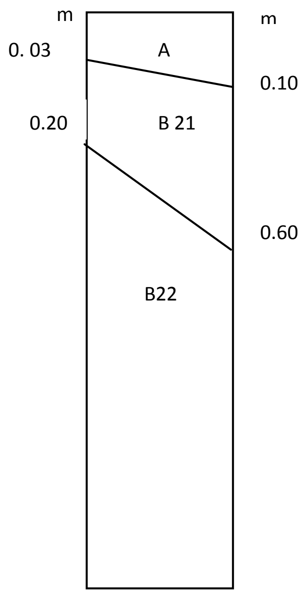
Run-off, Perm. & Drainage : Slowly permeable and moderately well-drained

Surface features : Hard setting. Frequently gravels to cobles – mainly sediments

Surface Fertility : High phosphorus, Nitrogen and Calcium levels.

Estimated PAWC : 27 – 42 mm

Investigation sites : None **Sample sites** : Nil – data from WDH 9062, 9114



Soil profile description

A – Brown light to medium clay (fine sandy) moderae to strong blocky structure pH 6.0 – 8.0

B21 – Brown medium to medium heavy clay (sandy), blocky or lenticular structure. pH 8.0 – 9.5

B22 – Brown, medium to heavy clay (sandy), blocky or lenticular structure. pH 8.5 – 9.5

Soil chemical and physical data - data from WDH 9062

- High clay content throughout matches the field textures.
- High CEC matches the high clay content
- CEC/Clay ratio is only moderate
- Fine sand content is high throughout, which is generally reflected in the field texture and indicates the soil material may readily slake.
- High to extreme salinity from 0.30 m.
- Measured Dispersion index is high throughout suggesting the surface will be hard setting, which agrees with the field descriptions and indicates it will be subject to water erosion on all slopes where appropriate runoff control structures are not constructed. This also correlates with the coarse structure of the subsoil which is evident in field descriptions.

- High ESP levels at and below 0.30 m combined with high measured dispersion index suggests the subsoil is dispersive and unstable once disturbed.

Summary

Any salvaged material from this soil is likely to be subject to slaking, sealing and have poor physical properties due to the high fine sand content and is therefore susceptible to water erosion. Appropriate runoff control structures should be constructed where this soil is placed on slopes. Any stripping below 0.30 m should be avoided to minimise inclusion of material with high sodicitiy and dispersion index.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0 25 m	Strip surface to 0.25 m for seed surface material and root zone media
	Subsoil	0.30 m	Strip subsoil to 0.30 m depth from original surface for root zone media.
Single stage stripping	Combined	0.30 m	Do not strip combined surface/subsoil beyond 0.30 m to avoid sodic and dispersive material.

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 Unsuitable	m5, sa4
Grazing	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	m4, sa4

Soil PgMp Similar soil profile to Pg soil but with Melonhole Gilgai to 1 m deep.

Area : 11 ha

One investigation site in this survey but no analysed data.

Field EC was moderate to extreme from 0.30m.

Field pH was extremely acid from 0.60 m (pH 4.5 or less).

It is assumed that the chemical data for Pg soil applies to this soil.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil		Not recommended for reuse as useable soil too difficult to separate due to depth and frequency of melonhole gilgai.
	Subsoil		
Single stage stripping	Combined		

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 Unsuitable	m5, sa5, g5
Grazing	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	m4, sa4

Soil PgSp Moderately deep, alkaline brown non-cracking to weakly cracking clay.

Area : 27 ha

Similar soil to Pg but with unconsolidated sediments occurring below 0.60m in the soil profile

No investigation sites in this survey or analysed soil profiles.

Two field sites from previous soils report (Emmerton 2004). Both had moderate to extreme field EC levels by 0.40 m.

It is assumed that the chemical data for Pg soil applies to this soil.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0 25 m	Strip surface to 0.25 m for seed surface material and root zone media
	Subsoil	0.30 m	Strip subsoil to 0.30 m depth from original surface for root zone media.
Single stage stripping	Combined	0.30 m	Do not strip combined surface/subsoil beyond 0.30 m to avoid saline, sodic and dispersive material.

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 Unsuitable	m5, sa4
Grazing	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	m4, sa4

Soil Lg Very deep, alkaline, black cracking clay with strongly self-mulching surface.

Australian Soil Classification : Self-mulching Black Vertosol
World Reference Base Reference Soil Group : gm, so VR, ca, pe **Area mapped** 256 ha

Landform : Alluvial plain **Geology** : Recent alluvium (Qa)

Vegetation : Brigalow

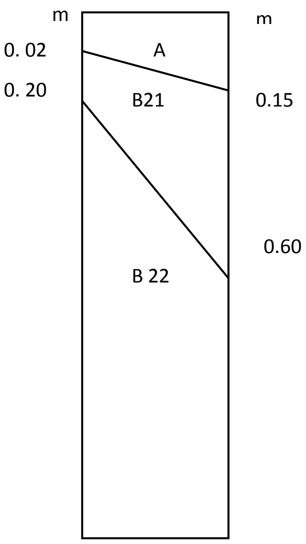
Run-off, Perm. & Drainage : Slowly permeable and moderately well-drained

Surface features : Strong medium self-mulch Often gilgai to 0.30 m deep.

Surface Fertility : Low Phosphorus, High Nitrogen and Very high Calcium levels.

Estimated PAWC : 84 mm

Investigation sites : five **Sample sites** : 74 plus WDH 9031, 9080 & 9081



Soil profile description

A – Black, medium to medium heavy clay, pH 6.5 – 8.0. Surface 2 - 5 mm is strong medium granular self-mulch

B21 – Black, medium to medium heavy clay, blocky or lenticular structure. Moderately to highly calcareous pH 8.0 – 9.0

B22 – Black to grey, medium to heavy clay, lenticular structure. Moderately to highly calcareous. pH 8.0 – 9.0

Soil chemical and physical data from site 74

Sample depth (m)	pH (water)	EC (dS/m)	Cl (mg/kg)	CEC or/ECEC (meq/100g)	Exchangeable cations (meq/100 g)				Calculated ratios	
					Ca	Mg	Na	K	ESP	Ca:Mg
0.10	6.9	0.06	12	40	17.3	17.5	0.4	0.36	1.1	1.0
0.30	7.5	0.07	30	45	19.9	19.9	1.5	0.10	3.3	1.0
0.60	8.5	0.26	270	45	19.7	24.0	4.0	0.15	8.9	0.8
0.90	8.4	0.66	770	53	20.3	27.8	4.6	0.07	8.7	0.7
1.20	8.6	0.70	810	52	19.4	27.9	4.8	0.09	9.2	0.7
1.50	8.7	0.63	685							
1.80	8.8	0.59	630							

- pH is neutral at the surface becoming alkaline in the subsoil
- EC and chloride levels are low to 0.30 m, but increase to moderate levels by 0.90 m
- ESP levels are low at the surface increasing in the subsoil to moderate levels by 0.60 m.
- Measured dispersion index is low throughout.
- However, the EC data from WDH sampled sites shows high EC levels, high ESP and moderate to high Dispersion index from 0.40 m.
- High CEC levels correspond with high clay content of the soil profile.

Soil physical properties – data from site 74

Sample depth (m)	Particle size analysis (%)				Calculated ratios and ratings				
	C sand	F sand	Silt	Clay	R1 Dispersion	CEC/Clay	Sodicity rating	Salinity rating	Ca : Mg rating
0.10	24	20	9	44	0.40	0.91	Low	Low	High
0.30	22	20	7	52	0.39	0.86	Low	Low	High
0.60	20	19	9	52	0.40	0.86	Moderate	Moderate	Moderate
0.90	20	16	8	57	0.37	0.93	Moderate	Moderate	Moderate
1.20	22	16	7	56	0.38	0.93	Moderate	Moderate	Moderate

- This soil has high clay content with low silt content. High CEC/clay ratios as well as lenticular structure in the subsoil suggest the clay fraction is reactive, has shrink/swell properties and contains significant proportion of montmorillonite.
- Measured dispersion index (R1) is low throughout this sampled profile, but high from 0.40 m in the sampled WDH profiles. These levels from WDH sampled profiles combines with the high ESP suggests the subsoil below 0.40 m is dispersive and unstable once disturbed. This is despite the soil chemistry being dominated by calcium.

Summary

The surface soil/upper subsoil to 0.4m is characterised by high clay content, strong structure, significant shrink-swell behaviour and limited dispersion (R1<0.65), sodicitiy (ESP mostly <6) and salinity (<0.3dS/m). Such attributes suggest that material to this depth will be relatively stable and resilient following disturbance. Subsoil material below 0.40 m should be avoided because of likely rapidly increasing salinity and sodicitiy levels and highly dispersive subsoil.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0 20 m	Strip surface to 0.20 m for seed surface material and root zone media
	Subsoil	0.40 m	Strip subsoil to 0.40 m depth from original surface for root zone media.
Single stage stripping	Combined	0.40 m	Do not strip combined surface/subsoil beyond 0.40 m to avoid likely dispersive material with high salinity and sodicitiy.

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 4 Marginal for summer crops ; Class 5 Unsuitable for Winter crops	m4 (summer); m5 (winter)
Grazing	Class 3 – Suitable land for the production of 2-3 year old, grass-fed, export quality cattle, but only in good seasons	m2, nd3

Soil Pr Deep to very deep, alkaline, brown non-sodic texture contrast soil with very thick, sandy topsoil.

Australian Soil Classification : Eutrophic Brown Chromosol
World Reference Base Reference Soil Group : ab, LV, ap, ce **Area mapped** 1 ha

Landform : Creek flats **Geology** : Recent alluvium (Qa)
Vegetation : Eucalypts

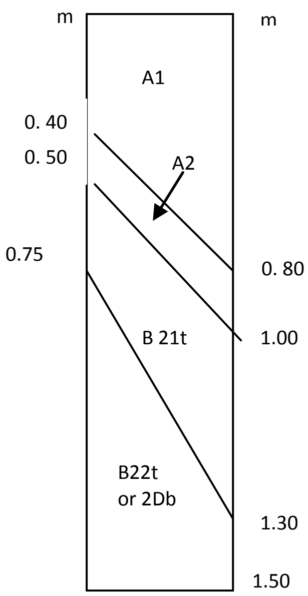
Run-off, Perm. & Drainage : Slowly permeable and moderately well-drained

Surface features : Firm to hard setting

Surface Fertility : Moderate Phosphorus and Calcium; Very high Nitrogen levels.

Estimated PAWC : 58 – 76 mm

Investigation sites : One **Sample sites** : Nil – data from WDH 9013



Soil profile description

A1 – Brown, sand to loamy sand. Massive. pH 5.5 – 7.5

A2e – As above but sporadically or conspicuously bleached with ironstone nodules

B 21t – Mottled, brown light to medium clay (sandy), blocky to prismatic structure. pH 6.0 - 9.0. Manganese soft segregatons.

B22t as above but weakly structured or variable buried layers. pH 6.0 – 9.0

Soil chemical and physical data – data from WDH 9013

- pH acid to neutral throughout
- EC and Cl low throughout
- ESP and measured dispersion index (R1) are both low to 1.20 m.
- Moderate ESP levels occur in buried layers below 1.20 m (associated with high measured dispersion index)
- Clay content increases significantly between the topsoil and subsoil, reflecting the duplex nature of the soil profile and the corresponding field textures.

- This soil has high fine sand content with low silt content and moderate clay content corresponding to the subsoil field textures. However, the high fine sand content and lower clay content of the surface compared to the subsoil suggests it will be hard setting, which agrees with the field descriptions and indicates it will be subject to water erosion on all slopes where appropriate runoff control structures are not constructed. The surface may tend to become bulldust when disturbed due to its massive to poor surface structure.

Summary

This surface soil may become bulldust upon disturbance. Any salvaged material is likely to be subject to slaking, sealing and have poor physical properties due to the high fine sand content and is therefore susceptible to water erosion. Appropriate runoff control structures should be constructed where this soil is placed on slopes. . The material below 0.75 m is not recommended for salvage due to variable properties associated with buried soil layers.

Soil reuse recommendations

Method	Material	Lower depth	Recommendation
Two stage stripping	Topsoil	0.50 m	Strip surface to 0.50 m for seed surface material and root zone media
	Subsoil	0.75 m	Strip subsoil to 0.75 m depth from original surface for root zone media.
Single stage stripping	Combined	0.75 m	Do not strip combined surface/subsoil beyond 0.75 m to avoid possible sodic and dispersive material associated with variable buried layers.

Agricultural Suitability Assessment

Land use	Suitability class	Main Limitations
Rainfed cropping	Class 5 Unsuitable	m5
Grazing	Class 3 – Suitable land for the production of 2-3 year old, grass-fed, export quality cattle, but only in good seasons	m3, nd2

5. Soil Reuse for Mining Operation

The methodologies for both topsoil stripping and Agricultural Land Suitability assessment were taken largely from QDME 1995, except where indicated. The following discussion is based on Burgess (2010) which is expanded from the Growth Media Management Section of QDME 1995.

5.1 Topsoil Striping – Assumptions and Explanations

Topsoil stripping recommendations are primarily determined by inherent soil characteristics and spatial soil variability within the landscape. Suitability of materials available for stripping depends not only on the presence/absence and severity of inherent limitations (such as salinity or dispersive behaviour) but also on the landform design and final end uses of the material. Different landform designs and final end uses will change acceptable soil parameters and recommended stripping depths accordingly. Stripping recommendations where commitments are made to reinstate pre-mining cropping or grazing suitability to high agricultural potential, will be very different to those where final uses with no or limited agricultural potential are planned.

Stripping recommendations are presented which have been purposefully designed to maximize the salvage of soil resources (primary and secondary growth media) suitable for the establishment of functional native vegetation ecosystems capable of sustainably rehabilitating and stabilizing moderate slopes. Soil materials recommended for salvage have been selected to provide suitable growth media for the establishment and long term survival of selected/adapted native tree and groundcover species. Poor outcomes in terms of low productivity and excessive erosion risk could be expected where attempts to implement agricultural activities other than appropriately managed cattle breeding operations on rehabilitated land without revising the stripping recommendations in this report to ensure they were appropriate and purpose specific.

Revision of the findings and outcomes from this investigation would be required where end uses other than the stabilization of moderate slopes through the establishment of sustainable native vegetation cover are envisaged.

5.2 Topsoil Management Plan

In any topsoil stripping, stockpiling and replacement operation, planned activities need to carefully follow actions outlined in a detailed topsoil management plan. The aim of any such plan should be to ensure optimal allocation of available primary and secondary growth media reserves across all future rehabilitation activities proposed for the mine.

It is important ongoing topsoil management planning is implemented during the normal operation of the mine to ensure shortfalls in rehabilitation media are not experienced prior to mine closure.

Selection of material to be stockpiled as primary or secondary growth media for planned activities must consider proposed landform designs, nature of the rehabilitated material and intended rehabilitation methods to be employed. A management plan should outline the intended depth and surface treatment of material to be reinstated and the intended type/nature of vegetative cover to be established.

In practice, a detailed topsoil management plan should clearly outline:

- areas to be disturbed;
- volumes/characteristics of suitable materials available from areas proposed for disturbance;
- methodology for optimal soil management during stockpiling;
- areas for reinstatement;
- physical conditions expected at each rehabilitation site (e.g. slope degree/length, spoil characteristics, proposed rehabilitation technique);
- selection methodology to identify the most appropriate soil materials from available stockpiled resources for different rehabilitation scenarios; and
- volumes and characteristics of material (or other cover materials) required for stripping to meet rehabilitation requirements.

The following general guidelines apply to all areas recommended for stripping within the ML and MLA areas :

- Where recommended stripping depth exceeds 0.30 m two-stage stripping and replacement is recommended to minimize mixing of surface soil and subsoil materials. Materials stripped using a two-stage process are referred to as primary and secondary growth media respectively. Separation of these materials will optimize physical conditions in stockpiled resources and assist in preserving seed source potential.

- Salvage of primary growth media or topsoil should be maximized from all disturbed areas to an optimal depth 0.1-0.3 m (depending on soil properties) and should be stockpiled separately from secondary growth media material, where practical and appropriate to achieve the desired rehabilitation goals.

- Primary growth media which may contain at least some native seed source should be segregated and stockpiled separately where possible from material which is likely to contain heavy loads of introduced pasture or weed seed, where this is desirable to achieve the rehabilitation goals. This may be important over much of the ML and MLA where thick patches of Parthenium weed are evident.

- Stockpiles of primary growth media which potentially contain significant native seed should be used in preference to other stockpiled resources, wherever possible, to obtain maximum benefit from the available native seed stores; providing this fits with the rehabilitation plans and soil and cover types required.

- Design of any stockpiles must consider the inherent properties of the soil material to ensure stability of any side-slopes. Soil material with poor physical properties (such as slaking and sealing) should only be utilized only on low slopes to minimise erosion risk.

- Stockpiles containing predominantly surface soil material should ideally be formed no more than 1.5m in height and should be ripped and seeded (with species selection based on the desired outcome of rehabilitation) as soon as practical following stockpile laydown.

- Stripped materials (whether primary or secondary growth media) should be segregated into stockpiles which have similar reuse characteristics. Soils with good surface physical characteristics should not be stockpiled with soils with poorer physical attributes.

- Secondary growth media should be salvaged from all disturbed areas where suitable material has been identified, and stockpiled separately from primary growth media.

- Secondary growth media can be stockpiled to greater depths than those specified for topsoil materials and should only be constructed in areas from which topsoil has first been stripped. Stockpiles should be ripped and seeded following laydown to stabilize and protect the material.

Topsoil Stripping Recommendations

Two stage stripping and replacement is widely recognized as best management practice for the salvage and reuse of soil/rehabilitation media from areas of mining disturbance. Two stage stripping recommendations for each soil within the ML and MLA are included in the detailed soil descriptions in Section 4.2 above.

It is recognized however that single stage stripping which involves the salvage of maximum quantities of useable soil material, irrespective of its source, is often the preferred stripping methodology for many mines. Recommendations for single stage stripping outlining one-off salvage depths for the retrieval of all useable materials for each soil are also included in the detailed soil descriptions in Section 4.2 above.

Single stage stripping will result in greater mixing of discordant materials and a dilution of soil quality. When compared with two stage reinstatement, single stage material will usually be subject to slower infiltration and higher runoff rates, with plant establishment typically slower and less successful overall. Initial erosion control will be of increased importance during the establishment phase but over time as plant/ground cover increases and profile leaching, biological activity and structural improvement occur, erosion risk may decrease.

For most rehabilitation situations, subsoil clays with elevated levels of soluble salts (e.g., soluble chloride contents >300-600 ppm or EC1:5 >0.6 dS/m), such as areas of soil Pg and variant PgSp, are not recommended for salvage. Reinstatement of such materials, particularly as surface materials, will typically be subject to poor physical behaviour (sodicitiy, dispersion and coarse/dense structure) and limited plant establishment. Cumulatively, these effects restrict the development of ground and canopy cover and slow water relations and structural recovery in the surface soil. Such effects impact significantly on rehabilitation outcomes at a site by increasing both erosion risk and the potential for localized rehabilitation failure.

Where available soil mapping indicates high levels of subsoil salinity or sodicitiy may be present or significant spatial variability in salinity or sodicitiy levels exists, localized field testing of materials prior to salvage is recommended.

1. Two – stage stripping – primary growth media

Suitable **primary growth media** for rehabilitation of mine spoil should ideally conform to most, if not all, of the following characteristics:

- represent that part of the natural soil profile with maximum biological activity and seed source potential (i.e. immediate surface soil);
- have a particle size distribution that is dominated either by the coarse sand fraction or alternatively the reactive clay fraction; preferably with limited fine sand and/or silt fractions;
- have a pH range appropriate for plant growth;
- be characterized by non-sodic/non-dispersive physical behavior, particularly in the case of clay material; and
- Have very low levels of soluble salts
- Have fertility levels appropriate for the plant species to be grown.

Materials conforming to these general principles would typically be considered appropriate for salvage as primary growth media during two-stage stripping operations. **Where materials are suitable except for elevated fine sand/silt fractions, as applies for some soils identified in the Lake Vermont ML and MLA, salvage may still be possible but reinstatement should be restricted to as low a slope angle as possible because of increased runoff and erosion risk. Construction of appropriate drainage structures is critical where these soils are reused to minimise erosion risk.**

2. Two – stage stripping – secondary growth media

During the two-stage stripping process, root zone materials are usually salvaged for the purpose of constructing a surrogate subsoil cover over reshaped spoil prior to final topsoiling or application of a layer of suitable primary growth media.

Suitable root zone material should ideally conform to most, if not all, of the following characteristics:

- have a particle size distribution that is dominated either by the clay loam fraction or alternatively by the clay fraction; preferably with limited fine sand and/or silt fractions;
- have a pH range appropriate for plant growth;
- have a non-sodic (optimal) to weakly sodic (acceptable) clay fraction;
- be characterized by non-dispersive (optimal) or low to moderately dispersive (acceptable) physical behavior, particularly where clay materials are being considered for stripping;

- Have very low (optimal) to moderate (acceptable) levels of soluble salts.

Materials conforming to these general principles would typically be considered appropriate for salvage as secondary growth media during two stage stripping operations. **Where materials are suitable except for elevated fine sand/silt fractions, as applies for some soils identified in the Lake Vermont ML and MLA, salvage may still be possible but reinstatement should be restricted to as low a slope angle as possible because of increased runoff and erosion risk. Construction of appropriate drainage structures is critical where these soils are reused to minimise erosion risk.**

3. Single stage stripping – primary and/or secondary plant growth media

The primary objective with single stage stripping is the one off salvage of maximum volumes of useable material, irrespective of original soil depth or origins (i.e., salvage of all suitable topsoil, subsoil and/or substrate material). Typically, surface soil and subsoil materials with differing characteristics are not kept segregated and are subject to significant mixing during stripping operations. Because any of the stripped material, whether topsoil or subsoil, can potentially be exposed as final surface cover on reshaped spoil, all materials to be salvaged should have characteristics capable of supporting this use. For these reasons, generalized goals for single stage stripping are similar in many ways to those presented above for topsoil materials under two stage stripping. Materials to be stripped during single stage operations should ideally conform to most, if not all, of the following characteristics:

- have a particle size distribution that is dominated either by the coarse sand fraction; or alternatively the reactive clay fraction; preferably with limited fine sand and/or silt fractions;
- have a pH range appropriate for plant growth;
- be characterized by non-sodic/non-dispersive physical behavior, particularly in the case of clay material; and
- Have very low levels of soluble salts.
- Have fertility levels appropriate for the plant species to be grown.

Materials conforming to these general principles would typically be considered appropriate for salvage during single stage stripping. **Where materials are suitable except for elevated fine sand/silt fractions, as applies for some soils identified in the Lake Vermont ML and MLA, salvage may still be possible but reinstatement should be restricted to as low a slope angle as possible because of increased runoff and erosion risk. Construction of appropriate drainage structures is critical where these soils are reused to minimise erosion risk.**

Careful identification of the limitations and undesirable attributes associated with inferior soil resources is essential to ensure only the least hostile and therefore most appropriate media are selected, and that such materials are used in accordance with their capability (i.e., capable of sustaining the end use to which they are put).

5.3 Recommended maximum depths for Soil Reuse

The depths of recommended reuse based on soil properties for each soil is included in **Section 4.2** above and is summarised in **Table 3** on the next page.

Maximum recommended depth for soil reuse is limited by sodic, saline or dispersive subsoils identified in most soils.

For most soils, maximum depth for soil reuse is between 0.30 to 0.40 m for secondary growth media and 0.20 – 0.30 m for primary growth media assuming a two stage stripping process.

For a single stage stripping process, the maximum recommended depth of useable soil is 0.30 – 0.40 m.

Maximum stripping depths of 0.60m is shown for three soils – Pc and Mf and phase PcXp which have elevated sodic, dispersive or saline levels deeper in the subsoils or overly substrate from 0.60 m.

Parrot soil (Pr) has the greatest depth of soil suitable for reuse, 0.75 m, of the soils identified, but has very limited extent within the MLA. Recommended maximum soil reuse depth for Pr soil is limited by the depth to buried variable layers which are likely to be sodic or saline.

Salvaging or reusing any material is not recommended from four soils which have a combined total area of 13 ha (or 2.8 %) within the MLA and 34 ha (or 1.2%) within the existing ML surveyed. The four soils are :

- PcR which has abundance of surface ‘rocks’ ;
- PgMp which has melonhole gilgai preventing separation of topsoil material from sodic and saline subsoil;
- KkWp which has significant wetness issues; and
- KkSp which has significant erosion potential, exposed surface rocks and is shallow to underlying substrate.

Table 33 Soil reuse recommendations for Lake Vermont Mining Lease and Mining Lease Application Areas.

Soil	Two stage process		Single stage reuse (from original surface)	Comments
	Primary growth media (from original surface)	Secondary growth media (from original surface)		
Hb	0.15 m	0.50 m	0.50 m	Not recommended for reuse > 0.50 m to avoid sodic and dispersive material.
Kk	0.30 m	0.40 m	0.40 m	Not recommended for reuse > 0.40 m to avoid strongly alkaline and possibly highly saline and sodic material.
KkWp	0	0	0	Not recommended for reuse due to significant soil wetness issues
KkSp	0	0	0	Not recommended for reuse due to surface "rocks" and significant erosion potential due to surface slope and shallow depth to underlying substrate"
Nw	0.20 m	0.30 m	0.30 m	Not recommended for reuse > 0.30 m to avoid saline, sodic and dispersive material
Pc	0.30 m	0.60 m	0.60 m	Not recommended for reuse > 0.60 m due to avoid material with moderate to high salinity.
PcXp	0.20 m	0.40 m	0.40 m	Not recommended for reuse > 0.40 m to avoid material with moderate salinity.
PcR	0	0	0	Not recommended for reuse due to significant "rock" content.
Kc	0.40 m	0.60 m	0.60 m	Not recommended for reuse > 0.60 m to avoid sodic and dispersive material.
Mf	0.25 m	0.60 m	0.60 m	Not recommended for reuse > 0.60 m to avoid possible contamination with underlying substrate.
MfSv	0.20 m	0.20 m	0.20 m	Not recommended for reuse > 0.20 m to avoid sodic, dispersive and coarsely-structured material.
Pg	0.25 m	0.30 m	0.30 m	Not recommended for reuse > 0.30 m to avoid sodic and dispersive material.
PgMp	0	0	0	Not recommended for reuse as it is not practical to separate topsoil from subsoil due to depth and abundance of melonhole gilgai.
PgSp	0.25 m	0.30 m	0.30 m	Not recommended for reuse > 0.30 m to avoid saline, sodic and dispersive material.
Lg	0.20 m	0.40 m	0.40 m	Not recommended for reuse > 0.40 m to avoid likely dispersive material with high salinity and sodicitiy.
Pr	0.50 m	0.75 m	0.75 m	Not recommended for reuse > 0.75 m to avoid buried soil layers likely to be sodic and dispersible.

6. Agricultural Suitability

6.1 Agricultural Assessment Methodology

Agricultural suitability includes an assessment of rainfed cropping and grazing for beef cattle enterprises. The suitability classification for rainfed cropping (summer and winter cropping) evaluates the broad acre potential of land to grow sorghum, wheat, barley, sunflowers and chickpeas under rainfed conditions. Cropping systems in the Bowen Basin are opportunistic and the actual crops planted are dependent upon the timing, amount and variability of rainfall, as well as such things as previous cropping history and fallow management. The two dominant crops are summer grown grain sorghum and winter grown wheat.

Grazing suitability is defined in terms of the ability of the pasture system to produce grass-fed, export quality cattle >600 kg live weight at 2–3 years of age, with 12-18 mm of rump fat without inputs other than pasture development. Success in this regard is directly dependent on the plane of nutrition cattle receive from weaning through to finishing, which in turn is largely dependent on the level of inherent soil fertility driving the system.

The framework of QDME 1995 is the basis for assessing Rainfed Cropping and Grazing Suitability for this report. A more robust suitability scheme based on updated soils and technology information since 1995 is being developed by the Queensland Government Department of Resource Management (DERM), but after discussions with DERM regarding similar recent surveys and reports to this one, it was recognised for this project the QDME 1995 suitability scheme should be used as the newer version has not been published to date. However the newer Suitability Scheme of Burgess (in prep) has more definitive classes for water availability (m) and nutrient deficiency (nd) limitations. These newer classes for both m and nd were adopted in this survey instead of those defined in QDME 1995.

A grazing suitability classification assumes pasture improvement has been undertaken, particularly the establishment of a legume component on all sandy or loamy surfaced soils, and that the pasture system is well managed and in good condition, in a "normal season" and without significant regrowth.

However, there are significant vegetation management issues that have been identified within parts of the survey area, such as management of thick brigalow regrowth and weeds such as currant bush and Parthenium weed.

Pre-mining agricultural potential has been assessed within the area using a five class land suitability classification (Land Resources Branch Staff (1990), QDME (1995)). The five classes used in this survey are taken from the QDME 1995 guidelines which in turn are based on the 1990 DPI Guidelines. The classes adopted for this survey are outlined in **Table 4** below.

Table 44 Definition of Agricultural Land Suitability Classes (ALC)

Agricultural Land Class	Definition
Class 1	**Suitable land with negligible limitations** that is highly productive and requires only simple management practices to maintain economic production
Class 2	**Suitable land with minor limitations** which either slightly reduce productivity or require more than the simple management practices of Class 1 to maintain economic production
Class 3	**Suitable land with moderate limitations** which either further lower productivity or require more than the management practices of Class 2 to maintain economic production
Class 4	**Marginal land with severe limitations** which make it doubtful whether the benefits from the activity will outweigh the inputs/costs required to achieve and maintain production in the long-term
Class 5	**Unsuitable land with extreme limitations** that preclude its use.

Land is considered less suitable as the severity of limitations for a land use increase. Increasing limitations may reflect either:

- (a) reduced potential for production; and/or
- (b) increased inputs to achieve an acceptable level of production; and/or
- (c) increased inputs required to prevent land degradation

Suitability classes 1 to 3 are considered suitable for a specified land use because the benefits from using the land for that use outweigh the inputs required to initiate and maintain production. Typically, the benefits from using Class 4 land approximate the inputs required for production and its long-term suitability for the specified land use is doubtful, due either to increasing costs and/or increasing land degradation.

Class 4 is also used in situations where reducing the effect of a particular limitation may suggest production is possible, but additional studies are needed to determine the feasibility of such actions (e.g., leveling of melonholes may assist cultivation and wetness problems but subsoil salinity levels may require investigation).

In contrast, Class 5 land has limitations that in aggregate are so severe that the benefits are unlikely to ever justify the inputs required to initiate and maintain production. It would require a major change in economics, technology or management expertise before Class 5 land could be considered suitable for a particular land use. Many Class 5 lands generally have physical characteristics that totally preclude any form of development (e.g., mountains or eroded areas).

The suitability framework for Grazing outlined in QDME 1995, assesses land using limitations. These are outlined in **Table 5 below**.

Table 55 Limitations for Rainfed Cropping and Grazing Suitability Assessment.

	Symbol
Water availability	m
Nutrient deficiency	nd
Soil physical factors	p
Salinity	Sa
Rockiness	R
Microrelief	g
pH	pH
ESP	ESP
Wetness	w
Topography	t
Water erosion	e
Flooding	f
Vegetation management	vm

The class definitions for each limitation are as per the QDME 1995 Guidelines, with the exception of both the water availability (m) and nutrient deficiency (nd) limitations.

Water availability limitation (m) is based on PAWC and soil permeability classes. The following discussion is mostly based on Burgess (in prep.)

The estimated Plant Available Water Capacity (PAWC) of the soils, which was not directly measured in the field, is an important soil property considered as part of the agricultural suitability assessment.
However, it is notoriously difficult, time consuming and costly to measure in the field for most soils. Therefore, it is often estimated from soil morphology and chemical data.

In this survey, PAWC was estimated separately for each soil, based on the average or mean soil properties recorded in the morphological descriptions of soil profiles examined in the field as well as chemical data from analysed representative profiles.

The average or mean morphological soil properties used in this estimation are the lower depth, texture and structure of the A and B Horizons.

The Effective Rooting Depth (ERD) was determined for each soil in this survey by:

- Depth to hard pan or weathered or hard rock
- Depth to high salinity (EC > 0.8 dS/m or Cl > 800 mg/kg)
- Depth to high sodicitiy or ESP (Exch.Na > 20 per cent of CEC; not relevant if CEC< 5 meq/100g)

- Depth to magnesium dominant clays (Ca:Mg ratio of < 0.5 if CEC >5 meq/100g and/or Mg+Na > 80 per cent of CEC)
- Where there is no restriction, the maximum rooting depth considered in this survey is 1.00 m, based on the assumption that Buffel grass is the main pasture species supporting beef cattle grazing and rainfed crops such as sorghum can exploit soil water to this depth if soil properties allow.

The Total Available Water (TAW) as mm water per metre depth of soil was estimated for the A and B Horizon of each soil based on mean soil texture and structure using the TAW data from Table 29.3 in *Guidelines for Surveying Soil and Land Resources* (McKenzie *et al* 2008).

The estimated Readily Available Water (RAW) was then calculated as the sum of the estimated TAW to the ERD, and was added to the detailed data presented for each soil in **Section 4.2** above. Details on estimated ERD and RAW for each soil are given in Table 6 on the next page.

Note that RAW is equivalent to Plant Available Water Capacity (PAWC), which is the term used for soil water in the following discussion.

The estimated PAWC in most soils is limited by the ERD, which in turn is limited by subsoil salinity and sodicitiy levels. Pc soil has less restriction to ERD and hence the highest estimated PAWC. Soils such as MfSv and Pg (and phases) have the lowest estimated PAWC as they have a shallow ERD due to shallow depth to highly saline and sodic subsoil. Estimated PAWC for Pr soil is limited by the thick sandy topsoil which has less water holding ability due to its texture while PcR has limited estimated PAWC due to its shallow depth to underlying substrate.

Although PAWC is an important concept in determining water available in the soil for plant growth, the amount of water intercepted, trapped and stored within the root zone compared with the amount lost to deep drainage determines the level of stored moisture available for plant growth (Burgess in prep.).

The quantity of water that reaches the soil surface is a function of rainfall, evaporation and runoff (determined by land slope and soil position in the landscape). Water entry and downward drainage is dependent on the infiltration rate of the surface soil and the permeability of the least permeable layer within the soil (usually the subsoil) respectively. Surface texture, clay mineralogy, structural development, pore size, total pore space and structural stability of the soil surface are particularly important in this process.

Because PAWC by itself does not account for the rate of water entry into the soil (or water infiltration) or losses in potential stored moisture associated with excess runoff and long-term deep drainage, qualitative descriptors to account for these factors have been added to the water availability limitation (m) within the suitability framework (based on Burgess in prep.).

The descriptors use a combination of surface structure, surface texture and surface condition to describe relative differences in water infiltration and surface runoff between soils

Table 66 Criteria for estimating Readily Available Water Capacity (RAW) [1] of the soils of Lake Vermont Mining Lease & Mining Lease Application Areas.

Soil	Estimated ERD (cm) [2]	Mean Texture, Structure and depth of A horizon (cm)	Mean Texture, Structure and depth of B horizon (cm)	Estimated RAW
Hb	90 (high EC/ESP)	25 massive sandy clay loam	25 - 90 well-structured clay	**84 - 123**
Kk	90 (high ESP/ EC)	10 well-structured clay	60 – 90 well-structured clay	**81 - 126**
Nw	60 (high ESP/ EC)	10 well-structured clay	10 - 60 well-structured clay	**126**
Pc	100 (high EC)	10 well-structured clay	10 – 100 well-structured clay	**210**
PcXp	100 (high EC)	10 well-structured clay	10 – 100 well-structured clay	**210**
PcR	25 (depth to substrate)	10 well-structured clay	10 – 25 well-structured clay	**53**
Kc	120	10 well-structured clay	10 – 120 well-structured clay	**108 - 168**
Mf	100 (depth to substrate)	25 – Clay loam (massive)	25 – 100 well-structured clay	**93 - 130**
MfSv	25 (subsoil structure)	25 – Clay loam (massive)	-	**25**
Pg	30 (high EC)	10 well-structured clay	10 - 30 well-structured clay	**27 - 42**
PgMp	20 (high EC)	10 well-structured clay	10 - 20 well-structured clay	**18 - 28**
PgSp	30 (high EC)	10 – well-structured clay	10 – 30 well-structured clay	**27 - 42**
Lg	40 (high ESP/ EC)	10 well-structured clay	10 - 40 well-structured clay	**84**
Pr	100 (Buried sodic soil)	80 – Loamy sand	80 – 100 well-structured clay	**66 - 100**

[1] RAW estimated using soil texture and structure from Table 29.3 of McKenzie *et al* (2008). Note RAW is equivalent to PAWC) (Plant Available Water Capacity).
[2] Effective Rooting Depth (see text for explanation)

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Sandy (where the soil surface does not readily seal after rainfall) and self-mulching descriptors are assigned to soils where runoff losses are minimal and infiltration rates do not restrict the ability of the soil to achieve its full PAWC when adequate rainfall is received. In contrast, soils assigned a hard setting to weakly self-mulching description or suffer significant runoff losses when subject to the same rainfall conditions rarely achieve PAWC because of water entry restrictions associated with slow surface infiltration rates.

Similarly, soil permeability descriptors based on the classes of National Committee on Soil and Terrain (2009) have been used to separate slowly drained soils (e.g. sodic texture contrast soils and some clays), where long term deep drainage is minimal, from freely drained soils where such losses may continue indefinitely.

Nutrient deficiency limitation (nd) is based on results of surface fertility analysis of representative soil profiles for most soils. The following discussion is also based on Burgess (in prep.). Where no samples were analysed soil fertility status was assumed from the analysis of samples from similar soils reported for the Windeyers Hill area (Burgess 2003) referred to as WDH soil analyses.

Nitrogen and phosphorus are the dominant nutrients controlling grazing productivity in the Bowen Basin and combined levels of these two nutrients provide a useful framework for evaluating overall nutrient availability. Soil analyses that are important to determine limitation classes include Bicarb. or Colwell Phosphorus which estimates Phosphorus availability for plant growth and total Nitrogen to determine Nitrogen availability. Calcium also needs to be considered both as an essential nutrient for plant and animal growth and as an indicator of leaching history and current leaching status within the soil. Available calcium from cation analysis provides a good indicator of soil calcium status.

6.2 Agricultural Assessment results

The results of agricultural suitability analysis for each soil identified in this survey are included in the detailed descriptions in **Section 4.2.** Rainfed cropping and grazing suitability classes for each soil are presented in Table 7 on the following pages. Total areas of each suitability class for rainfed cropping and grazing within the Mining Lease (ML) and Mining Lease Application (MLA) are given in Tables 8 and 9. Maps of the results of the rainfed cropping and grazing suitability analyses are presented at the back of the report as maps 2 and 3.

Table 7 7 Results of Agricultural Suitability Analysis

Soil	Area * (ha)	Brief soil description	Cropping suitability		Grazing Suitability		Good Quality Agricultural Land
			Suitability	Main Limitations	Suitability	Main Limitations	Yes or No
Hb	28 ha	Deep to very deep alkaline, brown or grey texture contrast soil with thick clay loamy topsoil	Class 5 Unsuitable	m5	Class 2 - Land suitable for the production of 2-3 year old, grassfed, export quality cattle in most seasons	nd2	Yes
Kk	1342 ha	Moderately to very deep, alkaline, grey or brown cracking clay with hard setting surface.	Class 5 Unsuitable	m5	Class 3 – Suitable land for the production of 2-3 year old, grassfed, export quality cattle, but only in good seasons	nd3	No
KkWp	9 ha	Moderately to very deep, alkaline, mottled, grey cracking clay with hard setting surface.	Class 5 Unsuitable	m5	Class 3 – Suitable land for the production of 2-3 year old, grassfed, export quality cattle, but only in good seasons	nd3, w3	No
KkSp	21 ha	Shallow to moderately deep, alkaline, grey or brown cracking clay with hard setting surface.	Class 5 Unsuitable	m5	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	nd3, w3, e3, r2-3, often t4	No
Nw	93 ha	Deep to very deep, alkaline grey or brown cracking clay with moderately to strongly self-mulching surface	Class 4 Marginal	m3, nd3, sa4	Class 3 – Suitable land for the production of 2-3 year old, grassfed, export quality cattle, but only in good seasons	nd3	No
Pc	198 ha	Deep to very deep, alkaline black cracking clay with strongly self-mulching surface.	Class 2 Suitable with slight limitations	nd2	Class 2 - Land suitable for the production of 2-3 year old, grassfed, export quality cattle in most seasons	nd2	Yes

Table 7 (cont'd)

Soil	Area * (ha)	Brief soil description	Cropping suitability		Grazing Suitability		Good Quality Agricultural Land
			Suitability	Main Limitations	Suitability	Main Limitations	Yes or No
PcXp	27 ha	Deep to very deep, alkaline black cracking clay with strongly self-mulching surface.	Class 2 Suitable with slight limitations	nd2	Class 2 - Land suitable for the production of 2-3 year old, grassfed, export quality cattle in most seasons	nd2	Yes
PcR	6 ha	Very shallow, gravelly black cracking clay with self-mulching surface	Class 5 Unsuitable	m5, r4	Class 3 – Suitable land for the production of 2-3 year old, grassfed, export quality cattle, but only in good seasons	m3	No
Kc	710 ha	Moderately to very deep, neutral to alkaline red-brown non-cracking to weakly cracking clay.	Class 4 Marginal	m4	Class 3 – Suitable land for the production of 2-3 year old, grassfed, export quality cattle, but only in good seasons	nd3	No
Mf	183 ha	Moderately to very deep, alkaline red-brown non-sodic texture contrast soil with thick, clay loamy topsoil.	Class 5 Unsuitable	m4, nd4	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	nd4	No
MfSv	115 ha	Deep to very deep, alkaline grey or brown sodic duplex soil with thick, clay loamy topsoil.	Class 5 Unsuitable	m5	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	m4	No
Pg	11 ha	Very deep, alkaline brown, non-cracking to weakly cracking clay.	Class 5 Unsuitable	m5, sa5	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	m4, sa4	No

Table 7 (Cont'd)

Soil	Area * (ha)	Brief soil description	Cropping suitability		Grazing Suitability		Good Quality Agricultural Land
			Suitability	Main Limitations	Suitability	Main Limitations	Yes or No
PgMp	11 ha	As for Pg soil but with deep melonhole gilgai.	Class 5 Unsuitable	m5, sa5, g5	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	m4, sa4	No
PgSp	27 ha	Moderately deep, alkaline brown non-cracking to weakly cracking clay.	Class 5 Unsuitable	m5, sa5	Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	m4, sa4	No
Lg	256 ha	Very deep, alkaline black cracking clay with strongly self-mulching surface.	Class 4 Marginal for summer crops; Class 5 Unsuitable for winter crops	m4 (summer), m5 (winter)	Class 3 – Suitable land for the production of 2-3 year old, grassfed, export quality cattle, but only in good seasons	m2, nd3	No
Pr	1 ha	Deep to very deep, alkaline brown non-sodic texture contrast soil with very thick sandy topsoil.	Class 5 Unsuitable	m5	Class 3 – Suitable land for the production of 2-3 year old, grassfed, export quality cattle, but only in good seasons	m3, nd2	No

* Total areas surveyed within the Mining Lease and Mining Lease Application.

Table 8 Cropping Suitability Analysis Results, Lake Vermont Mining Lease area surveyed (ML) and Mining Lease Application (MLA) area.

Results of Rainfed Cropping Suitability analysis	**ML**	**MLA**
Class 1 – Suitable land with negligible limitations	0 ha	0 ha
Class 2 – Suitable land with slight limitations	195 ha	30 ha
Class 3 – Suitable land with moderate limitations	0 ha	0 ha
Class 4a – Marginal land with severe limitations for both summer and winter crops	746 Ha	57 ha
Class 4b – Marginal land for summer crops but unsuitable for winter crops	256 ha	0 ha
Class 5 -Unsuitable land with extreme limitations	1448 ha	365 ha
Total Area	2645	452 ha

Table 9 Grazing Suitability Analysis Results, Lake Vermont Mining Lease area surveyed (ML) and Mining Lease Application Area (MLA).

Results of Grazing Suitability analysis	**ML**	**MLA**
Class 1 - Land suitable for the production of 2 year old, grassfed, export quality cattle in all seasons	0 Ha	0 ha
Class 2 - Land suitable for the production of 2-3 year old, grassfed, export quality cattle in most seasons	223 Ha	30 ha
Class 3 – Suitable land for the production of 2-3 year old, grassfed, export quality cattle, but only in good seasons	2152 Ha	263 ha
Class 4 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	270 Ha	159 ha
Class 5 Unsuitable land for production of export quality cattle and marginal as breeding country all year round	0 Ha	0 ha
Total Area	2645	452

Soil units Pc and PcXp are suitable for rainfed cropping due to high moisture holding capacity and generally good surface condition. All other soils are Marginal (Class 4) or Unsuitable for rainfed cropping, with the main limitations being water availability and nutrient deficiency and in same soils salinity. Rockiness is a major limitation for soil unit PcR and microrelief for soil unit PgMp.

Most soils are suitable for production of 2-3 year old grass-fed expert quality cattle only in good season (Grazing class 3). Soil units KkSp, Mf, MfSv and Pg (and variants) are marginal for production of export cattle but suitable as breeding country all year round (Grazing class 4) with the major limitations being water availability, nutrient deficiency and salinity or gilgai. Only the better cracking clay soils Pc and PcXp as well as the non-sodic texture-contrast soil Hb are suitable for production of 2-3 year old grass-fed export quality cattle in most seasons (Grazing class 2).

6.3 Good Quality Land Assessment

State Planning Policy 1/92 – Development and Conservation of Agricultural Land, Gazetted 18th December, 1992 seeks to protect Good Quality Agricultural Land (GQAL) from development. *Planning Guidelines - The Identification of Good Quality Agricultural Land, (*January 1993) provides the definition of GQAL in terms of four Agricultural Land Classes (ALC). A brief Definition of each of the four Agricultural Land Classes as defined in the Planning Guidelines (1993) is:

- Class A - Crop Land – Land that is suitable for current and potential crops with limitations to production which range from none to moderate levels.
- Class B - Limited Crop Land – Land that is marginal for current and potential crops due to severe limitations and suitable for pastures. Engineering and / or agronomic improvements may be required before the land is considered suitable for cropping.
- Class C - Pasture Land - Land that is suitable only for native or improved pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment.
- Class D - Non-Agricultural Land – Land not suitable for agricultural uses due to extreme limitations. This land may be undisturbed land with significant habitat, conservation and / or catchment values or land may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

In the Central Highlands area, Class A Land is land that is suitable for rainfed broad acre crops. Class C Pasture land is commonly split into subclasses, to reflect differences in grazing potential. In this survey Class C is split as :

- Class C 1 – Land suitable for production of 2-3 year old grass-fed export quality cattle in most seasons. (Class 2 for Gazing Suitability in this survey).
- Class C 2 – Land suitable for production of 2-3 year old grass-fed export quality cattle only in good seasons. (Class 3 for Gazing Suitability in this survey).
- Class C 3 – Marginal land for production of export quality cattle but suitable as breeding country all round (Class 4 for Gazing Suitability in this survey).

- Class C 4 – Unsuitable land for production of export quality cattle and marginal as breeding country all year round

The extent of the ALC over the ML and MLA is shown on Map 4 at the end of the report. Only Land that is assessed as Class A or C1 should be considered as GQAL within the Central Highlands Regional Council Area.

Good Quality Agricultural Land (GQAL) analysis of each soil (and phase and variant) mapped in this survey is given in Table 10 below. Areas of Agricultural Land Classes over the area mapped is presented in Table 11 on the next page. There are a total of 30 ha of GQAL within the Mining Lease Application Area (MLA) and 223 ha of GQAL within the Mining Lease Area (ML) mapped in this project.

Table 108 ALC* status of each soil within area of the Lake Vermont Mining Lease (ML) area surveyed and Mining Lease Application (MLA) Area.

Soil Unit	ALC *	Area (ha) ML	Area (ha) MLA
Hb	C1	28	0
Kk	C2	1137	205
KkWp	C2	6	3
KkSp	C3	9	12
Nw	B	55	38
Pc	A	168	30
PcXp	A	27	
PcR	C2	6	
Kc	C2	691	19
Mf	C3	38	145
MfSv	C3	115	
Pg	C3	11	
PgMp	C3	11	
PgSp	C3	27	
Lg	C2	256	
Pr	C2	1	
DAMs	C3	59	
Total area surveyed (ha)		2645	452

* Agricultural Land Class (ALC) – refer to the discussion above for definitions.

Table 119 Results of GQAL analysis, Lake Vermont Mining Lease (ML) area surveyed and Mining Lease Application Area (MLA)

Results of GQAL analysis	ML	MLA	GQAL
Class A	195 ha	30 ha	Yes
Class B	55 ha	38 ha	No
Class C1 - Land suitable for the production of 2-3 year old, grassfed, export quality cattle in most seasons	28 ha	0 ha	Yes
Class C2 – Suitable land for the production of 2-3 year old, grassfed, export quality cattle, but only in good seasons	2097ha	227 ha	No
Class C3 - Marginal land for production of export quality cattle, but suitable as breeding country all year round	270 ha	157 ha	No
Class C4 Unsuitable land for production of export quality cattle and marginal as breeding country all year round	0 ha	0 ha	No
Total area surveyed (ha)	**2645 ha**	**452 ha**	
Total area of GQAL (ha)	**223 ha**	**30 ha**	

7. SCL Assessment of the Mining Lease Application Area (MLA).

Strategic Cropping Land is a finite resource that must be conserved and managed for the longer term. *State Planning Policy 1/12 - Protection of Queensland's strategic cropping land* commenced on 30 January 2012. This SPP seeks to protect SCL by ensuring that:

1) Development impacts on SCL or potential SCL are managed to preserve the productive capacity of the land for future generations

2) Development impacts on SCL or potential SCL are managed through assessment under this SPP and through imposing conditions on the development

a) to the extent that SCL or potential SCL in a protection area will be permanently impacted upon by a development with a footprint greater than 3000 square metres (m^2), the development must not proceed except in exceptional circumstances, and where the development is an exceptional circumstance, mitigation is provided for the permanently impacted land

b) to the extent that SCL or potential SCL in the management area will be permanently impacted upon by a development with a footprint greater than 3000 m², mitigation is provided for the impacted land.

The MLA comprises 452 hectares immediately adjacent to the existing ML (see Map 1). The area has been almost completely cleared, and regrowth of Brigalow, Eucalypts and some currant bush is evident. A small area of uncleared Eucalypt vegetation occurs near the small dam in the north-west corner. No evidence was found in the soil profile or land surface, such as contour banks etc., that any of the area had been cultivated in the past. Generally, there is good grass cover of Buffel grass, some Rhodes grass and some thick patches of Parthenium weed.

Soil profiles were described at 15 ground observation sites within the MLA which are shown on Map 1.

The MLA lies within Lot 4 on CNS382, freehold land owned by RW & LT Berry and KJ & K Parkinson known as 'Lake Vermont". Lot 4 is within the Management Area, Western Cropping Zone, and Central Highlands Isaac Mitigation Subzone on the Strategic Cropping Land Trigger Map, accessed 16th Feb, 2012 from the DERM website. A copy of this map appears at the end of the report (Map 4) and shows almost all of Lot 4 as white – not potential SCL which does not warrant further SCL investigation. There is a small area in the SE corner of Lot 4, (total of 6 ha) coloured green on the Map, which indicates it is Potential Strategic Cropping Land.

Land in the management area will need to have the required cropping history and the meet the zonal criteria to be validated as SCL. Sections 46, 49 and 50 of the SCL Act (2011) as well as the *Cropping history assessment guidelines* (dated January 2012) provide information on the criteria to assess cropping history of a parcel of land. If the site does not meet the required cropping history, it not considered as SCL according to the SPP 1/12. Once it has been determined that an area meets this required cropping history, the soils of the site are then assessed using the eight criteria (as well as minimum area requirements) to determine its SCL status.

Based on the definition provided in the SCL Act (2011), a property has the required cropping history if either of the following uses applied for any of the property –

a) It was cropped or cultivated (other than for a perennial crop) at least 3 times from 1 January 1999 to 31 December 2010;
b) For periods totalling 3 years or more from 1 January 1999 to 31 December 2010, perennial crops or timber plantations existed on the property.

The above history applies even if the uses:

- only occurred on part of the property – even if cropping did actually occur at the site under investigation but did occur on another part of the property the site is deemed to fulfil the cropping requirements;
- the crop, cultivation or tree crops were not for sale;
- the 3 crops were not consecutive;
- the 3 years were not consecutive.

From the information currently available, it is highly likely that at least some of the property included in the expansion would have the required history of cropping. Therefore as the area of potential SCL is so small within Lot 4, it is not worth pursuing the cropping history of the land but accept that it fulfills the cropping history requirement and the SCL validation will be determined by the eight zonal criteria (see below).

On 14 April 2011, the Queensland Government released the proposed criteria for identifying strategic cropping land (SCL) in Queensland, to be used in drafting the SCL legislation. The criteria are designed for an on-ground property level assessment to confirm whether a particular site is or is not SCL and were developed to reliably and consistently identify the state's best cropping land—land that is suitable for a range of crops in most seasons—and to minimise the assessment burden and costs to landholders and development proponents.

The criteria were included within the Sept 11 Guidelines, which identify whether an SCL assessment should be undertaken, helping landholders and development proponents avoid unnecessary assessment costs and outline how to undertake an assessment with the criteria to define the extent of SCL. At the time of this report, the Sept 11 Guidelines have not been updated.

The eight criteria for Division 1 Western Cropping Zone taken directly from Part 2 – Criteria of the SCL Act 2011 are :

Criterion 1 Slope is 3% or less.
Criterion 2 Rockiness is 20% or less.
Criterion 3 The average density of gilgai microrelief with depressions of more than 500mm is less than 50% of the land surface.
Criterion 4 Soil depth is 600 mm or more.
Criterion 5 The land has favourable drainage.
Criterion 6 Soil pH at 300mm depth and 600mm depth is as follows—
- for rigid soils—5.1 or more to 8.9;
- for non-rigid soils—more than 5.0.

Criterion 7 Soil at 600mm depth or shallower has a chloride content of less than 800mg/kg.
Criterion 8 The land's soil water storage is 100mm or more

Criterion are assessed in order from 1 to 8 as listed above. The assessment is a 'negative' assessment, as once a land parcel fails any criterion it is assessed as "non-SCL" and other criterion are not assessed. For example, if a land parcel is proven to have slope > 3% it fails the slope criterion and is assessed as 'non-SCL" without reference to any of the other seven criterion. The last criterion, Soil Water Storage, is only assessed for land that passes all of the seven criterion preceding it.

Land considered as SCL must pass all of the 8 criteria above and have greater area than the minimum size which is defined in the September 2011 Guidelines for the Western Cropping Zone as 100 ha that is at least 80 metres wide. The minimum size refers to the soil resource and not to Cadastral boundaries.

Criterion 1. Slope

Detailed LIDAR data is routinely collected over the ML and MLA areas, using data on a 1 m grid. LIDAR Data collected in December 2011 covering the /MLA Area was interrogated to define land with slopes > 3 %, that is land that fails the slope criterion. A GIS map was produced which highlighted the areas with slopes > 3 % from this LIDAR data. This map is presented in the back of the report as Map 6. The Potential Strategic Cropping Land from the DERM mapping is also shown on this map

It can be seen from Map 6, just over half of the area of the Potential SCL within the MLA Area has slope > 3 %, and therefore fails the slope criterion. Site 8 which is within the Potential SCL area has slope recorded in the field of 4 %, which matches the LIDAR data interrogation result.

The area therefore that passes the slope crierion within the MLA Area is 3 ha.

The main soil unit mapped over this potential SCL area is Kk with minor Nw - both are cracking clays. Neither of these soils has surface rocks, gilgai, shallow soil depth, soil pH, wetness or salinity properties that will fail the next 6 of the SCL Criteria. Estimated PAWC from the lookup table is 120 mm for both soils, so both will pass the soil water storage criterion. Areas of both soils will therefore pass all 8 SCL criterion.

The results of the SCL assessment using the 8 criterion shows that within the 6 ha of potential SCL within the MLA Area, 3 ha fails the slope criterion and 3 ha passes all eight criterion.

However, the minimum size requirements for SCL validation also need to be considered for the area that passes the eight criterion.

An examination of Map 6 shows that the 3 ha of SCL occupies three small units that are difficult to incorporate into a larger viable cropping unit due to their size and locations split by the area with slopes > 3 % (non-SCL). For areas less than 100 ha minimum size, consideration must be made of amalgamating the area with adjoining SCL areas which may or may not be on a different cadastral land parcel. The only possibility in this case is to amalgamate with SCL land to the south on the neighbouring cadastral unit, assuming this exists and it is practical to do so.

The land to the south is itself constrained for rainfed cropping use as it includes uncleared land which is non-SCL located in a broad wet drainage line (this will fail slope and/or soil wetness criterion). This area can be seen clearly seen on Map 1 at the back of the report. Therefore, the small area that passes the eight SCL criterion will fail the SCL validation test based by being below minimum size and not being able to be combined with adjacent land to produce a combined farming area > 100 ha. It should therefore be validated as “non-SCL”. The MLA Area therefore will NOT permanently impact on any SCL area.

7. Conclusions

- Most of the area surveyed is cleared with Brigalow communities the most common over the area, although significant areas of Eucalypts do occur.
- 16 soils (including phases and variants) were mapped with differing soil morphology and chemical properties.
- Depth of useable soil for primary or secondary growth media is limited in most soils by shallow depth to dispersible, sodic and saline subsoil.
- Most salvageable material is recommended for reuse only on level to very low slopes.
- Construction of appropriate runoff control structures is critical as part of any soil ruse program to minimise potential soil erosion.
- Most of the land has been assessed as marginal to unsuitable for rainfed broad acre cropping.
- Most of the land has been assessed as Class 3 Grazing Land, capable of producing export quality grass-fed cattle but only in good seasons.
- There are 30 ha of GQAL within the Mining Lease Application area and 223 ha of GQAL within the Mining Lease area surveyed in this project.
- The Mining Lease Application area does not encroach onto SCL.

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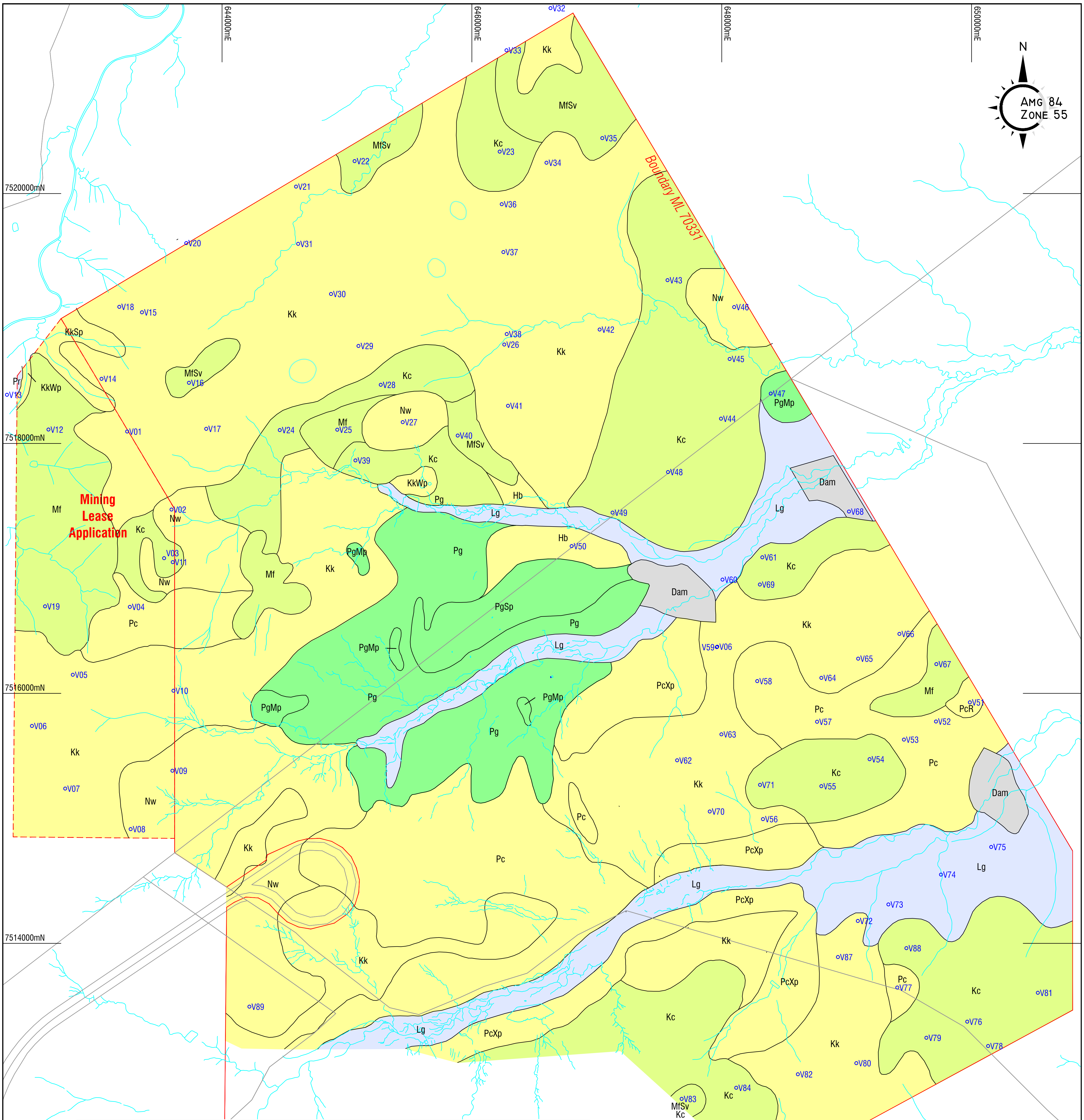

Brigalow Vegetation

Hb	*Deep to very deep, brown or grey texture contrast soil; non-sodic upper subsoil.*
Kk	*Moderately deep to very deep, grey to brown cracking clay with hard setting surface.*
KkWp	*Wet phase of Kk soil, occurring in drainage lines and seasonal swamps.*
KkSp	*Shallow phase of Kk soil, occurring on steep slopes and gullies associated with Philips creek.*
Nw	*Deep to very deep, grey or brown cracking clay with moderately to strongly self-mulching surface.*
Pc	*Deep to very deep, black cracking clay with strongly self-mulching surface.*
PcXp	*Similar to Pc soil but weak surface seal forms after rainfall.*
PcR	*Very shallow and gravelly, black cracking clay with strongly self-mulching surface.*

Eucalypt Vegetation

Kc	*Moderately to very deep, red-brown non-cracking to weakly cracking clay.*
Mf	*Moderately to very deep, red-brown non-sodic texture contrast soil with thick, clay loamy topsoil.*
MfSv	*Deep to very deep, grey or brown sodic texture contrast soil with thick, clay loamy topsoil.*

Soils developed on calcareous unconsolidated sediments sourced from Sedimentary Landscapes (TQa) with Brigalow vegetaion

Pg	*Very deep, salty, brown non-cracking to weakly cracking clay; usually gravelly surface.*
PgMp	*Similar to Pg soil but with frequent melonhole gilgai.*
PgSp	*Moderately deep, salty, brown non-cracking to weakly cracking clay; usually gravelly surface.*

Soils developed on recent alluvium (Qa)

Lg	*Very deep, black cracking clay with strongly self-mulching surface.*
Pr	*Deep to very deep, brown non-sodic texture contrast soil with very thick, sandy topsoil.*

SCALE

500 0 500 1000

metres

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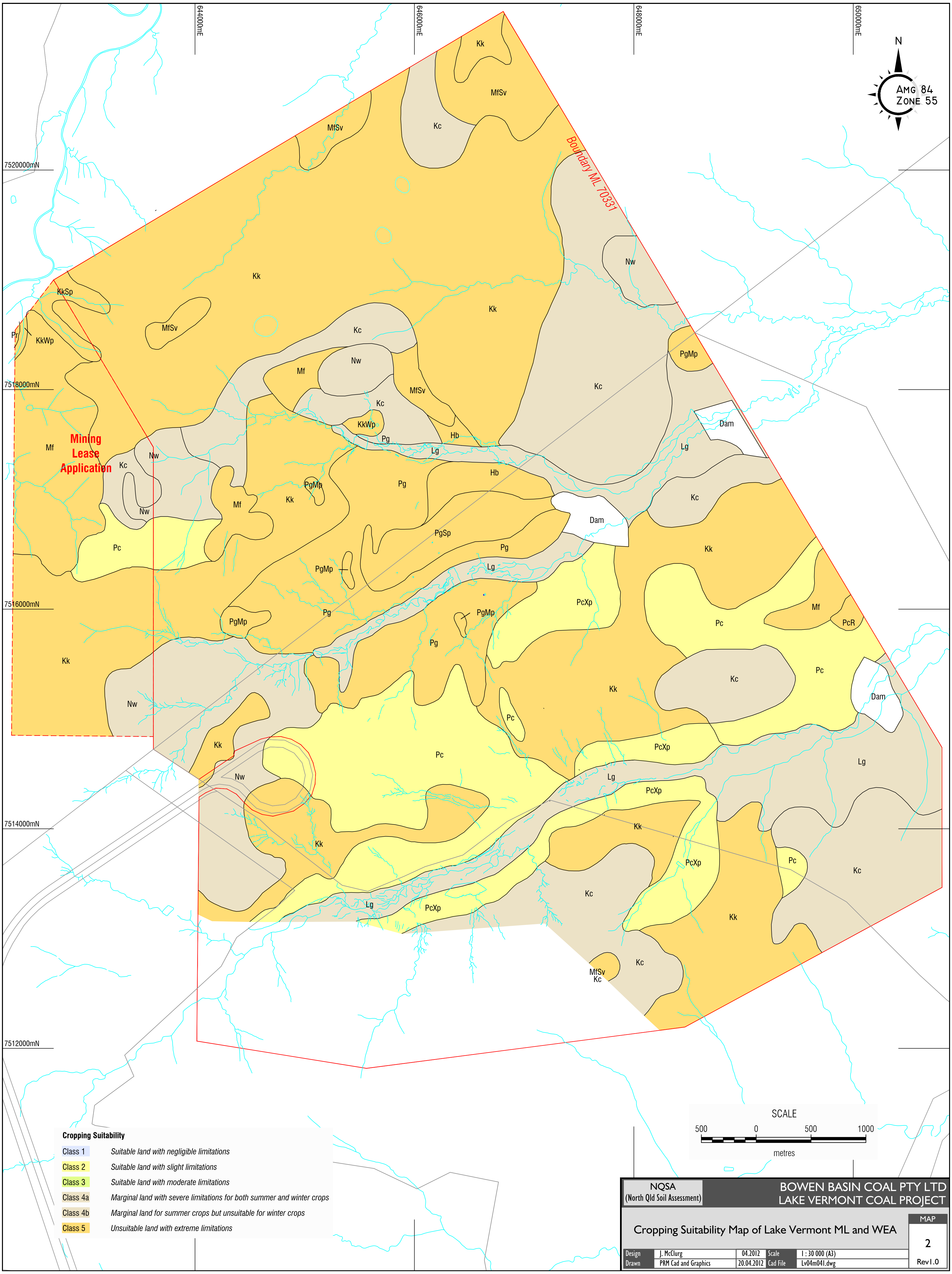
Soil Map of Lake Vermont ML and WEA
and Soil Survey Sample Sites

MAP 1

Design	J. McClurg	04.2012	Scale	1 : 30 000 (A3)
Drawn	PRM Cad and Graphics	20.04.2012	Cad File	Lv04m041.dwg

Rev1.0



Cropping Suitability

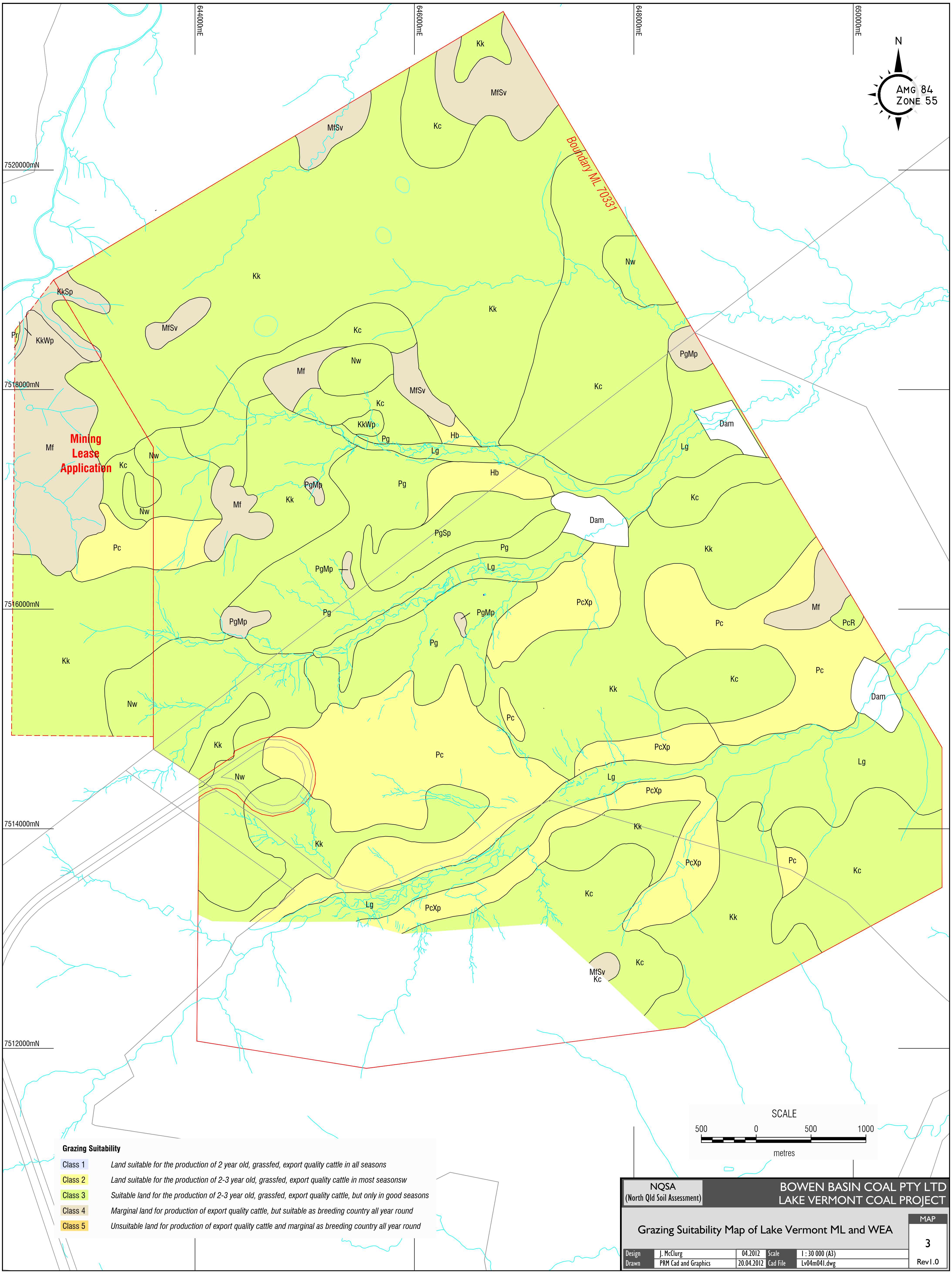
Class 1	*Suitable land with negligible limitations*
Class 2	*Suitable land with slight limitations*
Class 3	*Suitable land with moderate limitations*
Class 4a	*Marginal land with severe limitations for both summer and winter crops*
Class 4b	*Marginal land for summer crops but unsuitable for winter crops*
Class 5	*Unsuitable land with extreme limitations*

NQSA
(North Qld Soil Assessment)

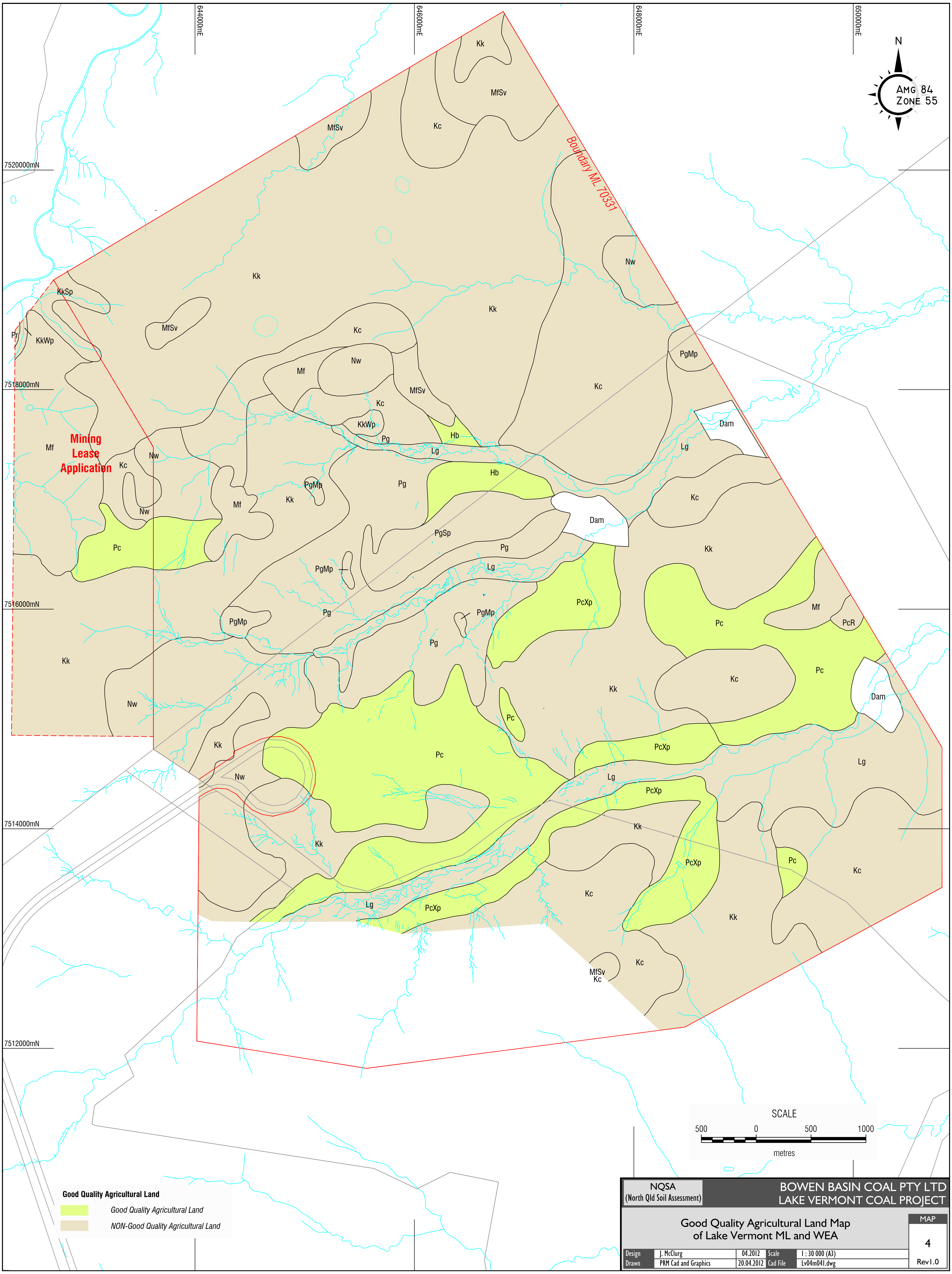
BOWEN BASIN COAL PTY LTD
LAKE VERMONT COAL PROJECT

Cropping Suitability Map of Lake Vermont ML and WEA

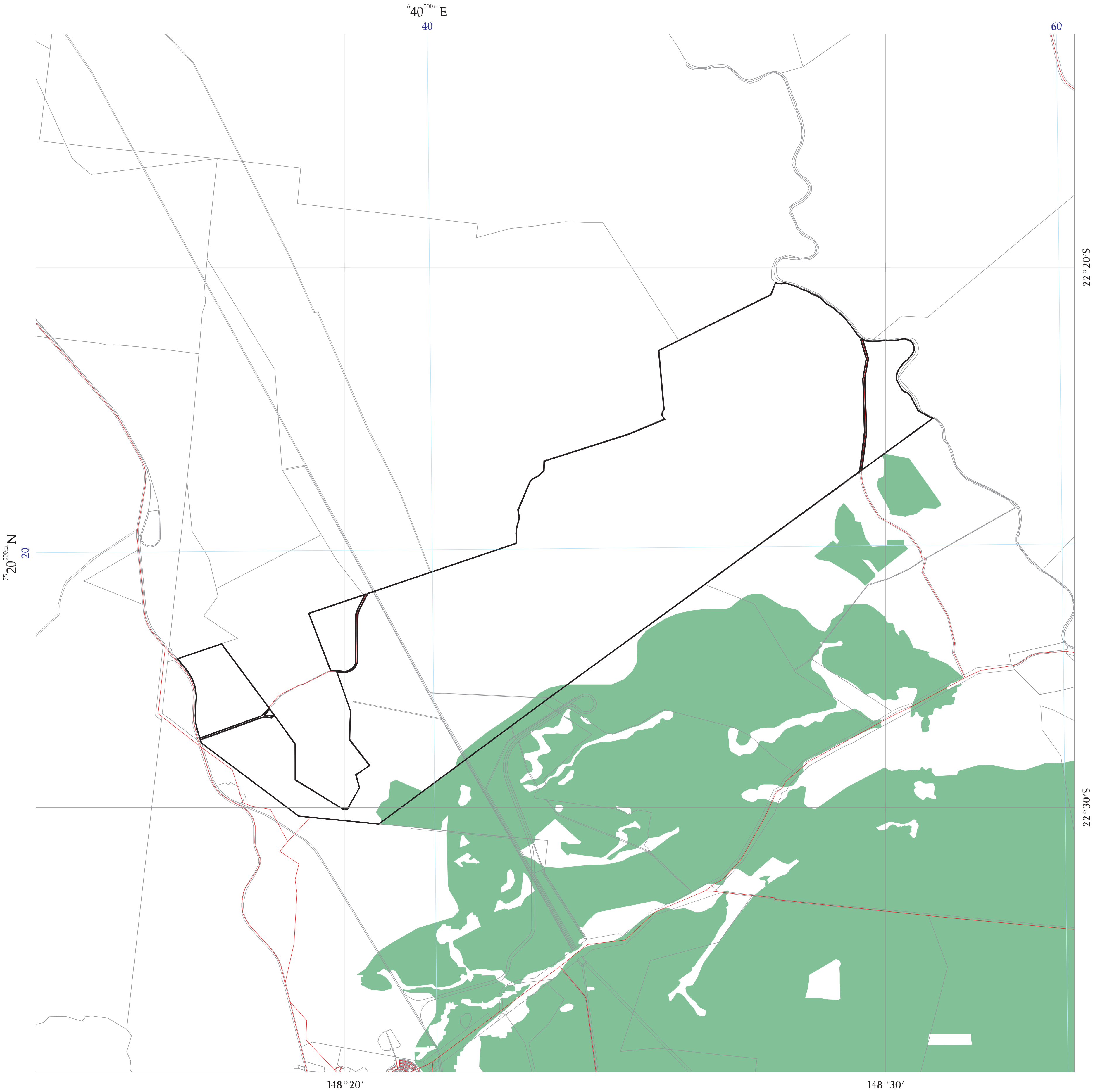
Design	J. McClurg	04.2012	Scale	1 : 30 000 (A3)	MAP 2
Drawn	PRM Cad and Graphics	20.04.2012	Cad File	Lv04m041.dwg	Rev1.0



N
AMG 84
ZONE 55
644000mE
646000mE
648000mE
650000mE
7520000mN
7518000mN
7516000mN
7514000mN
7512000mN
Boundary ML 70331
Mining Lease Application
Kk
MfSv
Kc
KkSp
KkWp
Pr
Mf
Nw
PgMp
KkWp
Pg
Lg
Hb
Dam
PgSp
Pc
PcXp
PcR
Lg
MfSv Kc
SCALE
500 0 500 1000
metres
Grazing Suitability
Class 1 Land suitable for the production of 2 year old, grassfed, export quality cattle in all seasons
Class 2 Land suitable for the production of 2-3 year old, grassfed, export quality cattle in most seasonsw
Class 3 Suitable land for the production of 2-3 year old, grassfed, export quality cattle, but only in good seasons
Class 4 Marginal land for production of export quality cattle, but suitable as breeding country all year round
Class 5 Unsuitable land for production of export quality cattle and marginal as breeding country all year round
NQSA (North Qld Soil Assessment)
BOWEN BASIN COAL PTY LTD
LAKE VERMONT COAL PROJECT
Grazing Suitability Map of Lake Vermont ML and WEA
MAP 3
Rev1.0
Design J. McClurg 04.2012 Scale 1 : 30 000 (A3)
Drawn PRM Cad and Graphics 20.04.2012 Cad File Lv04m041.dwg



Mining Lease Application
Boundary ML 70331
AMG 84 ZONE 55
N
644000mE
646000mE
648000mE
650000mE
7520000mN
7518000mN
7516000mN
7514000mN
7512000mN
SCALE
500 0 500 1000
metres
Good Quality Agricultural Land
Good Quality Agricultural Land
NON-Good Quality Agricultural Land
NQSA (North Qld Soil Assessment)
BOWEN BASIN COAL PTY LTD
LAKE VERMONT COAL PROJECT
Good Quality Agricultural Land Map of Lake Vermont ML and WEA
MAP 4
Rev1.0
Design J. McClurg 04.2012
Drawn PRM Cad and Graphics 20.04.2012
Scale 1 : 30 000 (A3)
Cad File Lv04m041.dwg



STRATEGIC CROPPING LAND TRIGGER MAP

Potential strategic cropping land

Strategic cropping land

Zonal criteria validated (management area only)

Cropping history validated (management area only)

Decided non-strategic cropping land

Current validation applications
Application reference number(s) shown on map face

Protection area boundary

Zone boundary

Subject lot

Roads
© Pitney Bowes Software 2012

Cadastral line
Lot on Plan boundaries shown are provided as a locational aid only.

Towns

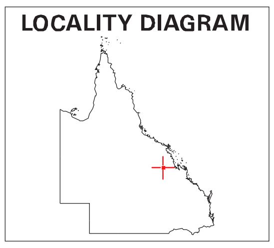
This Lot on Plan is located in:

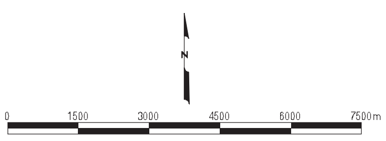
(1) MANAGEMENT AREA
(2) WESTERN CROPPING ZONE
(3) CENTRAL HIGHLANDS ISAAC MITIGATION SUB-ZONE

Requested By: JASOIL@MACKAY.NET.AU
Date: 12 Apr 12 Time: 23.17.08

Centred on Lot on Plan:
4 CNS382

Queensland Government





This map can be used to identify land that is subject to the *Strategic Cropping Land Act 2011*.

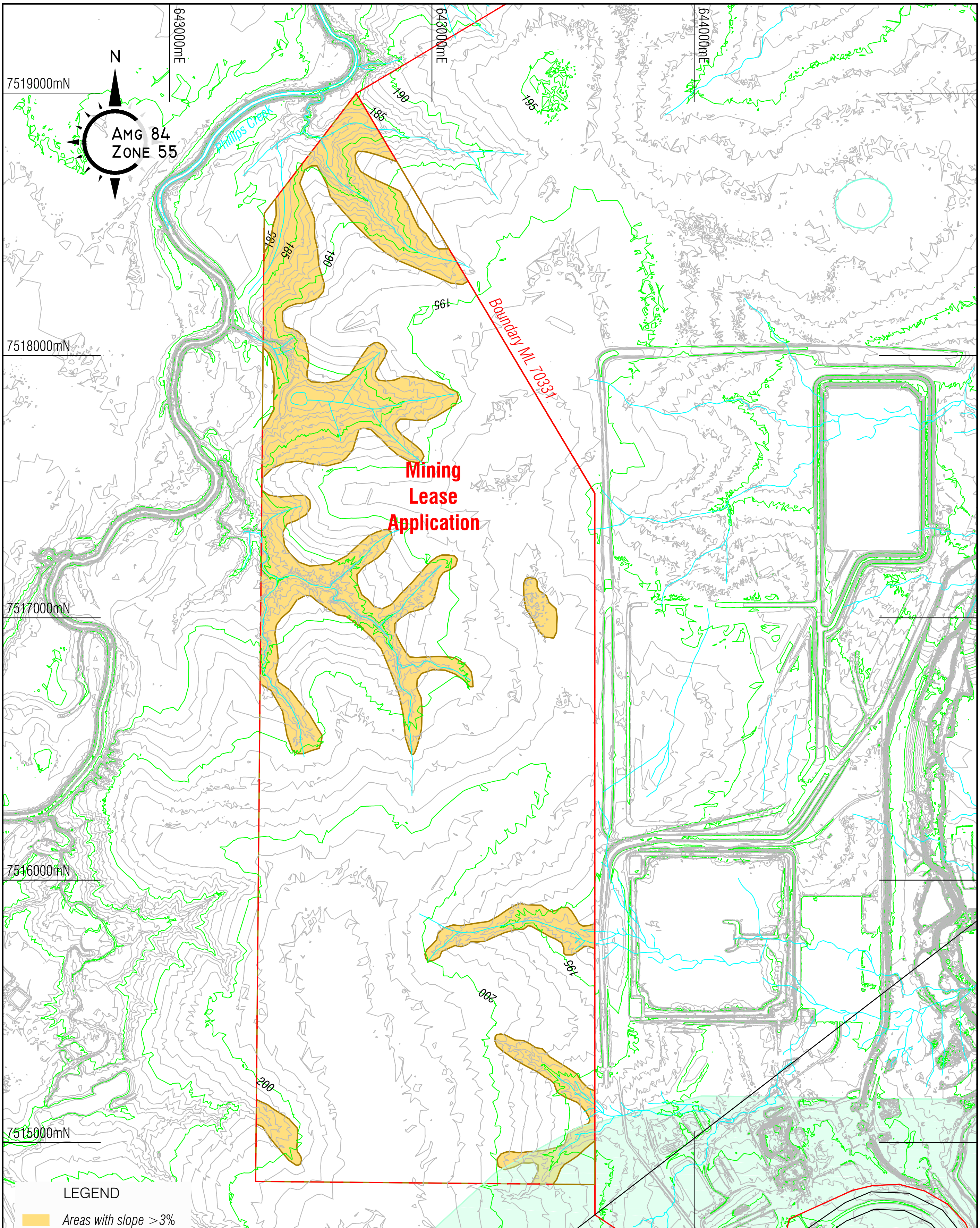
The location of potential strategic cropping land (SCL) was prepared using Class A Agricultural Land and Versatile Cropping Land data and 1999 Queensland Land Use Mapping Program (QLUMP) data identified as production from agriculture or plantations. Land is excluded as potential SCL where it is remnant vegetation, or is in a national park, state forest, timber reserve or forest reserve. Land is excluded as potential SCL where it is within the urban footprints for Far North Queensland or South East Queensland, or is in a collection of small cadastral parcels. The extent of potential SCL is limited to those areas within the five SCL zones.

The map shows land that has been validated as SCL or decided non-SCL under the *Strategic Cropping Land Act 2011*. It also indicates areas that are currently subject to a validation application, and where a zonal criteria or cropping history decision has been made but further assessment is required to validate the land as SCL or decided non-SCL.

For further information on the strategic cropping land policy or the specific assessment requirements of land under the strategic cropping land policy, go to the website: www.derm.qld.gov.au

Digital GIS data and full metadata can be obtained from <http://dds.information.qld.gov.au/dds/>

Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)



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Areas with slope >3% (Derived from Dec. 2011 LIDAR Data) and Strategic Cropping Land

Design	J. McClurg	04.2012	Scale	1 : 20 000	FIGURE
Drawn	PRM Cad and Graphics	13.04.2012	Cad File	Lv04m040.dwg	Rev1.1

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	1	McCJI	23-Nov-2011	Kk	TQab	643240 E	7518095 N	C	VR	mz, so, ca		VE	AD	GS	FM	E	R	S	W	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Agent	Type	State	Degree	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.30	10	M	0				1	1	R	GV	0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
				SW	U	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	
Mod to strongly cracking clay with weak, very patchy SM generally HS. Cleared buffel grass, Rhodes grass Site located on very broad gentle HSL to SW of gentle rise					

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.10	10 YR 4/1	0	MC		1 1 R GV		0			
B 21		0.10	0.25	10 YR 4/2	0	MC		1 1 R GV		2KN1			
B 22		0.25	0.40	2.5 Y 4/2	0	MHC		1 1 R GV	S 5 LE	2KN1/2KS3	K 3 P		
B 23		0.40	0.70	2.5 Y 4/2	0	MHC		1 1 R GV	S 5 LE	2KN1/2KS3	K 3 P		
B 24		0.70	1.30	10 YR 5/4	0	MHC		1 1 R GV	S 5 LE	2KN1/2KS3	K 3 P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20		1.50		1.80				
pH - RP		7.5		8.7			8.7			8.7			8.7								
Field EC		0.12	0.11	0.12	0.07	0.16	0.21	0.54	0.58	0.87	1.36										
Field pH (1:5)		8.1	8.5	9.2	8.6	9.2	9.3	9.2	9.1	9.4	8.6										
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	2	McCJI	23-Nov-2011	Nw	TQab	643595 E	7517471 N	C	vR	gm, so, ca		VE	AD	EI	FM	E	S	S	W	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.35	12	M	0				1	1	R	GV	0		4	G	99	99				
																M						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
				SW	M	HSL		RIS		0	3	2	4

Land use | Land condition | Notes

Moderate SM surface compared to first site - cleared with very sparse brigalow regrowth slightly lower on rise than last site but located on same general very gentle slope.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.02	10 YR 4/1	0	MHC		1 1 R GV	S 2 GR	0			
A 12		0.02	0.12	10 YR 4/1	0	MHC		1 1 R GV	S 4 AB	0			
B 21		0.12	0.22	10 YR 4/1	0	MHC		1 1 R GV	S 5 AB	0			
B 22		0.22	0.80	10 YR 4/1	0	MHC		1 1 R GV	S 5 LE	2KN1/2KS3	K 3 P		
B 23		0.80	1.20	7.5 YR 4/3	0	MHC		1 1 R GV	S 5 LE	2KN1/2KS3	K 3 P		

Test depth (m)	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20		1.50		1.80					
pH - RP	7.0		8.5			8.5			7.5			7.5									
Field EC	0.10	0.08	0.08	0.20	0.14	0.28	0.37	0.67	1.03	1.50		1.25									
Field pH (1:5)	7.0	8.6	7.6	8.8	8.9	8.6	8.6	8.6	8.4	8.3		8.4									
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	3	McCJI	23-Nov-2011	Kc	TQab	643536 E	7517082 N	C	KS	vr, ca, so		DE	AB	CQ	EO	B	E	O	O	X

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	R	GV	0		4	H	99	99				

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage	Land use		Land condition		Notes	
Eval	Height (m AHD)	Eval	%																
		A	2		R	HCR		RIS		0	2	3	4						

Site located on broad HCR/RIS on calcareous sediments Soil profile better as Dermosol rather than Vertosol with some surface cracking though. Some weak gilgai also around - VI 10 - 15 cm. BC is MARL here with plenty of Calcium.

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.25	7.5 YR 5/3	0	FSLC		0	S 3 AB	0			
B 21		0.25	0.60	7.5YR 5/4	2 2 D B	LMC		0	S 4 AB	0			
B 22		0.60	0.80	7.5YR 5/4	0	LMC		0	S 5 LE	2KS2			
BC k		0.80	1.50	10 YR 6/4	0	LMC		0	S 5 AB	4KS3			

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20		1.50						
pH - RP		6.5		7.0			7.0			7.0			8.0		9.2						
Lab EC		0.03	0.03	0.02	0.03	0.03	0.05	0.12	0.12	0.12	0.13		0.15		0.20						
Cl		< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6		< 6								
Lab pH (w)		6.8	6.7	7.1	7.7	7.8	7.9	8.6	8.8	8.9	9.0		9.2								
CEC		11		12			16			14			13								
ESP		0.7		0.9			1.8			3.4			7.3								
Ca/Mg		1.9		2.5			1.8			1.4											

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg). Sampled all 10 cm depths to 1.20 m. Field EC and pH at 1.50 m

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K: Accuracy	AMG Location 55K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	ASC: Order	ASC: S.Ord	ASC: G Grp	ASC: S Grp	ASC: Fam 1	ASC: Fam 2	ASC: Fam 3	ASC: Fam 4	ASC: Fam 5
VER	4	McCJI	23-Nov-2011	Pc	TQab	643262 E	7516692 N	C	VR	gm, so, pe		VE	AD	EI	CD	E	S	S	X	

Microrelief: Type	Microrelief: PROP	Microrelief: V.I. (m)	Microrelief: H.I. (m)	Microrelief: Prop Sample	Erosion: Type	Erosion: State	Erosion: Degree	Erosion: Gully Depth	Surface coarse fragments: Abund	Surface coarse fragments: Size	Surface coarse fragments: Shape	Surface coarse fragments: Lith	Rock Outcrop: Abund	Rock Outcrop: Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Vegetation: Broad floristic formation (Level 3)	Vegetation: Broad floristic subformation (Level 4)	Vegetation: Wetland Type & Gr.form
N		0.10			0				0				0		4	G	99	99				
																M						

Elevation: Eval	Elevation: Height (m AHD)	Slope: Eval	Slope: %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS		0	2	2	4

Land use		Land condition		Notes	

Soil profile is Vertosol with strong medium self mulching surface. Weak giglai cleared Brigalow but with lots of Parthenium weed. Most of the soil still moist to wet. Site located on very broad lower HSL or flat.

Horizon	Boundry	Depth (m): Upper	Depth (m): Lower	Colour: Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.02	2.5 Y 4/1	0	MHC		1 1 R GV	S 2 GR				
A 12		0.02	0.10	2.5 Y 4/1	0	MHC		1 1 R GV	S 4 AB				
B 21		0.10	0.80	2.5 Y 4/1	0	MHC		1 1 R GV	S 5 LE		K 3 P		
B 22		0.80	1.00	2.5 Y 4/1	0	MHC		1 1 R GV	S 5 LE		K 3 P		
B 23		1.00	1.30	10 YR 5/2	0	MHC		1 1 R GV	S 5 LE	1KN3	K 3 P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20		1.50
pH - RP		7.0		6.5			6.5			7.5			6.5		
Lab EC		0.18	0.12	0.06	0.16	0.24	0.24	0.37	0.58	0.67	1.01		1.20		
Cl		15	<6	<6	16	48	83	190	420	540	950		1200		
Lab pH (w)		7.9	8.5	8.6	8.9	8.9	8.9	8.9	8.7	8.4	8.4		8.6		
CEC		33		34			40			41			44		
ESP		1.0		3.3			8.9			11.6			12.4		
Ca/Mg		2.6		1.9			1.1			0.9			0.8		

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg)   Sampled all 10 cm depths to 1.00 plus 1.20 m.

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K: Accuracy	AMG Location 55K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	ASC: Order	ASC: S.Ord	ASC: G Grp	ASC: S Grp	ASC: Fam 1	ASC: Fam 2	ASC: Fam 3	ASC: Fam 4	ASC: Fam 5
VER	5	McCJI	23-Nov-2011	Kk	TQab	642805 E	7516149 N	C	VR	mz, so, ca		VE	AD	GS	GO	E	R	S	W	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.30	12	M	0				0				0		4	G	99	99				
																H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					R	HCR		RIS		0	2	2	4

Land use | Land condition | Notes

Site located on bread HCR on calcareous sediments. Cleared with good buffel grass.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15	10 YR 4/1	0	MC		0	S 3 AB	0			
B 21		0.15	0.30	10 YR 4/1	0	MHC		0	S 4 AB	0			
B 22		0.30	0.80	2.5 Y 5/2	0	MHC		0	S 5 LE	2KS3	K 3 P		
B 23		0.80	1.25	10 YR 5/3	0	MHC		0	S 5 LE	0	K 3 P		
BC k / C ?		1.25	1.80	7.5 YR 5/4	0	MHC		0	S 5 LE	4KS3	K 3 P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20		1.50		1.80		2.10		
pH - RP		7.5		8.0			9.0			8.0			8.5		8.0		7.5				
Field EC		0.08	0.04	0.06	0.14	0.23	0.30	0.54	0.57	0.80	0.97		0.90		1.23		1.33				
Field pH (1:5)		7.7	8.6	8.3	9.1	9.1	9.2	9.2	9.1	9.2	9.0		8.9		8.6		8.4				
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	6	McCJI	23-Nov-2011	Kk	TQab	642478 E	7515739 N	C	VR	mz, so, ca		VE	AB	GS	GO	E	Q	R	W	

Microrelief Type	Microrelief PROP	Microrelief V.I. (m)	Microrelief H.I. (m)	Microrelief Prop Sample	Erosion Type	Erosion State	Erosion Degree	Erosion Gully Depth	Surface coarse fragments Abund	Surface coarse fragments Size	Surface coarse fragments Shape	Surface coarse fragments Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Vegetation: Broad floristic formation (Level 3)	Vegetation: Broad floristic subformation (Level 4)	Vegetation: Wetland Type & Gr.form
N	B	0.40	12	M	0				1	3	R	SA	0		4	G	99	99				
																H						

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Site on Lower HSL of Rise Cleared brigalow with good buffel grass HS Vertosol couple of melon hole here to 0.6 m deep but not enough for SCL exclusion Note Fine Sand in A horizon texture here

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.18	10 YR 4/3	0	FSLC		0	M 3 AB	0			
B 21		0.18	0.30	2.4 Y 5/3	0	MC		0	S 3 AB	2MN1			
B 22		0.30	0.80	2.5 Y 5/3	0	MC		0	S 5 LE	2MN1	K 3 P		
BC k		0.80	1.00	2.5 Y 7/4	0	MC		0	S 5 LE	4KS3	K 3 P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20		1.50		1.80		2.10		
pH - RP		7.5		8.0			8.5			8.5											
Field EC		0.03	0.06	0.09	0.05	0.10	0.10	0.14	0.10	0.23	0.23										
Field pH (1:5)		8.0	7.8	8.7	8.4	8.7	8.7	8.7	8.9	8.9	9.5										
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	ASC Order	ASC S.Ord	ASC G Grp	ASC S Grp	ASC Fam 1	ASC Fam 2	ASC Fam 3	ASC Fam 4	ASC Fam 5
VER	7	McCJI	23-Nov-2011	Kk	Tqab	642744 E	7515238 N	C	VR	mz, so, ca		VE	AD	GS	GO	E	Q	R	X	

Microrelief Type	Microrelief PROP	Microrelief V.I. (m)	Microrelief H.I. (m)	Microrelief Prop Sample	Erosion Type	Erosion State	Erosion Degree	Erosion Gully Depth	Surface coarse fragments Abund	Surface coarse fragments Size	Surface coarse fragments Shape	Surface coarse fragments Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Vegetation: Broad floristic formation (Level 3)	Vegetation: Broad floristic subformation (Level 4)	Vegetation: Wetland Type & Gr.form
N	C	0.30	18	M	0				1	2	R	SA	0		4	G	99	99				
																H						

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Vertosol on calcareous sediments cleared - brigalow ? Some melon hole again but not enough for SCL exclusion Better SM surface with calcareous nodules in the depressions compared to the mounds. Similar profile & LF to site 6

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.20	10 YR 4/2	0	FSLC		0	W 3 AB	0			
B2		0.20	0.40	10 YR 4/2	0	MC		0	S 5 AB	0			
BC k		0.40	1.30	2.5 Y 6/4	3 2 D O	MC		0	S 5 LE	4KS3 / 2MN2	K 3 P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50		1.80			
pH - RP		7.5		8.6			8.6			8.6			8.6								
Field EC		0.21	0.08	0.10	0.07	0.11	0.12	0.12	0.14	0.13	0.09		0.13								
Field pH (1:5)		8.2	8.7	8.4	8.5	8.7	8.6	8.7	8.8	8.9	8.8		8.8								
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	8	McCJI	23-Nov-2011	Nw	TQab	643268	7514914 N	C	VR	gm, so, ca		VE	AB	GS	BP	E	Q	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	R	SD	0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
		A	4.0	SE	M	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	
Siter located on midslope of very long, very gentle HSL to SE. Very little weak linear gillgai here but hard to find.					

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.10	10 YR 4/2	0	LMC		1 1 R GV	M 3 AB				
B 21		0.10	0.30	2.5 Y 5/3	0	MC		1 1 R GV	S 5 AB	1 K N 2			
B 22		0.30	0.65	2.5 Y 5/3	0	MC		1 1 R GV	S 5 LE	2 K S 3	K 3 P		
B 23		0.65	1.30	2.5 Y 5/3	0	MC		1 1 R GV	S 5 LE	2 K S3	K 3 P		
B 24		1.30	1.80	7.5 YR 5/4	0	MC		1 1 R GV	S 5 LE	2 M V 1	K 3 P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20		1.50		1.80				
pH - RP		7.0		9.0			9.0			9.0			9.0		7.0		5.5				
Lab EC		0.12	0.20	0.21	0.30	0.34	0.39	0.54	0.67	0.80	1.10		1.36		1.38		1.18				
Cl		55	71	21	22	44	80	215	355	535	990		1525		1900		1700				
Lab pH (w)		7.2	8.6	9.0	9.1	9.4	9.5	9.5	9.4	9.4	9.2		9.0		7.8		5.6				
CEC		22		33			30			30			34		36		29				
ESP		2.3		7.4			19.7			25.1			23.0		22.0		20.9				
Ca/Mg		2.7		1.0			0.5			0.5			0.5		0.4		0.4				

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg). Sampled all 10 cm depths to 1.00 m plus 1.20, 1.50 & 1.80 m.

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	ASC: Order	ASC: S.Ord	ASC: G Grp	ASC: S Grp	ASC: Fam 1	ASC: Fam 2	ASC: Fam 3	ASC: Fam 4	ASC: Fam 5
VER	9	McCJI	23-Nov-2011	Nw	TQab	643603 E	7515381 N	C	VR	gm, so, ca		VE	AD	EI	CD	E	R	R	W	

Microrelief: Type	Microrelief: PROP	Microrelief: V.I. (m)	Microrelief: H.I. (m)	Microrelief: Prop Sample	Erosion: Type	Erosion: State	Erosion: Degree	Erosion: Gully Depth	Surface coarse fragments: Abund	Surface coarse fragments: Size	Surface coarse fragments: Shape	Surface coarse fragments: Lith	Rock Outcrop: Abund	Rock Outcrop: Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Vegetation: Broad floristic formation (Level 3)	Vegetation: Broad floristic subformation (Level 4)	Vegetation: Wetland Type & Gr.form
N	C	0.25	10	M	0				0				0		4	G	99	99				
																M						

Elevation: Eval	Elevation: Height (m AHD)	Slope: Eval	Slope: %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	3	2	4

Land use:

Land condition:

Notes: Site located on broad hillcrest on calcareous sediments. Sampled all 10 cm depths to 1.00 m plus 1.20 & 1.50 m. Field EC and pH at 1.80 m. Cl (mg/kg)

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.02	10 YR 4/1	0	MC		0	M 3 GR				
A 12		0.02	0.15	10 YR 4/1	0	MC		0	M 4 AB				
B 21		0.15	0.30	10 YR 4/1	0	MC		0	S 5 PO		1 K S 2		
B 22		0.30	0.90	10 YR 4/1	0	MC		0	S 5 LE		1 K S 2	K 3 P	
B 23		0.90	1.40	2.5 Y 4/1	0	MC		0	S 5 LE		1 K S 2	K 3 P	
BC k		1.40	1.80	10 YR 6/3	0	MC		0	S 5 LE		4 K S 4	K 3 P	

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20		1.50		1.80			
pH - RP		7.0		9.0			9.0			9.0			8.5		8.0		8.1			
Lab EC		0.17	0.09	0.21	0.26	0.31	0.41	0.60	0.74	0.82	0.90		0.99		0.77		1.38			
Cl		150	53	60	82	140	270	545	800	940	1075		1250		940					
Lab pH (w)		7.0	8.3	9.0	9.2	9.3	9.3	9.1	9.1	9.0	9.0		8.9		9.1					
CEC		34		42			38			36			34							
ESP		3.3		5.8			11.8			13.2			12.4							
Ca/Mg		1.2		1.0			0.6			0.5			0.5							

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K: Accuracy	AMG Location 55K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	ASC: Order	ASC: S.Ord	ASC: G Grp	ASC: S Grp	ASC: Fam 1	ASC: Fam 2	ASC: Fam 3	ASC: Fam 4	ASC: Fam 5
VER	10	McCJI	23-Nov-2011	Kk	TQab	643611 E	7516021 N	C	VR	mz, so, ca		VE	AB	GS	GM	E	R	R	V	

Microrelief: Type	Microrelief: PROP	Microrelief: V.I. (m)	Microrelief: H.I. (m)	Microrelief: Prop Sample	Erosion: Type	Erosion: State	Erosion: Degree	Erosion: Gully Depth	Surface coarse fragments: Abund	Surface coarse fragments: Size	Surface coarse fragments: Shape	Surface coarse fragments: Lith	Rock Outcrop: Abund	Rock Outcrop: Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Vegetation: Broad floristic formation (Level 3)	Vegetation: Broad floristic subformation (Level 4)	Vegetation: Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																H						

Elevation: Eval	Elevation: Height (m AHD)	Slope: Eval	Slope: %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					M	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Vertosol on calcareous sediments - cleared brigalow ? Weak gilgai only if at all here - very hard to define

Horizon	Boundry	Depth (m): Upper	Depth (m): Lower	Colour: Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.20	10 YR 4/2	0	MC		0	M 3 AB	0			
B 21		0.20	0.65	10 YR 5/3	0	MC		0	S 5 L3	3 K S 3	K 3 P		
BC k		0.65	1.30	10 YR 7/6	0	MC		0	S 5 LE	4 K S 3	K 3 P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20
pH - RP		7.5		9.0			9.5			9.0			9.0
Lab EC		0.13	0.14	0.12	0.14	0.17	0.19	0.22	0.25	0.28	0.33		0.42
Cl		45	30	<6	6	15	<6	<6	22	10	35		160
Lab pH (w)		7.9	8.4	8.8	9.0	9.3	9.4	9.5	9.6	9.6	9.6		9.6
CEC		26		25			19			18			17
ESP		1.1		1.9			9.5			17.3			22.5
Ca/Mg		2.2		1.7			0.8			0.5			0.4

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg). Sampled all 10 cm depths to 1.00 m; plus 1.20 m.

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	11	McCJI	23-Nov-2011	Kc	TQab	643605 E	7517050 N	C	KS	vr, ca, so		DE	AC	CQ	EO	B	E	O	O	V

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	S	99	99				
																F						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					F	PLA		RIS		0	3	2	4

Land use: | Land condition: | Notes:

Site located on flat plain on higher level calcareous sediments Soft surface - odd surface crack but definitely not a Vertosol profile.

Horizon	Boundry	Depth Upper (m)	Depth Lower (m)	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.20	10 YR 6/4	0	FSLC		0	M 4 AB	0			
B 2		0.20	0.50	10 YR 6/4	0	FSLC		0	S 4 AB	0			
BC k		0.50	1.05	10 YR 5/4	0	FSLMC		0	S 4 AB	4 K S 4			

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20		1.50		1.80		2.10		
pH - RP		7.5		8.0			9.0			10.0											
Field EC		0.45	0.15	0.19	0.19	0.14	0.23	0.19	0.21	0.24	0.28										
Field pH (1:5)		7.7	8.4	8.2	8.7	8.9	8.9	9.2	9.3	9.4	9.4										
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	12	McCJI	24-Nov-2011	Mf	TQab	642610 E	7518111 N	C	LV	ha,ap,ca,cr		CH	AA	CQ	DQ	C	E	M	O	W

Microrelief Type	Microrelief PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	Erosion State	Erosion Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	3	R	SA	0		4	H	99	99				

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	3	3	5

Land use:

Land condition:

Notes: Site located on broad HCR of RIS on calcareous sediments. Cleared Euclaypts. Some dec. sandstone within BC horizon

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.30	5 YR 4/3		CLFS		0	V				
B 2 t		0.30	1.05	2.5 YR 4/6	4 2 D G	MC		0	S 5 PR				
BC k		1.05	1.40			LC			W 4 AB	4 K S 3			

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20
pH - RP		6.5		6.0			6.0			7.0			8.5
Lab EC		0.17	0.19	0.02	0.06	0.09	0.06	0.08	0.12	0.04	0.08		0.15
Cl		15	20	<6	<6	<6	<6	<6	<6	<6	<6		
Lab pH (w)		8.0	8.1	6.6	6.9	7.0	6.8	7.0	7.4	7.1	7.6		
CEC		8		6			15			19			
ESP		1.4		0.6			2.2			3.0			
Ca/Mg		1.4		1.5			1.0			0.9			

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl mg/kg. Sampled all 10 cm depths to 1.00 ;
Field EC and pH at 1.20 m.

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	13	McCJI	24-Nov-2011	Pr	Qa	642278 E	7518389 N	C	LV	ab, ap, ce		CH	AB	AH	DQ	C	E	L	O	X

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					R	LEV		FLO		0	3	2	4

Land use		Land condition		Notes	

Site located on small levee from current creek line. Cleared Eucalypts - Blue gums and bloodwoods in creek line. Appers to be bulldust soil surface. Buried soil below 0.75 m.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.40	10 YR 4/2	0	FSL		0	V	0			
B 21		0.40	0.75	10 YR 5/4	3 2 D O	FSLC		0	S 3 PR	1 M N 2			
2 B 22 b		0.75	1.40	10 YR 3/1	0	FSMC		0	S 5 PR	0	C 3 P		
3 B 23 b		1.40	1.90	7.5 YR 4/3	0	FSLC		0	S 5 PR	0	C 3 P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50		1.80			
pH - RP		8.5		8.0			8.5			8.0			8.0			8.5		8.5			
Field EC		0.10	0.07	0.13	0.03	0.06	0.03	0.04	0.03	0.05	0.05		0.07			0.13		0.12			
Field pH (1:5)		8.2	8.4	8.0	8.1	8.0	8.0	8.1	8.0	8.0	8.0		8.2			8.4		8.6			
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	14	McCJI	24-Nov-2011	Kk	TQab	643035 E	7518517 N	C	VR	mz, so, ca		VE	AB	GS	GM	E	R	R	V	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					U	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Another harsetting Verstosol profile on calcareous sediments. Cleared Brigalow with regrowth and currant bush. No or very weak gilgai at this site and surrounds.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15	10 YR 3/2	0	MC		1 1 R SA	S 3 AB				
B 21		0.15	0.30	10 YR 4/3	0	MC		1 1 R SA	S 5 AB				
B 22		0.30	0.80	10 YR 5/4	0	MC		1 1 R SA	S 5 LE	3 K S 3	K 3P		
BC k		0.80	0.90	10 YR 5/4	0	MC		1 1 R SA	S 5 LE	4 K S 4	K 3P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50		1.80			
pH - RP		7.5		8.0			8.0			10.0											
Field EC		0.03	0.05	0.07	0.07	0.07	0.12	0.10	0.11	0.20											
Field pH (1:5)		7.6	8.4	8.7	8.7	9.1	9.1	9.5	9.5	9.5											
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K: Accuracy	AMG Location 55K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	15	McCJI	24-Nov-2012	Kk	TQab	643359 E	7519049 N	C	VR	mz, so, ca		VE	AB	GS	BR	E	R	R	X	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N		0.30			0				0				0		4	G	99	99				
																H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					R	HCR		RIS		0	3	2	4

Land use		Land condition		Notes	

Another Vertosol with HS surface. Site located on broad ridge, near fences at Gate G6. Brown B horizon texture fells very sodic. Probably Cacareous sediments at depth.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15	10 YR 4/1	0	MC		0		0			
B 21		0.15	0.70	2.5 Y 5/3	0	MC		0		2 K S 3			
B 22		0.70	0.90	10 YR 5/3	0	MC		0		2 K S 3	K 3 P		
B23		0.90	1.60	10 YR 6/3	0	MC		0		0	K 3 P		

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				8.0		9.0		10.0		8.5		8.0		8.0		7.5					
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	16	McCJI	24-Nov-2011	MfSv	TQab	643735 E	7518485 N	C	SN	ca, so, ab, ap		SO	AB	DP	CQ	B	E	M	O	V

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	R	SA	0		4	H	99	99				

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	3	1	3

Land use		Land condition		Notes	

B horizon field textures feel very sodic. Cleared - Eucalypts. Site on broad HCR of RIS on Calcareous sediments. Weak surface cracking appears to be around Columns in B horizon.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 1		0.00	0.18	10 YR 3/2	0	CLFS		0	V	0			
A 2 e		0.18	0.25		0	CLFS		0	V	0			
B 21 t	A	0.25	0.45	10 YR 5/3	0	MHC		0	S 5 CO	0			
B 22 t		0.45	0.60	7.5 YR 5/4	0	MHC		0	S 5 AB	0			
B 3 ?		0.60	0.90	7.5 YR 5/4	0	MHC		0	S 3 AB	2 K S 3			
BC k		0.90	1.00		0	LMC		0		4 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	7.0	8.5	8.5				
Field EC		0.05		0.13	0.34				
Field pH (1:5)		6.4		9.0	9.2				
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	17	McCJI	24-Nov-2011	Kk	TQab	643873 E	7518117 N	C	VR	mz, so, ca		VE	AD	GS	CD	E	R	S	W	

Microrelief Type	Microrelief PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	Erosion State	Erosion Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
M	C	0.90	20	M	0				0				0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					F	PLA		RIS		0	3	2	4

Land use:

Land condition:

Notes: Another HS to weak SM Vertosol presumably on Calcareous sediments. Variable gilgai in unit - some 0.3 m VI but mostly Melonholes to 0.9 m deep. Cleared - Brigalow ? B horizon field texture feels sodic. Sand patches to lenses within B horizon clay.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.10	10 YR 4/2	0	MC		1 1 R SA	M 3 AB				
B 21 k		0.10	0.35	10 YR 6/3	0	MC		1 1 R SA	S 5 LE	2 K N 3	K 3 P		
B 22		0.35	1.10	10 YR 5/3	0	MC		1 1 R SA	S 5 LE		K 3 P		
2B23b / B3 ?		1.10	1.70	2.5 Y 6/2	3 2 D R	HC		1 1 R SA	S 5 LE		K 3 P		

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.70		2.10			
pH - RP				8.5		9.0		8.0		9.0		7.5		8.5		8.5					
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	18	McCJI	24-Nov-2011	Kk	TQab	643177 E	7519093 N	C	VR	mz, so, ca		VE	AD	GS	E	R	R	X		

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.25	10	M	0				0				0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					C	HCR		RIS		0	3	2	4

Land use		Land condition		Notes	

HS Vertosol on Calcareous sediments again. Site located on edge of very broad HCR

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.10		2 2 D R	MC		1 1 R SA	S 3 AB	0			
B 21		0.10	0.30	10 YR 4/2	2 2 D 0	MC		1 1 R SA	S 4 AB	1 K S 3			
B 22		0.30	0.55	10 YR 4/2	0	MC		1 1 R SA	S 5 LE	1 K S 2	K 3 P		
B 23 k		0.55	1.10	10 YR 5/3	0	MC		1 1 R SA	S 5 LE	3 K S 3	K 3 P		
B 24		1.10	1.45	10 YR 6/2	3 3 D R	MC		1 1 R SA	S 5 LE	1 K S2	K 3 P		

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.45		1.80		2.10			
pH - RP				6.0		8.0		9.0		9.5		9.5		9.5							
Field EC				0.07		0.10		0.18		0.27											
Field pH (1:5)				6.6		8.3		9.1		9.4											
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	19	McCJI	24-Nov-2011	Mf	TQab	642583 E	7516696 N	C	LV	ha, ap. ca, cr		CH	AA	BD	DQ	B	E	M	O	W

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	2	3	5

Land use		Land condition		Notes	

Red non-sodic duplex soil (Chromosol) on Calcareous sediments. Site on broad HCR. Cleared - Eucalypts ? Mealy decomposing sandstone with CaCo3 soft patches from 1.05 m.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.25	5 YR 4/3	0	CLFS		0	V	0			
B 21 t		0.25	0.60	2.5 YR 4/4	3 3 D G	MC		0	S 4 PO	0			
B 22 t		0.60	0.90	5 YR 4/4	3 2 D R	MC		0	S 5 PR	0			
B 23 t		0.90	1.05	2.5 YR 4/6	0	MC		2 2 R SA	S 4 PR	2 K S 3			
BC k / C ?		1.05	1.15					4 2 R SA		3 K S 3			

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50		1.80			
pH - RP		7.0		6.5			6.0			8.0											
Field EC		0.05	0.02	0.01	0.03	0.03	0.05	0.03	0.05	0.11	0.11										
Field pH (1:5)		6.5	6.7	7.1	6.3	6.1	6.1	7.1	7.3	8.4	8.5										
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	20	McCJI	24-Nov-2011	Kk	TQab	643713 E	7519603 N	C	VR	mz, so, ca		VE	AB	GS	BP	E	R	R	V	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N		0.25			0				0				0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					C	HCR		RIS		0	3	2	4

Land use		Land condition		Notes	

Another HS Vertosol on calacareous sediments Site on broad HCR Site located near northern boundary of survey near main water tank on access track. Brigalow regrowth with thick currant bush

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.10		0	MC		0	S 3 AB				
B 21		0.10	0.40	10 YR 5/3	0	MC		0	S 4 AB				
B23		0.40	0.90	10 YR 5/4	0	MC		0	S 5 LE				
BC k		0.90	1.40		0	MC		0	S 5 LE	4 K S 4			

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				7.5		8.0		8.5		8.8		10.0									
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	21	McCJI	28-Nov-2011	Kk	TQab	644592 E	7520055 N	C	VR	mz, so, ca		VE	AD	GS	BP	E	R	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.30	10	M	0				1	1	R	CH	0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					V	DDE		RIS			3	2	4

Land use		Land condition		Notes	

Cleared brigalow but thick regrowth with currant bush around this site and throughout broad depression. Landform here significantly lower compared to last site and to the east. Mostly HS surface but patchy weak SM as well.

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.15		0	MHC		0	M 3 AB	0			
B 21		0.15	0.25	10 YR 4/2	0	MHC		0	S 5AB	0			
B 22		0.25	0.80	10 YR 4/2	0	MHC		0	S 5 LE	2 K S 2	K 3 P		
B 23		0.80	1.40	10 YR 5/3	0	MHC		0	S 5 LE	1 K S 2	K 3 P		
B 24 / B3 ?		1.40	1.75	10 YR 5/4	0	HC		0	S 5 LE	2 M V 1	K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.75	2.10
pH - RP		7.5	8.5	8.5	8.5	8.0	7.5	7.0	
Field EC		0.08	0.20	1.01	1.23	1.67	1.56	1.40	
Field pH (1:5)		7.9	9.0	9.0	8.8	8.5	7.3	6.2	
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	ASC: Order	ASC: S.Ord	ASC: G Grp	ASC: S Grp	ASC: Fam 1	ASC: Fam 2	ASC: Fam 3	ASC: Fam 4	ASC: Fam 5
VER	22	McCJI	28-Nov-2011	MfSv	TQab	645061 E	7520259 N	C	SN	ca, so, ab, ap		SO	AC	FN	CQ	C	E	L	O	V

Microrelief Type	Microrelief PROP	Microrelief V.I. (m)	Microrelief H.I. (m)	Microrelief Prop Sample	Erosion Type	Erosion State	Erosion Degree	Erosion Gully Depth	Surface coarse fragments Abund	Surface coarse fragments Size	Surface coarse fragments Shape	Surface coarse fragments Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Vegetation: Broad floristic formation (Level 3)	Vegetation: Broad floristic subformation (Level 4)	Vegetation: Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS		0	3	1	3

Land use		Land condition		Notes	

Soil profile is Sodosol with CO B horizon and still on Calcareous sediments. Buffel still grows OK here though. Slightly raised area compared to last site. Sampled - standed depths except 40 cm not 30 cm due to depth of A horizon.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 1		0.00	0.25		0	FSL			V	0			
A 2 e		0.25	0.30		0	FSL			V	0			
B 21 t		0.30	0.60	10 YR 6/4	3 3 DO	MHC			S 5 CO	0			
B 21 t		0.60	0.90	2.5 Y 6/4	0	MHC			S 5 PR	2 M N 2			
BC k		0.90	1.50	2.5 Y 5/3	0	MHC				4 K S 3			

Test depth (m)	0.02	0.10	0.40	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		6.5	7.0	8.0	8.5	9.0	10.0		
Field EC		0.13	0.07	0.08	0.07	0.28	0.38		
Lab EC		0.01	0.07	0.08	0.16	0.37	0.45		
Cl		10	10	5	5	30	150		
Lab pH (w)		6.9	8.5	9.0	9.6	10.0	10.0		
CEC		9	12	12	12	13	18		
ESP		<1	6.0	11.0	28.0	43.0	44.0		
Ca/Mg		3.1	0.9	0.6	0.2	0.2	0.2		

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg). Sampled standard 30 cm depths to 1.50 m - except 40 cm to sample top of B horizon

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	23	McCJI	28-Nov-2011	Kc	TQab	646222 E	7520335 N	C	KS	vr, so		DE	AB	AH	CD	C	E	O	O	W

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	3	3	4

Land use: | Land condition: | Notes:

Site located on broad HCR of RIS Rainfall of around 20 mm has penetrated to depth of hard, massive, silcrete PAN. Good buffel grass after rain.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.40	10 YR 3/2	0	FSLC			M 4 AB	0			
B		0.40	1.00	10 YR 4/3	0	FSLC			M 4 AB	0			
C / R ?		1.00	1.10									L V	

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.2	7.2	7.2	7.2				
Field EC		0.11	0.03	0.02	0.06				
Field pH (1:5)		6.6	7.1	7.9	7.8				
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	24	McCJI	29-Nov-2011	Kc	TQab	644462 E	7418107 N	C	KS	vr, ca, so		DE	AB	CQ	EO	C	F	O	O	W

Microrelief Type	Microrelief PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	Erosion State	Erosion Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				2	4	U	SA	0		4	H	99	99				

Elevation Eval	Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	2	3	4

Land use		Land condition		Notes	

Site on braod HCR of RIS on Calcareous sediments Sample of surface cobble identified as Fine to Grained Sandstone. Cleared Eucalypts with currant bush as well.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.35		0	FSLC		0	M 3 AB				
B 21		0.35	0.70	10 YR 5/4	0	MC		1 1 R GV	S 3 PR				
B 22		0.70	1.00	10 YR 5/3	0	MC		1 1 R GV	S 3 PR	2 K S 2			
BC k		1.00	1.40	10 YR 6/4	0	MC		2 2 R GV	M 4 AB	4 K S 3			

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50		1.80			
pH - RP		7.0		7.5			8.0			8.5			10.0								
Field EC		0.04		0.03			0.05		0.15	0.16			0.26								
Field pH (1:5)		7.3		7.7			8.6		9.5	8.9			9.5								
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	25	McCJI	29-Nov-2011	Mf	TQab	644922 E	7518110 N	C	LV	ha, ap, ca, cr		CH	AC	BD	DQ	C	E	M	O	W

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					C	HCR		RIS		0	2	3	4

Land use		Land condition		Notes	

Still on same broad HCR on Calcareous sediments. Chromsol but A2 not bleached. Cleared Eucalypts with currant bush and blodwood (?) regrowth Reasonable buffel with black spear grass.

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A1		0.00	0.30		0	CLFS		0	V	0			
A2		0.30	0.40		0	CLFS		1 1 R GV	V	0			
B 21 t		0.40	0.70	10YR 6/4	0	MHC		0	S 4 AB	0			
B 22 t		0.70	1.20	10 YR 5/4	2 2 F R	MHC		0	S 5 LE	2 M V 1	K3P		
BC k		1.20	1.30			MC		2 2 R GV	M 4 AB	2MV2/3KS3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		6.5	6.0	8.0	8.0	8.5			
Field EC		0.06	0.02	0.05	0.04	0.14			
Field pH (1:5)		8.2	6.3	7.3	7.9	8.6			
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	26	McCJI	29-Nov-2011	Kk	TQab	646259 E	7518791 N	C	VR	mz, so, pe		VE	AE	GS	BL	F	R	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				2	2	A	CH	0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					L	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Brigalow clay over buried soil from 1.0 m. Regrowth of brigalow, currant bush and Bauhinia. Profile wet/moist to rock at 1.8 m. Surface water logging 10 m to north of hole. Hard to tell SM but looks weak at best. Good buffel with lots of surface chert and strongly acid below 1 m.

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.12		0	MC		1 1 R CH	M 3 AB	0			
B 21		0.12	0.70	10 YR 3/1	0	MC		1 1 R CH	S 5 LE	0	K 3 P		
B 21 ?		0.70	1.00	7.5 YR 6/6	0	MC		1 1 R CH	S 5 LE	0	C 3 P		
2 B 22 b?		1.00	1.70	7.5 YR 5/6	0	MHC		1 1 R CH	S 4 AB	0	C 3 P		
2 BC		1.70	1.80		3 3 D R	MC		1 1 R CH	M 3 AB	0			
2 C / R		1.80				RSA							

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		8.0	8.5	8.0	8.0	5.0	4.5	4.5	
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Site located on end of long, gentle slope north to site 23.

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base Reference Soil Group	World Reference Base Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	27	McCJI	29-Nov-2011	Nw	TQab	645446 E	7518170 N	C	VR	gm, so		VE	AD	EI	BP	E	R	R	X	

Microrelief Type	Microrelief PROP	Microrelief V.I. (m)	Microrelief H.I. (m)	Microrelief Prop Sample	Erosion Type	Erosion State	Erosion Degree	Erosion Gully Depth	Surface coarse fragments Abund	Surface coarse fragments Size	Surface coarse fragments Shape	Surface coarse fragments Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation Formation (Level 1 & 2)	Vegetation Broad floristic formation (Level 3)	Vegetation Broad floristic subformation (Level 4)	Vegetation Wetland Type & Gr.form
N	D	0.30	12	M	0				1	2	R	CH	0		4	G	99	99				
																M						

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					U	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Brigalow Vertosol on upper HSL/Broad HCR. Mostly weak to some moderate SM. Some surface sand patches - may seal. Buried acid clay from 1.20 m. Brigalow regrowth with currant bush.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12		0	MHC		1 1 R CH	S 3 AB				
B 21		0.12	0.30	10 YR 4/2	0	MHC		0	S 5 AB				
B 22		0.30	0.80	10 YR 4/2	0	MHC		0	S 5 LE	1 K N1	K 3 P		
B 23		0.80	1.20	10 YR 5/2	0	MHC		0	S 5 LE		K 3 P		
2 B 24		1.20	1.65	5 YR 5/4	0	MHC		0	S 5 LE		K 3 P		
2 B 25		1.65	1.95	7.5 YR 5/4	0	MHC		0	S 5 LE		K 3 P		

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				7.0		7.5		8.3		8.3		7.0		4.5		4.0					
Field EC				0.05		0.04		0.18		0.48		1.32		0.79		1.30					
Field pH (1:5)				6.8		8.4		8.9		8.7		6.6		4.9		4.5					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	28	McCJI	29-Nov-2011	Kc	TQab	645270 E	7518469 N	C	KS	vr, ca, so		DE	AB	BD	EO	B	E	O	O	X

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	1	R	CH	0		4	H	99	99				

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS		0	2	3	4

Land use		Land condition		Notes	
Similar profile to site 24.					

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.20	10 YR 4/2	0	FSLC		0	V				
B 21		0.20	0.60	10 YR 5/4	1 2 D R	FSMC		0	S 5 AB				
B 22		0.60	0.90	10 YR 6/6	2 2 D G	FSMC		0	S 5 AB	2KN3/2MS2	C 3 P		
B 23 k		0.90	1.30	10 YR 5/6	0	FSMC		0	S 5 AB	3KS3/2MS2	C 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		6.7	7.2	8.6	8.7	8.7			
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	29	McCJI	29-Nov-2011	MfSv	TQab	645092	7518780 N	C	SN	ca, so, ap		SO	AD	ES	BD	B	E	M	O	X

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					C	HCR		RIS		0	3	1	3

Land use		Land condition		Notes	

Sodosol on broad HCR. Cleared Brigalow. B horizon textures do feel sodic. A2 not bleached. Profile looks like just touching top of black Mn PAN at 1.80 m.

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.22		0	CLFS		0	V				
B 21		0.22	0.50	10 YR 4/2	0	MHC		0	S 5 PR				
B 22 k		0.50	1.30	10 YR 6/4	0	MHC		0	S 5 AB	3 K S 3			
B 23		1.30	1.80	10 YR 5/3	0	MHC		0	S 5 AB	2 M V 1			

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50		1.80			
pH - RP		7.2		7.0			9.0			8.6			8.6			8.6		8.6			
Field EC		0.08		0.06	0.04	0.07	0.20	0.21		0.23			0.31			0.61		0.70			
Field pH (1:5)		8.2		7.6	8.6	8.7	9.1	9.2		9.4			9.4			9.1		8.4			
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	30	McCJI	29-Nov-2011	Kk	TQab	644872 E	7519196 N	C	VR	mz, so, ca		VE	AD	GS						

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage

Land use | Land condition | Notes

Vertosol associated with site 29 - call unit a complex ? Brigalow regrowth with currant bush. Some SM surface weak gilgai here as well as areas of deeper gilgai. Check hole only.

Horizon	Boundry	Depth Upper (m)	Depth Lower (m)	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12	D Grey	0	MC							
B 21		0.12	0.40	D Grey	0	MC							
B 22		0.40	1.05	Black	0	MC			S 5 LE				
B23 k		1.05	1.30	L Grey	0	MC			S 5 LE	3 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP									
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	31	McCJI	29-Nov-2011	Kk	TQab	644609 E	7519597 N	C	VR	mz, so		VE	AD	GS	BP	E	R	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.20	10	M	0				1	4	R	SA	0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage	Land use		Land condition		Notes	
Eval	Height (m AHD)	Eval	%											HS to weakly SM cracking clay with Brigalow One piece conglomerate /coarse Sandstone on surface. Site located on broad open depression within Rise.					
					V	DDE		RIS		0	3	2	4						

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.15		0	MHC		1 1 R SA					
B 21		0.15	0.50	10 YR 5/2	0	MHC		1 1 R SA	S 5 LE		K 3 P		
B 22		0.50	1.10	10 YR 5/3	0	MHC		1 1 R SA	S 5 LE	1 K N 1	K 3 P		
B 23		1.10	1.75	10 YR 5/3	0	MHC		1 1 R SA	S 5 LE		K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10	pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)
pH - RP		8.7	8.7	8.7	8.7	8.7	8.7			
Field EC		0.08	0.09	0.52	1.22	1.38	0.79			
Field pH (1:5)		7.9	8.7	9.0	8.3	8.4	8.9			
CEC										
ESP										
Ca/Mg										

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	32	McCJI	29-Nov-2011	Kk	TQab	646629 E	7521483 N	C	VR	mz, so, ca		VE	AD	GS	GM	E	Q	R	X	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.20	10	M	0				1	2	A	CH	0		4	G	99	99				
																H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					M	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Site on mid/upper HSL close to NE corner boundary of project area. Patchy weak SM but also sandy vener - may have surface seal ??

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15		0	LMC		1 2 A CH		0			
B 21		0.15	0.30	10 YR 4/2	0	MHC		1 2 A CH		0			
B 22		0.30	0.90	10 YR 4/1	0	MHC		1 2 A CH	S 5 LE	2 K S 2	K 3 P		
B 23 k		0.90	1.40	7.5 YR 5/3	0	MHC		1 2 A CH	S 5 LE	3 K S 3	K 3 P		
B 24		1.40	1.75	7.5 YR 5/3	0	MHC		0	S 5 LE	0	K 3 P		
B 25		1.75	1.90	7.5 YR 5/3	0	MHC		0	S 5 LE	3 M S 3	K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10	
pH - RP		7.0	7.5	8.9	8.9	8.7	7.0	6.7		
Field EC		0.06	0.09	0.44	1.35	1.85	1.82	1.63		
Field pH (1:5)		7.2	8.9	8.9	8.4	8.2	7.7	7.5		
CEC										
ESP										
Ca/Mg										

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	33	McCJI	29-Nov-2011	MfSv	TQab	646277 E	7521146 N	C	SN	ca, so, ab, ap		SO	AB	DP	BD	B	E	M	O	X

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
				NW	U	HSL		RIS		0	3	1	3

Land use		Land condition		Notes	
Site on U HSL of significant RIS along fence line (see site 23). But profile similar to site 22.					

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 1		0.00	0.18			CLFS			V				
A 2 e		0.18	0.20			CLFS			V				
B 21 t		0.20	0.50	10 YR 5/4		MHC		1 1 R GV	S 4 PR	1 K S 2			
B 22 t		0.50	0.70	10 YR 5/4		MHC				1 K S 2			
B 23 t k		0.70	0.90	7.5 YR 5/4		MHC				3 K S 3			
B 24 t		0.90	1.40	7.5 YR 5/4	2 2 D R	MHC				2 M S 2			

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				7.2		7.5		9.9		9.9		9.9									
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	34	McCJI	29-Nov-2011	Kk	TQab	646597 E	7520246 N	C	vr	mz, so, ca		VE	AD	GS	BP	E	Q	R	W	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	A	0.10	10	M	0				0				0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS					

Land use:

Land condition:

Notes: Site on broad Ridge/ HCR of Rise. Good buffel grass - very disturbed / rough surface here.

Horizon	Boundry	Depth Upper (m)	Depth Lower (m)	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12		0	FSLMC		0		0			
B 21		0.12	0.30	10 YR 4/1	0	MC		0		0			
B 22		0.30	0.50	10 YR 4/1	0	MC		0	S 5 LE	0	K 3 P		
B 23		0.50	0.90	10 YR 4/1	0	MC		0	S 5 LE	2 K S 2	K 3 P		
B 3 ?		0.90	1.10	10 YR 5/4	0	MC		0	S 5 LE	0	K 3 P		
BC k		1.10	1.30	10 YR 5/4	0	MC		0	S 5 LE	4 K S 3	K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	7.0	8.9	9.0	9.0			
Field EC		0.14	0.09	0.12	0.63	1.34			
Field pH (1:5)		7.6	7.7	8.6	9.1	8.6			
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	35	McCJI	29-Nov-2011	MfSv	TQab	647044 E	7520443 N	C	SN	ca, so, ab, ap		SO	AB	DP	CQ	C	E	M	O	W

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
				S	M	HSL		RIS		0	3	1	3

Land use		Land condition		Notes	

Site located on mid/upper HSL to south from here. Slightly lower in landscape than previous site. Patches of ghost rock structure from 1.00 m.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 1		0.00	0.25		0	CLFS		0	V	0			
A 2 e		0.25	0.30		0	CLFS		0	V	0			
B 21 t		0.30	0.70	10YR 5/4	0	MHC		0	S 4 PR	0			
B 22 t		0.70	1.00	7.5 YR 5/4	0	MHC		1 1 R QZ	S 4 PR	2 K S 3			
BC k		1.00	1.80	10 YR 5/4	0	MC		1 1 R QZ	M 4 AB	4KS3/2MS2			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	7.8	9.9	9.9	9.9	9.9		
Field EC		0.23	0.09	0.18	0.85	1.35	2.04		
Field pH (1:5)		5.3	7.9	8.8	9.0	8.7	8.6		
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	36	McCJI	29-Nov-2011	Kk	TQab	646239 E	7519914 N	C	VR	mz, so, ca		VE	AD	GS	BP	E	R	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	D	0.20	15	S	0				0				0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage	Land use	Land condition	Notes
Eval	Height (m AHD)	Eval	%											Brigalow regrowth - good buffel grass		
					C	HCR		RIS		0	3	2	4			

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.20		0	MC		0		0			
B 21		0.20	0.40	10 YR 6/3	0	MHC		0		0			
B 22 k		0.40	1.00	2.5 Y 5/3	0	MHC		0	S 5 LE	3 K S 3	K 3 P		
B 23		1.00	1.80	10 YR 5/4	0	MHC		0	S 5 LE	2 K S 3	K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		8.6	8.6	8.6	9.5	9.5	8.6	8.6	
Field EC		0.11							
Field pH (1:5)		8.1							
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	ASC Order	ASC S.Ord	ASC G Grp	ASC S Grp	ASC Fam 1	ASC Fam 2	ASC Fam 3	ASC Fam 4	ASC Fam 5
VER	37	McCJI	29-Nov-2011	Kk	TQab	646252 E	7519531 N	C	VR	mz, so, ca		VE	AD	GS						

Microrelief Type	Microrelief PROP	Microrelief V.I. (m)	Microrelief H.I. (m)	Microrelief Prop Sample	Erosion Type	Erosion State	Erosion Degree	Erosion Gully Depth	Surface coarse fragments Abund	Surface coarse fragments Size	Surface coarse fragments Shape	Surface coarse fragments Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.10	12	M	0				0				0				99	99				

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage

Land use		Land condition		Notes	

Check hole 380 m S of site 36 Same grey HS Vertosol all the way. Brigalow regrowth with currant bush Weak gilgai at best here though and for most of the way from site 36.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12			FSLMC							
B 21		0.12	0.30	D Grey		MC							
B 22		0.30	0.80	D Grey		MC			S 5 LE	2 K N 3			
B 23		0.80	1.00	Brown		MC			S 5 LE	2 K N 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP									
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	38	McCJI	29-Nov-2011	Kk	TQab	646279 E	7518875 N	C	VR	mz, so		VE	AD	GS	BP	E	R	R	X	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.30	12	M	0				0				0		4	G	99	99				
																H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					F	PLA		RIS			2	2	3

Land use:

Land condition:

Notes:

HS / weak SM brigalow clay wet area just to south site on clay flat / v gentle lower slope Below 1.5 m - remnant pebbles of fine grained sediments.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.10		0	MC							
B 21		0.10	0.30	10 YR 4/2	0	MHC		1 2 R CH					
B 22		0.30	0.70	10 YR 5/3	0	MHC		1 2 R CH	S 5 LE	1 K S 2	K 3 P		
B 23		0.70	1.50	10 YR 5/4	0	MHC		1 2 R CH	S 5 LE	1 K S 2	K 3 P		
B 24		1.50	1.80	10 YR 6/4	0	MHC		2 3 R SD	S 5 LE	1 K S 2	K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	8.8	8.8	8.8	8.8	8.8	8.8	
Field EC		0.04	0.13	0.88	1.60	2.41	1.79	1.27	
Field pH (1:5)		7.2	8.8	8.8	8.3	7.6	8.4	8.4	
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	39	McCJI	30-Nov-2011	Kc	TQab	645068 E	7517864 N	C	KS	vr, so, ve		VE	AD	GS	BP	E	Q	R	X	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS			3	2	4

Land use		Land condition		Notes	

Site on lower HSL just above wet clayflat (=Lg soil on Qa). HS / weakly cracking clay if at all (? DE). Sandy veneer on the surface Regrowth of Eucalypts here.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12		0	FSLMC		1 1 R GV	S 3 AB	0			
B 21		0.12	0.20	10 YR 3/2	0	MHC		1 1 R GV	S 4 AB	0			
B 22		0.20	0.40	10 YR 4/2	0	MHC		1 1 R GV	S 5 LE	0	K 3 P		
B 23		0.40	0.50	10 YR 4/2	0	MHC		1 1 R GV	S 5 LE	0	K 3 P		
B 24		0.50	1.30	10 YR 6/4	0	MHC		1 1 R GV	S 5 LE	0	K 3 P		

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				7.6		7.9		9.9		9.9		9.9									
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	40	McCJI	30-Nov-2011	MfSv	TQab	645886 E	7518063 N	C	SN	so, ab, ap		SO	AB	ES	AH	B	E	M	O	V

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS		0	3	1	3

Land use | Land condition | Notes

Site on lower end of siginificant slope - Brigalow with currant bush Buffel is OK   Sodosol or Chromosol ?

Horizon	Boundry	Depth Upper	Depth Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 1		0.00	0.12		0	CLFS		0		0			
A2 e		0.12	0.18		0	CLFS		0		0			
B 21 t		0.18	0.30	10 YR 5/3	0	MHC		0	S 5 PR	0			
B 22 t		0.30	0.85	7.5 YR 5/4	0	MHC		0	S 5 PR	0			
BC		0.85	0.95		0	GHOST ROCK		0		0			
C / R		0.95				RSA							

Test depth (m)	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50		1.80				
pH - RP	7.0		8.6			8.8		8.9													
Field EC	0.07		0.31			0.64		0.83													
Field pH (1:5)	8.0		8.9			8.8		8.7													
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	41	McCJI	30-Nov-2011	Kk	TQab	646289 E	7518301 N	C	VR	mz, so		VE	AD	GS	BP	F	Q	R	W	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.20	15	M	0				1	3	U	BA	0		4	G	99	99				
									1	1	U	CH				H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	3	2	4

Land use: | Land condition: | Notes:

Site on broad HCR wihtin RIS. Better as VE rather than DE. Brigalow/ currant bush regrowth. Patchy weak gilgai. Some BA pebbles on surface but with mixed geol. Note red acid pH clay at depth again and no carbonate in profile.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15	10 YR 3/2	0	LMC		1 1 U BA					
B 21		0.15	0.30	10 YR 4/2	0	MC		0					
B 22		0.30	0.70	10 YR 5/3	0	MC		0	S 5 LE	1 K N 1	K 3 P		
2 B 23		0.70	1.10	5 YR 54	0	MC		0	S 5 LE	2 M N 1	K 2 D		
2 B3 / BC ?		1.10	1.90	5 YR 5/6	3 3 P R	LMC				3 M S 2			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	8.6	8.6	8.6	8.6	7.5	5.2	
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	42	McCJI	30-Nov-2011	Kk	TQab	647022 N	7518911 N	C	VR	mz, so		VE	AD	GS	BP	E	R	R	X	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.20	12	M	0				1	1	U	CH	0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	3	2	4

Land use: | Land condition: | Notes:

HS weak - mod cracking weak / mod cracking - better as VE than DE. Brigalow regrowth. Same brigalow clay flat as site 41.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15		0	MC		1 1 R GV					
B 21		0.15	0.50	10 YR 5/2	0	MC		1 1 R GV	S 5 LE	1 K N1	K 3 P		
B 22		0.50	1.25	7.5 YR 4/4	0	MC		1 1 R GV	S 5 LE	1 K N1	K 3 P		
B 23 c ?		1.25	1.75	10 YR 5/4	0	MC		1 1 R BA	S 5 PR	3 M V 1	0		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.6	8.8	8.8	8.8	8.8	8.8	6.5	
Field EC		0.05	0.10	0.43	1.54	1.44	1.54		
Field pH (1:5)		7.1	8.5	9.2	8.7	8.1	8.0		
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	43	McCJI	30-Nov-2011	Kc	TQab	647566 E	7519306 N	C	KS	vr, so, ca		DE	AB	BD	AT	B	E	O	O	W

Microrelief Type	Microrelief PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	Erosion State	Erosion Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	3	2	4

Land use:

Land condition:

Notes: White deco rock from 1.15 m. Similar non-cracking clay on slight rise.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 1		0.00	0.20		0	MC		0	W 5 AB	0			
A 2 e		0.20	0.22		0	MC		0	W 5 AB	0			
B 21		0.22	0.40	10 YR 4/3	0	MC		0	S 3 PR	0			
B 22 k		0.40	0.60	7.5 YR 5/4	0	MC		0	S 5 LE	2 K S 3			
B 3		0.60	1.1.5	5 YR 5/4	0	LMC		0	S 5 AB	1 K S 2			
BC		1.15	1.80			GHOST ROCK							

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		6.7	7.8	9.0	9.0	8.9			
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	44	McCJI	30-Nov-2011	Kc	TQab	647994 E	7518198 N	C	KS	vr, so, ve		VE	AB	GS	BL	F	R	R	X	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.40	12	M	0				2	1	U	CH	0		4	G	99	99				
																H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS		0	3	2	4

Land use | Land condition | Notes

Better cracking surface here. Cleared brigalow regrowth. Very acid red clay subsoil here

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.10		0	MHC		0	S 3 AB	0	0		
B 21		0.10	0.30	10 YR 5/3	0	MHC		0	S 4 AB	0	0		
B 22		0.30	0.90	7.5 YR 5/4	0	MHC		0	S 5 LE	1 K N 1	K 2 D		
B 23		0.90	1.50	7.5 YR 5/4	0	MHC		0	S 5 LE	0	K 2 D		
2 B 24 / 2BC ?		1.50	1.70	5 YR 5/4	3 3 D R	MC		0	M 4 AB	1 M S 2	0		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	8.6	8.6	7.0	4.6	4.6	4.6	
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	45	McCJI	30-Nov-2011	Kc	TQab	648063 E	7518676 N	C	KS	vr, ca, so		DE	AB	CQ	CD	B	E	O	O	W

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage	Land use		Land condition		Notes	
Eval	Height (m AHD)	Eval	%											Lower HSL - lower creek line nearby. Cleared at site - but Eucalypts infence line nearby and to SE. Currant bush regrowth.					
					L	HSL		RIS		0	3	2	4						

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.18		0	FSLC		0	V	0			
B 21		0.18	0.45	7.5 YR 5/4	0	FSLC		0	S 3 PO	0			
B 22 c		0.45	0.80	10 YR 6/6	0	MC		0	S 5 LE	3 M S 2			
B 23		0.80	1.20	10 YR 6/6	0	MC		0	S 5 LE	2 M S 2	K 3 P		
BC k		1.20	1.30			LMC		1 2 A SD		4 K S 3			

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				6.7		7.0		7.0		8.6		9.0									
Field EC				0.09		0.03		0.10		0.08											
Field pH (1:5)				7.4		7.5		7.6		8.1											
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	46	McCJI	30-Nov-2011	Nw	TQab	648099 E	7519091 N	C	VR	gm, so		VE	AD	EI	CD	E	R	R	X	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
M	C	0.60	20	M	0				1	2	U	CH	0		4	G	99	99				
																M						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
				S	M	HSL		RIS		0	3	2	4

Land use: | Land condition: | Notes:

Better SM stronger gilgai - Melonholes. Brigalow clay with currant bush. Site on Midslope above site 45.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15		0	MC		0	M 3 AB				
B 21		0.15	0.30	10 YR 4/1	0	MHC		0	S 3 AB				
B 22		0.30	0.65	10 YR 4/2	0	MHC		0	S 5 LE	1 K S 2	K 3P		
B 23		0.65	1.30	7.5 YR 5/4	0	MHC		0	S 5 LE	1 K N 1	K 3P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.5	7.8	9.0	9.0	9.0			
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	47	McCJI	30-Nov-2011	PgMp	TQ a	648392 E	7518399 N	C	VR	mz, so		VE	AM	GS	GL	E	S	S	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
M	C	1.00	22	M	0				1	2	U	CH	0		4	G	99	99				
																M						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					V	SWP		PLA			2	1	2

Land use		Land condition		Notes	

Site in lower, wetter area of MH grey clay. Sedges and bullrushes in depressions - very wet area. Mostly corase SM (size 3) but it is variable. This soil occupies not a large area within the project area.

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.20			HC		0		0			
B 21		0.20	0.30	5 Y 5/1		HC		0		0			
B 22		0.30	1.90	2.5 Y 6/1	3 2 D O	HC		1 1 R GV	S 5 LE	0	K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	8.6	5.5	4.5	4.5	4.5	4.5	
Field EC		0.18	0.49	1.80	1.64	2.54	2.41		
Field pH (1:5)		7.4	6.0	4.8	4.5	4.2	4.2		
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Thick brigalow regowth to south of site on other side of fenceline.

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location Accuracy	AMG Location Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	48	McCJI	30-Nov-2011	Kk	TQab	647570	7517771 N	C	VR	mz, so, ca		VE	AB	GS	BP	E	R	R	X	

Microrelief Type	Microrelief PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	Erosion State	Erosion Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
M	C	0.40	20	M	0				1	1	U	CH	0		4	G	99	99				
																M						

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					F	PLA		RIS		0	3	2	4

Land use		Land condition		Notes	

Another YB brigalow clay with patchy Melonholes. Flat. Surface variable SM but mostly weak

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.10		0	MHC		1 1 U CH					M
B 21		0.10	0.25	7.5 YR 5/4	0	MHC		1 1 U CH					M
B 22 k		0.25	0.60	7.5 YR 5/4	2 3 D G	MHC		0	S 5 LE	2 K S 2	K 3 P		M
B 23		0.60	1.80	7.5 YR 6/6	0	MHC		0	S 5 LE	0	K 3 P		M

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		8.6	9.0	9.0	9.0	9.0	9.0	7.8	
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	49	McCJI	30-Nov-2011	Kc	TQab	647126 E	7517446 N	C	KS	vr, so, px		DE	AB	CV	DC	C	E	O	O	V

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
				W	L	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Site located on L HSL of broad, very gentle HSL from G 11 Soil auger stopped by something very hard at 0.80 m = Probalby Mn Pan ? Brigalow / currant bush - very hard to tell soil boundary on the ground

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.30		0	FSLMC		1 2 R GV	W				
B 21		0.30	0.70	7.5 YR 5/4	0	FSLMC		1 2 R GV	S 5 PR				
B 22 / B3 ?		0.70	0.80		2 2 D R	FSLMC		1 2 R GV		2 M S 2			
R ?		0.80										M N	

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				7.5		7.0		7.0													
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	50	McCJI	30-Nov-2011	Hb	TQab	646798 E	7517178 N	C	LV	ha, ap, ca, sow		CH	AC	CQ	EO	C	E	M	O	W

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					V	DDE		RIS			3	3	4

Land use:

Land condition:

Notes: Site on broad Low RIS higher than site 49 also clay depression. Brigalow regrowth

Horizon	Boundry	Depth Upper (m)	Depth Lower (m)	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.30		0	CLFS		1 1 R GV	V	0			
B 21 t		0.30	0.90	7.5 YR 6/6	0	LMC		1 1 R GV	S 4 AB	0			
2 B 22 t b		0.90	1.35	10 YR 6/6	0	MC		1 1 R GV	S 5 AB	3 M S 2			
BC k		1.35	1.80	10 YR 5/4	2 2 D G	MC		1 1 R GV	S 4 AB	4 K S 4			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	7.0	7.2	8.6	10.0	10.0	10.0	
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	51	McCJI	1-Dec-2011	PcR	TQab	649986 E	7515928 N	C	VR	gm, ca, pe, nl		VE	AB	EI	FY	G	R	R	U	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				2	4	U	BA	0		4	G	99	99				
									3	2	U	SD				M						

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
		A	5	SE	U	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Shallow, gravelly SM clay on a RIS. Significant slope with contour banks - buffel may have been planted by ploughing in the past. Cleared - probably Brigalow. Mixed Geol on surface - SD + BA U HSL of siginificant RIS almost LOW Hill ?

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.02		0	MHC		2 2 U SD		1 K S 2			
A 12		0.02	0.12		0	MHC		2 2 U SD		1 K S 2			
B 2		0.12	0.25	10 YR 5/3	0	MHC		2 2 U SD	S 4 LE	3 K S 2			
BC k		0.25	1.00		0	MHC		4 2 U SD		4 K S 4			
C / R		1.00				RSA							

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				8.6		8.8		8.8													
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

No Gilgai here - soil too shallow ?

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	52	McCJI	1-Dec-2011	Pc	TQab	649715 E	7515775 N	C	Vr	gm, so, ca, pe		VE	AE	EI	CD	F	R	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	U	SD	0		5	G	99	99				
									2	2	U	BA				M						

Elevation: Eval	Elevation: Height (m AHD)	Slope: Eval	Slope: %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
		A	4	SE	M	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Good SM Brigalow clay - contour banks and may have been cropped in the past ? Or sown to Buffel grass ? Surface has SD + BA pebbles. Site on mid to Upper HSL below site 51.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.02		0	MHC		1 1 U SD	S 3 GR	0			
A 12		0.02	0.20		0	MHC		1 1 U SD	S 4 AB	0			
B 21		0.20	0.70	10 YR 2/1	0	MHC		1 1 U SD	S 5 LE	0	K 3 P		
B 22		0.70	1.20	10 YR 4/1	0	MHC		1 1 U SD	S 5 LE	1 K N 2	K 3 P		
B 23		1.20	1.50	10 YR 5/3	0	MHC		1 1 U SD	S 5 LE	2 K N 2	K 3 P		
B 24		1.50	1.80	10 YR 5/3	3 3 D G	MHC		0	S 5 LE	0	K 3 P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50		1.80			
pH - RP		8.6		8.6			8.6			8.6			8.6			8.6		7.5			
Field EC		0.06	0.05	0.05	0.06	0.07	0.11	0.11	0.17	0.17	0.35	0.64	0.68			0.86		1.70			
Field pH (1:5)		8.2	8.2	8.3	8.5	8.8	8.8	8.9	8.9	8.8	7.7	8.8	8.8			8.4		7.5			
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	53	McCJI	1-Dec-2011	Pc	TQab	649458 E	7515639 N	C	VR	gm, so, ca, pe		VE	AE	EI	CD	E	R	R	X	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	U	CH	0		5	G	99	99				
																M						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Another good SM clay. Site on Flat within general RIS. 150 - 200 m wide. Cleared - Belah regrowth but almost pure Belah left shade patch for cattle. May have been cultivated in the past ?

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.03		0	MHC		1 1 R SD	S 2 GR	0			
A 12		0.03	0.12		0	MHC		1 1 R SD	S 3 AB	0			
B 21		0.12	0.90	10 YR 3/1	0	MHC		1 1 R SD	S 5 LE	0	K 3 P		
B 22		0.90	1.20	10 YR 4/1	0	MHC		1 1 R SD	S 5 LE	0	K 3 P		
B 23		1.20	1.55	10 YR 4/2	0	MHC		1 1 R SD	S 5 LE	0	K 3 P		
B 24 / B3 k ?		1.55	1.80	10 YR 4/3	0	MHC		1 2 R SD	S 5 LE	3 K N 3	K 3 P		

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50		1.80			
pH - RP		7.2		7.4			7.9			7.9			7.9			7.9		7.9			
Field EC		0.16	0.14	0.06	0.08	0.16	0.20	0.45	0.64	1.06	1.57	1.71	1.37			1.11		1.13			
Field pH (1:5)		7.6	8.4	8.9	8.7	9.0	8.6	8.1	7.9	7.9	8.1	7.7	7.6			7.9		8.4			
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	54	McCJI	1-Dec-2011	Kc	TQab	649183 E	7515473 N	C	KS	vr, ca, so		DE	AA	CQ	CD	E	Q	Q	V	

Microrelief Type	Microrelief PROP	Microrelief V.I. (m)	Microrelief H.I. (m)	Microrelief Prop Sample	Erosion Type	Erosion State	Erosion Degree	Erosion Gully Depth	Surface coarse fragments Abund	Surface coarse fragments Size	Surface coarse fragments Shape	Surface coarse fragments Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Vegetation: Broad floristic formation (Level 3)	Vegetation: Broad floristic subformation (Level 4)	Vegetation: Wetland Type & Gr.form
Z					0				0				0				99	99				

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	2	3	4

Land use | Land condition | Notes

Red-brown DERMOSOL Obvious in nearby drain. Site on low ridge of RIS

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15		0	FSLC		0	V	0			
B 21		0.15	0.50	5 YR 4/4	0	LMC		1 3 A SD	S 4 AB	0			
B 22		0.50	0.75	5 YR 4/4	2 2 D G	LMC		0	S 5 LE	0	K 2 D		
BC k		0.75	1.25		0	LC		2 3 A SD		4 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		6.6	7.5	7.8	8.8	8.8			
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	55	McCJI	1-Dec-2011	Kc	TQab	648797 E	751527 N	C	KS	vr, so		DE	AD	AH	AT	B	E	O	O	V

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	U	CH	0		4	H	99	99				
																G						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					M	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Site on Mid / LOW HSL of RIS - lower than last site. Surface looks like weak cracking with weak SM in patches. No gilgai. Soil DE / VE ? Looks like surface seal after Rainfall. Looks like hard SD from 0.95 m.

Horizon	Boundry	Depth (m): Upper	Depth (m): Lower	Colour: Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 1		0.00	0.20		0	MC		0	W 3 AB	0			
A 2 e		0.20	0.22		2 2 DG	MC		0	M 3 AB	0			
B 21		0.22	0.35	10 YR 4/2	3 3 D G	MC		0	S 5 AB	0			
B 22		0.35	0.85	10 YR 5/4	0	MC		0	S 5 LE	0			
BC		0.85	0.95		0	LC		0		0			
C / R		0.95				RSA							

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10		
pH - RP				7.0		7.0		8.6		8.6										
Field EC																				
Field pH (1:5)																				
CEC																				
ESP																				
Ca/Mg																				

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	56	McCJI	1-Dec-2011	Kk	TQab	648330 E	7514994 N	C	VR	mz, so, ca		VE	AD	GS	BP	F	R	R	W	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	4	R	SD	0		4	G	99	99				
									2	2	U	SD				H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
		A	3	SE	L	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Mostly HS surface but weak / mod patchy SM also present. Cleared but with Brigalow along fenceline.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.10		0	MHC		1 1 R SD					
B 21		0.10	0.30	10 YR 3/1	0	MHC		1 1 R SD	S 5 LE				
B 22		0.30	0.90	10 YR 4/2	0	MHC		1 1 R SD	S 5 LE	2 K S 2			
B 3 ?		0.90	1.10	7.5 YR 5/4	0	MC		2 2 U SD		3 K S 2			
BC k		1.10	1.25		0					4 K S 2			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.8	8.6	8.6	8.6	8.6			
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	57	McCJI	1-Dec-2011	Pc	TQab	648763 E	7515773 N	C	Vr	gm, so, ca, pe		VE	AE	EI	BP	F	R	R	X	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				2	2	U	CH	0		5	G	99	99				
																M						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Very good SM brigalow clay. Ploughed in the past ? No gilgai but lots of Parthenium weed here.

Horizon	Boundry	Depth (m): Upper	Lower	Colour: Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.03	10 YR 3/1	0	MHC		0	S 3 GR	0			M
A 12		0.03	0.12	10 YR 3/1	0	MHC		0	S 3 AB	0			M
B 21		0.12	0.35	10 YR 3/1	0	MHC		0	S 4 AB	1 K V 1			M
B 22		0.35	1.00	10 YR 3/1	0	MHC		0	S 5 LE	1 K N 2	K 3 P		M
B 23		1.00	1.40	7.5 YR 5/4	0	MHC		0	S 5 LE	2 K N 2	K 3 P		M
2 B 24 b		1.40	1.80	5 YR 5/4	0	MHC		0	S 5 LE	0	K 3 P		M

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		8.6	8.6	8.6	8.6	8.6	7.6	6.0	
Field EC		0.07	0.12	0.12	0.26	0.35	0.54	0.54	
Field pH (1:5)		8.2	8.7	8.9	8.8	8.6	7.5	7.0	
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	58	McCJI	1-Dec-2011	Pc	TQab	648284 E	7516098 N	C	VR	gm, so, ca, pe		VE	AD	EI	BP	E	R	R	W	

Microrelief Type	Microrelief PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	Erosion State	Erosion Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																M						

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
				N	L	HSL		RIS		0	3	2	4

Land use:

Land condition:

Notes: Soil profile similar to last site. Floater ? Stopped auger at 0.65 m. Again no gilgai.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.03	10 YR 3/1	0	MHC		0	S 3 GR				
A 12		0.03	0.15	10 YR 3/2	0	MHC		0	S 4 AB				
B 21		0.15	0.20	10 YR 4/1	0	MHC		0	S 4 AB				
B 22		0.20	0.65	10 YR 4/1	0	MHC		0	S 5 LE		K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		8.5	8.5	8.5					
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	59	McCJI	1-Dec-2011	Kk	TQab	647960 E	7516370 N	C	VR	mz, so		VE	AD	GS	BP	E	R	R	X	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	4	U	SD	0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

HS surface here with little SM. Weak surface seal after recent rainfall ? Cultivated - no gilgai. Site located on L HSL below last site - soil boundary 150 m from here towards last site.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12		0	MC		S 3 AB					
B 21		0.12	0.25	10 YR 4/2	0	MC		S 4 AB					
B 22		0.25	0.50	10 YR 4/2	0	MC		S 5 LE	1 K N 1				
B 23		0.50	1.20	7.5 YR 5/4	0	MC		S 5 LE	2MN2 / 1KN1				

Test depth (m)	0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP			8.8		8.8		8.8		8.8		8.8									
Field EC																				
Field pH (1:5)																				
CEC																				
ESP																				
Ca/Mg																				

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	60	McCJI	1-Dec-2011	Lg	Qa	648006 E	7516910 N	C	VR	gm, so, pe		VE	AD	EI	CD	E	R	R	X	

Microrelief Type	Microrelief PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	Erosion State	Erosion Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																M						

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					F	PLA		ALP		3	3	2	4

Land use: | Land condition: | Notes:

Site located on relatively large alluvail plain with Brigalow regrowth.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.02	10 YR 4/1	0	ZMC		0	S 3 GR				
A 12		0.02	0.12	10 YR 4/1	0	ZMC		0	S 4 AB				
B 21		0.12	0.20	10 YR 4/1	0	ZMC		0	S 5 AB				
B22		0.20	0.80	10 YR 4/1	0	ZMC		0	S 5 LE			K 2 D	
B 23		0.80	1.10	10 YR 5/2	0	ZMC		0	S 5 LE			K 2 D	
B 24		1.10	1.45	10 YR 5/3	0	ZMC		0	S 5 LE	1 K N2		K 2 D	
2 D b		1.45	1.80	10 YR 5/4	0	KSLC		4 2 R QZ	V				D 1

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	7.8	7.9	8.6	8.6	8.1	8.0	
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	61	McCJI	1-Dec-2011	MfSv	TQab	648325 E	7517089 N	C	SN	ca, so, ab, ap		SO	AB	ES	CQ	B	E	M	O	V

Microrelief Type	Microrelief PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	Erosion State	Erosion Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
				N	L	HSL		RIS		0	3	1	4

Land use		Land condition		Notes	

Slightly higher L HSL of gentle RIS to South of site. Almost Mn Pan at 1.50 m. Layered bands of deco. and clay from 0.50 m.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A1		0.00	0.25		0	CLFS		0	V				
A 2 e		0.25	0.28		0	CLFS		0	V				
B 2 t		0.28	0.50	10 YR 5/4	0	MHC		0	S 4 PR				
BC 1 k		0.50	1.25	2.5 Y 7/4	0	MC		0	S 5 AB	4 K S 4			
BC 2		1.25	1.50	10 YR 6/4	0	MC		0	S 5 AB	3 M S 2			
BC 3		1.50	1.55		0	MC		3 2 R SD		3 M S 3			
BC 4		1.55	1.90		3 2 D R	LMC		GHOST ROCK					

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	7.5	9.0	9.0	9.0	9.0	7.8	
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	62	McCJI	5-Dec-2011	Kk	TQ ab	647643 E	7515464 N	C	VR	mz, so, ca		VE	AD	GS	BP	E	R	R	X	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	A	CH	0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS			3	2	4

Land use		Land condition		Notes	

Wet to 20 mm dpeth after 6 mm rain. Surface does crack but closed today due to overnight rain No obvious gilgai. Good buffel grass cover - no evidence of SM so call surface HS

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15	10 YR 4/2	0	MHC		0					
B 21		0.15	0.20	10 YR 4/2	0	MHC		0					
B 22		0.20	0.90	10 YR 5/4	0	MHC		0	S 5 LE	3 K S 2	K 3 P		
B 23		0.90	1.65	7.5 YR 5/4	0	MHC		0	S 5 LE		K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.9	9.5	9.5	9.5	9.5	9.5		
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	63	McCJI	5-Dec-2011	Kk	TQ ab	647997 E	7515672 N	C	VR	mz, so, ca		VE	AB	GS	BP	E	R	R	X	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	4	A	SD	0		4	G	99	99				
																H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage	Land use		Land condition		Notes
					C	HCR		RIS		0	3	2	4					

Soil profile wet as per last site. Similar good buffel grass. Lower B horizon texture feels very sodic. Some 'Ghost Rock' below 1.6 m. Site on edge of broad HCR U HSL on RIS / Low Hill

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12	10 YR 4/2	0	MHC		1 1 A SD		0			
B21		0.12	0.35	10 YR 4/3	0	MHC		1 1 A SD		0			
B 22 k		0.35	0.70	10 YR 5/3	0	MHC		1 1 A SD	S 5 LE	3 K S 3			
B23		0.70	0.90	7.5 YR 5/4	0	MHC		1 1 A SD	S 5 LE	2 K S 3			
B 24		0.90	1.20	7.5 YR 5/4	0	MHC		1 1 A SD	S 5 LE	0			
B 25		1.20	1.60	7.5 YR 5/4	0	MHC		1 1 A SD	S 5 LE	2 M V 1			
B 26 / BC ?		1.60	1.80	7.5 YR 6/4	3 3 D R	MHC		1 1 A SD	S 5 LE	2 M V 1			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10	
pH - RP		8.0	8.5	9.0	9.0	9.0	9.0	9.0		
Field EC										
Field pH (1:5)										
CEC										
ESP										
Ca/Mg										

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	64	McCJI	5-Dec-2011	Kk	TQ ab	648797 E	7516124 N	C	VR	mz, so, ca		VE	AE	GS	BP	F	R	R	V	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				2	2	U	SD	0		4	G	99	99				
									1	4	U	SD				H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
				NW	U	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	
Site on same U HSL - Broad HCR of siginificant RIS. Assume HS surface although hard to tell after recent rainfall. Couldn't pick soil boundary between here and last site. BC - mixed layers of deco SD					

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.10	7.5 YR 3/1	0	FSMHC		1 1 R SD					
B21		0.10	0.50	7.5 YR 3/1	0	FSMHC		1 1 R SD	S 5 LE				
B22		0.50	0.70	10 YR 4/2	0	FSMHC		1 1 R SD	S 5 LE				
B23		0.70	0.95	10 YR 5/2	0	FSMHC		1 1 R SD		1 K S 3			
BC k		0.95	1.30							4 K S 3			

Test depth (m)		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00		1.20		1.50		1.80		2.10		
pH - RP		8.6		8.6			9.0			9.0			9.0		9.0						
Lab EC		0.10	0.11	0.14	0.19	0.22	0.27	0.33	0.37	0.42	0.44										
Cl		<6	<6	<6	<6	10	20	63	105	183	330										
Lab pH		8.5	8.4	8.8	9.1	9.2	9.3	9.3	9.3	9.3	9.0										
CEC		29		38			38			34											
ESP		0.6		3.7			12.7			18.6											
Ca/Mg		3.6		1.9			1.1			0.8											

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg). Sampled all depths to 1.00 m.

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	65	McCJI	5-Dec-2011	Kk	TQ ab	649092 E	7516278 N	C	VR	mz, so, ca		VE	AC	GS	GM	E	R	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	1	A	SD	0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					C	HCR		RIS		0	3	2	4

Land use		Land condition		Notes	
Site located on HCR of Low Ris above site 64.					

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.10		0	MC		0					
B 21		0.10	0.30		0	MC		0					
B 22		0.30	1.10	10 YR 6/4	0	MC		0	S 5 LE	3 K S 3			
B 23		1.10	1.30	7.5 YR 6/4	0	MC		0	S 5 LE	3 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		8.5	9.0	9.0	9.0	9.0			
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	66	McCJI	6-Dec-2011	Kk	TQ ab	649422 E	7516476 N	C	VR	mz, so, ca		VE	AB	GS	BP	F	R	R	W	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	4	U	SD	0		4	G	99	99				
									2	1	U	SD				H						

Elevation: Eval	Elevation: Height (m AHD)	Slope: Eval	Slope: %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	3	2	4

Land use | Land condition | Notes

Site located on broad HCR cleared with Brigalow regrowth with shrubs along fence line. No SM surface. DE or VE ? Profile but better as VE. BC - deco. sediments

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12	10 YR 4/2	0	MC		1 1 R SD		0			
B 21		0.12	0.40	7.5 YR 4/3	0	MC		1 1 R QZ		0			
B 22		0.40	0.70	7.5 YR 4/3	0	MC		1 1 R QZ	S 5 LE	1 K S 2			
B 23		0.70	1.10	7.5 YR 4/3	0	MC		1 1 R QZ	S 5 LE	2K S 3			
BC		1.10	1.30					4 2 R SD		0			

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				7.0		7.6		8.9		8.9		8.9									
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	67	McCJI	6-Dec-2011	Mf	TQ ab	649718 E	7516234 N	C	lv	ha, ap, ca, cr		CH	AA	CQ	EX	B	E	M	O	V

Microrelief Type	Microrelief PROP	Microrelief V.I. (m)	Microrelief H.I. (m)	Microrelief Prop Sample	Erosion Type	Erosion State	Erosion Degree	Erosion Gully Depth	Surface coarse fragments Abund	Surface coarse fragments Size	Surface coarse fragments Shape	Surface coarse fragments Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Vegetation: Broad floristic formation (Level 3)	Vegetation: Broad floristic subformation (Level 4)	Vegetation: Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
				SE	U	HSL		RIS		0	2	3	4

Land use		Land condition		Notes	

Upper HSL / broad HCR Red Ch on calcareous sediments from 0.90 m. Looks like larger area of this soil in this locality.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 1		0.00	0.20		0	CLFS		0	V	0			
A 2 j		0.20	0.24		0	CLFS		0	V	0			
B 21 t		0.24	0.40	2.5 YR 4/3	0	MHC		0	S 3 AB	0			
B 22 t		0.40	0.90	10 YR 6/4	2 3 D R	MHC		0	S 5 LE	3 2 M S	K 3 P		
BC k		0.90	1.30		3 3 D G					4 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	7.0	8.6	8.8	8.9			
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	68	McCJI	6-Dec-2011	Lg	Qa	649018 E	7517455 N	C	Vr	gm, so, ca, pe		VE	AD	EI	CD	E	R	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	U	CH	0		4	G	99	99				
																M						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					F	PLA	ALP			3	3	2	4

Land use		Land condition		Notes	

Lower B horizon textures fells sodic. Thick brigalow regrowth regrowth to Norht of site. Flat / v gentle lower HSL = assume Tqa or Qa geology ?? Self mulch is only patchy - Tralee soils or Langley ?

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.20		0	MHC		0		0			
B 21		0.20	0.40	10 YR 5/2	0	MHC		0	S 5 LE	0			
B 22		0.40	1.00	10 YR 5/2	0	MHC		0	S 5 LE	1 K N 2			
B 23 k ?		1.00	1.50	10 YR 6/4	0	MHC		0	S 5 LE	2 K S 3			
B24		1.50	1.85	10 YR 6/4	0	MHC		0	S 5 PR	2 M V 1			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.3	8.9	8.9	8.9	8.9	7.6	6.5	
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	69	McCJI	6-Dec-2011	Kc	TQ ab	648305 E	7516871 N	C	KS	vr, so, ve		VE	AB	GS	BP	E	R	R	X	

Microrelief Type	Microrelief PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	Erosion State	Erosion Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	U	SD	0		5	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
				N	L	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Red Vertosol here on calcareous sediments - obvious on contour banks. Textures of A hroizon feels sodic. Lots of Parthenium weed here. Looks like ironstone country on nearby banks.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15		0	MC		2 2 R SD		0			
B 21		0.15	0.50	7.5 YR 5/4	0	MC		2 2 R SD	S 5 LE	0			
B 22		0.50	0.80	5 YR 5/4	0	MC		2 2 R SD	S 5 LE	0			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		6.6	8.4	6.5					
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	70	McCJI	6-Dec-2011	Kk	TQ ab	647904 E	7515055 N	C	VR	mz, so, ca		VE	AB	GS	BP	E	R	R	V	

Microrelief Type	Microrelief PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	Erosion State	Erosion Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Rock Outcrop Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0				99	99				

Elevation Eval	Elevation Height (m AHD)	Slope Eval	Slope %	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
				S	U	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

10 M away black vertosol to 45 cm over dark grey calcareous clay on contour bank. Complex here ? Red / YB Vertosol looks like Chromosol but it is a clay. Some bloodwood regrowth. Soil Kk or Kc or site close to soil boundary ?

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.20		0	MC		0		0			
B 2		0.20	0.60	2.5 Y 5/3	0	MC		0	S 5 LE	2 K S 3	K 3 P		
BC k		0.60	1.20	10 YR 6/4	0	MC		0	S 5 LE	4 K S 3	K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		8.0	8.9	8.9	8.9	8.9			
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	71	McCJI	6-Dec-2011	Kc	TQ ab	648306 E	7515268 N	C	KS	vr, ca, so		DE	AA	BD	EO	B	E	O	O	W

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					L	HSL		RIS			2	3	4

Land use		Land condition		Notes	
Some Eucalypt regrowth Dermosol here some ptaches of Ghost Rock structure below 1.40 m					

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.30		0	FSLMC		0	V	0			
B 21		0.30	0.60	5 YR 5/4	0	MC		0	S 4 PR	0	C 3 P		
B 22		0.60	0.90	10 YR 4/2	0	MC		0	S 5 AB	2 K S 3			
B 23		0.90	1.40	7.5 YR 5/4	0	MC		0	S 5 AB	1 K N 2			
B 3		1.40	1.80	7.5 YR 5/4	0	MC		0	S 5 AB	2 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	7.0	8.9	9.9	9.9	8.9	9.0	
Lab EC		0.04	0.03	0.11	0.30	0.54	0.86		
Cl		<6	<6	<6	50	300	710		
Lab pH (w)		7.1	7.8	8.7	9.4	9.5	9.2		
CEC		17	16	22	26	33			
ESP		0.3	1.4	7.0	14.4	18.3			
Ca/Mg		2.9	3.2	0.9	0.6	0.4			

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg) Sampled standard 0.3 m depths to 1.50 m.

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	ASC: Order	ASC: S.Ord	ASC: G Grp	ASC: S Grp	ASC: Fam 1	ASC: Fam 2	ASC: Fam 3	ASC: Fam 4	ASC: Fam 5
VER	72	McCJI	6-Dec-2011	Kk	TQ ab	649089 E	7514179 N	C	VR	mz, so, ca		VE	AB	GS	BP	E	Q	R	V	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					C	HCR		RIS		0	3	2	4

Land use: | Land condition: | Notes:

HS / weakly cracking VE. Also areas of red/brown DE around this area as well. Brigalow regrowth with currant bush. HS but patches of SM especially where disturbed. From 70 cm - layers of Marl, deco SD rocks and clay.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12		0	FSLMC		0	W 3 AB				
B 21		0.12	0.35	7.5 YR 5/3	0	MC		0	S 4 PR				
B 22		0.35	0.70	7.5 YR 5/3	0	MC		0	S 5 LE	2 K S 3			
BC k		0.70	1.80		3 3 D O					4 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.2	7.8	9.0	9.0	9.0	9.0	9.0	
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	73	McCJI	6-Dec-2011	Lg	Qa	649334 E	7514311 N	C	VR	gm, so, ca, pe		VE	AD	EI	CD	E	S	S	W	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																M						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					F	PLA		ALP			3	2	4

Land use		Land condition		Notes	

Mostly good/strong SM here. Resonably thick Brigalow regrowth. No obvious gilgai Lots of Calcareous 'rubble' below 1.40 m.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.15		0	MHC		0		0			
B 21		0.15	0.40	10 YR 4/1	0	MHC		0	S 5 LE	0			
B 22		0.40	1.00	10 YR 4/1	0	MHC		0	S 5 LE	1 K S 2	K 3 P		
B 23		1.00	1.15	10 YR 4/2	0	MHC		0	S 5 LE	1 KN 2			
B 24		1.15	1.40	10 YR 5/3	0	MHC		0	S 5 LE	2 K S 3			
2 BC k		1.40	1.60		0	MHC		2 2 R SD		4 K S 3			

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				7.0		8.3		9.0		9.0		9.0		9.0							
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	74	McCJI	6-Dec-2011	Lg	Qa	649755 E	7514550 N	C	VR	gm, so, pe		VE	AE	EI	CD	E	R	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	U	SD	0		4	G	99	99				
																M						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					F	PLA		ALP		3	3	2	4

Land use		Land condition		Notes	
Site located in large, wide Qa flat with lots of Brigalow regrowth. Good even SM surface					

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.03	10 YR 3/1	0	MHC		0	S 3 GR				
A 12		0.03	0.15	10 YR 3/1	0	MHC		0	S 4 AB				
B 21		0.15	1.30	10 YR 3/1	0	MHC		0	S 5 LE				
B 22		1.30	1.80	10 YR 4/1	0	MHC		0	S 5 LE	1 K N2			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		6.7	6.7	7.8	7.8	7.8	7.8	8.2	
Lab EC		0.06	0.07	0.26	0.66	0.70	0.63	0.59	
Cl		12	30	270	770	810	685	630	
Lab pH (w)		6.9	7.5	8.5	8.4	8.6	8.7	8.8	
CEC		40	45	45	53	52			
ESP		1.1	3.3	8.9	8.7	9.2			
Ca/Mg		1.0	1.0	0.8	0.7	0.7			

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/Kg) Sampled standard 0.30 m depths to 1.80 m.

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55K Accuracy	AMG Location 55K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	75	McCJI	6-Dec-2011	Lg	Qa	650157 E	7514771 N	C	VR	gm, so, pe		VE	AE	EI	CD	E	R	S	V	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	U	CH	0		4	G	99	99				
																M						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					F	PLA		ALP		3	3	2	4

Land use:

Land condition:

Notes: Similar Qa clay to last site, but over buried soil below 75 cm. From 1.30 m includes deco. Mudstone (green) and Marl and ZS. Brigalow with Emu apple as well

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.02		0	MHC		0	S 3 GR	0			
A 12		0.02	0.12		0	MHC		0	S 4 AB	0			
B 21		0.12	0.60	10 YR 3/1	0	MHC		0	S 5 LE	0			
B 22 / B3 ?		0.60	0.80	10 YR 5/3	0	MC		0	S 5 LE	1 K S 3			
2 BC 1 b		0.80	1.30	10 YR 7/6	0	ZS		0	S 4 PR	3 M V 2			
2 BC 2 k b		1.30	1.40							3 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.1	8.6	8.8	8.8	8.8			
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	76	McCJI	6-Dec-2011	Kc	TQab	649965 E	7513373 N	C	KS	vr, ca, so, ve		VE	AD	GS	FY	E	R	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.10	10	M	0				0				0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					U	HSL		RIS		O	3	2	4

Land use		Land condition		Notes	
Site on Higher Ridge with Vertosol, weak gilgai and Euclaypts with Belah.					

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.05		0	MHC							
B 21		0.05	0.60	2.5 Y 4/2	0	MHC			S 5 LE	2 K N 2			
B 22		0.60	1.25	2.5 Y 5/2	0	MHC			S 5 LE	2 K N 2			
B 23		1.25	1.80	7.5 YR 5/4	0	MHC			S 5 LE	2 K N 2			
BC k		1.80	1.85			MARL				4 K S 4			

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				8.6		8.6		8.6		8.6		8.6		8.6		8.6					
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	77	McCJI	29-Feb-2012	Pc	TQab	649517 E	7513827 N	C	Vr	gm, so, ca, pe		VE	AE	EI	CD	E	R	R	X	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	B	0.30	12	M	0				0				0		4	G	99	99				
																M						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS			2	2	3

Land use		Land condition		Notes	

Good Self-mulching clay - Cleared Eucalypt regrowth with Bauhinai and Belah as well. Good buffel grass but with lots of Parthenium weed. Surface gravel on access track for wet weather access - wet area ? No coarse frags here.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.02	10 YR 3/2	0	MHC		0	S 3 GR				
A 12		0.02	0.12	10 YR 3/2	0	MHC		0	S 3 AB				
B 21		0.12	0.40	10 YR 3/2	0	MHC		0	S 4 AB				
B 22		0.40	0.90	10 YR 3/2	0	MHC		0	S 5 LE	1 K N 2	K 3 P		
B 23 k		0.90	1.35	7.5 YR 4/3	0	MHC		0	S 5 LE	3 K N 3	K 2 D		
B3 ?		1.35	1.90	7.5 YR 5/4	0	LC		0	S 5AB	1KN2 / 1MS2			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.8	8.8	8.8	8.8	8.8	8.8	8.8	
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Site located on lower flat compared to site 76 but on lower HSL from Rise to east ? - boundary 100m from this site.

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	AMG Location 55 K Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	78	McCJI	29-Feb-2012	Kc	TQab	650244 E	7513358 N	C	KS	vr, ca, so, ve		VE	AE	GS	BP	E	R	R	W	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
				S	M	HSL		RIS			3	2	4

Land use | Land condition | Notes

Site located downslope from site 76. Midslope with weak surface seal ? Cleared at site but Eucalypts other side of fence. Good stands of buffel and Qld Blue Grass but with lots of Parthenium weed as well.

Horizon	Boundry	Depth (m) Upper	Depth (m) Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12	10 YR 3/1	0	MHC		1 1 R Gv		0			
B 21		0.12	0.30	10 YR 3/1	0	MHC		1 1 R Gv		0			
B 22		0.30	0.90	10 YR 3/1	0	MHC		1 1 R Gv	S 5 LE	0	K 3 P		
B 23		0.90	1.30	10 YR 4/2	0	MHC		1 1 R Gv	S 5 LE	1 K N 1	K 3 P		
BC k		1.30	1.40	7.5 YR 4/3	0	MC		1 1 R Gv		4 K S 43			

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.40		1.80		2.10			
pH - RP				7.0		7.0		8.7		8.8		8.8		8.8							
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Photos taken of vegetation and soil profile here

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	79	McCJI	29-Feb-2012	Kc	TQab	649741 E	7513425 N	C	KS	vr, ca, so, ve		DE	AA	CQ	EX	B	E	O	O	W

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				1	2	R	SD	0		4	H	99	99				

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					C	HCR		RIS		0	2	2	3

Land use		Land condition		Notes	
Site located on broad HCR - cleared Eucalypts with Rhodes, Qld Blue and Buffel grasses. Profile moist and friable to 0.55 m over very dense, hard clay to 1.00 m over carb with deco SD mixed with brown clay.					

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.20	10 YR 4/1	0	SMC		1 2 R GV	S 3 AB	0			
B 21		0.20	0.55	5 YR 5/4	0	SMC		1 2 R GV	S 4 PR	0			
B 22 ?		0.55	1.00	10 YR 4/1	0	SMC		1 2 R GV	S 4 LE	2 K N 2	K 2 P		
BC k		1.00	1.30	7.5 YR 5/4	0	SLMC		3 2 R SD		4 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.8	7.8	8.8	8.8	8.8			
Field EC		0.04	0.03	0.07	0.22	0.78			
Field pH (1:5)		8.2	8.7	8.7	9.2	8.4			
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	80	McCJI	1-Mar-2012	Kk	TQab	649189 E	7513221 N	C	VR	mz, ca, so		VE	AD	GS	GM	F	Q	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	B	0.50	12	M	0				2	1	A	SD	0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					F	PLA		RIS		0	3	2	4

Land use		Land condition		Notes	

Cleared brigalow HS cracking clay. Carbonate nodules on surface of mounds only. Site located on higher level clay flat. Bauhinia, Brigalow, Currant bush with buffel and Qld Blue grasses. Moslty HS - patches of better SM as well.

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.12	10 YR 4/2	0	FSLMC		2 2 R GV		0			
B 21		0.12	0.60	10 YR 4/2	0	FSMC		2 2 R GV	S 5 LE	2 K S 2	K 3 P		
B 22		0.60	1.50	10 YR 5/2	0	FSMC		2 2 R GV	S 5 LE	2KS3/1KN3	K 3 P		
B 23		1.50	1.65	10 YR 5/2	0	FSMC		2 2 R GV	S 5 LE	2 K N 2	K 3 P		
BC k		1.65	1.85	10 YR 5/3	0	KSMC		2 2 A GV		3 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		8.5	8.7	7.9	8.6	8.7	8.7	8.7	
Field EC		0.10	0.11	0.13	0.37	0.66	0.75	1.60	
Field pH (1:5)		8.4	8.5	9.0	8.9	8.5	8.4	8.0	
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	81	McCJI	29-Feb-2012	Kc	TQab	650643 E	7513785 N	C	KS	vr, ca, so, ve		VE	AB	GS	BP	E	Q	R	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																H						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					C	HCR		RIS		0	3	2	4

Land use		Land condition		Notes	
Site is cracking clay with Eucalypts on higher HCR. No gilgai or coarse fractions on surface on within soil profile.					

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A		0.00	0.15		0	FSLMC		0		0			
B 21		0.15	0.40		0	MHC		0		0			
B 22		0.40	0.80	7.5 YR 5/3	0	MHC		0	S 5 LE	0			
B 23 k		0.80	1.60	10 YR 4/1	0	MHC		0	S 5 LE	2 K N 3			
B 24		1.60	1.80	10 YR 4/2	0	MHC		0	S 5 LE	0	K 3 P		

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10				pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)
pH - RP				7.0		7.5		8.7		8.8		8.8		8.8		8.8						
Field EC																						
Field pH (1:5)																						
CEC																						
ESP																						
Ca/Mg																						

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	82	McCJI	1-Mar-2012	Kk	TQab	648722 E	7513132 N	C	VR	mz, so, ca		VE	AB	GS	BL	E	R	S	X	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.40	12	M	0				0				0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS			3	1	3

Land use: | Land condition: | Notes:

Brigalow clay but very acid and saline at depth. Patches of darker clay with good SM surface as well in this unit, but mostly HS. Site on same gente slope as site 80.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12	10 YR 5/2	0	MHC		0	S 4 AB	0			
B 21		0.12	0.35	10 YR 5/2	0	HC		0	S 5 LE	0	K 2 D		
B 22 k ?		0.35	0.70	10 YR 5/2	0	HC		0	S 5 LE	2 K S 3	K 2 D		
B 23		0.70	1.05	10 YR 5/3	0	HC		0	S 5 LE	0	K 2 D		
B 24		1.05	1.85	5 Y 5/1	3 3 D R	HC		0	S 5 LE	0	K 3 P		

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		6.6	8.9	8.9	8.9	5.6	4.5	4.5	
Field EC		0.06	0.15	0.33	1.29	1.55	1.33	1.63	
Field pH (1:5)		6.3	8.3	8.4	7.6	5.8	4.9	4.7	
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K		Observation Type	World Reference Base		Australian Soil Classification									
						Accuracy	Datum GDA 94		Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	83	McCJI	1-Mar-2012	MfSV	TQab	647792 E	7512936 N	C	SN	ca, so, ab, ap		SO	AB	FN	BD	B	E	M	O	X

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	H	99	99				

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
					U	HSL		RIS		0	3	1	3

Land use		Land condition		Notes	
Profile dry > 0.45 m desptie recent rain. Cleared Eucs wih patch of Eucs & Belah nearby. Buffel grass apears OK but thick currant bush here. Site on gentle rise - slightly higher than clans to west of site.					

Horizon	Boundry	Depth (m)		Colour	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
		Upper	Lower	Hue : Value / Chroma									
A 1	C	0.00	0.20	7.5 YR 4/2	0	CLFS		0	W 3 AB				
A 2 e	A	0.20	0.25	7.5 YR 7/3 (d)	0	CLFS		0	V				
B 21 t	C	0.25	0.45	10 YR 5/4	3 3 D R	MHC		0	S 5 PR				
B 22 t	C	0.45	0.70	10 YR 5/3	0	MHC		0	S 5 PR				
B 23 t k		0.70	1.40	10 YR 5/3	0	MHC		0	S 5 PR	2 K S 3			

Test depth (m)		0.02		0.10		0.40		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				7.5		9.0		9.0		9.0		9.0									
Lab EC				0.12		0.09		0.15		0.31		0.56									
Cl				24		5		8		75		370									
Lab pH (w)				7.9		8.6		9.0		9.5		9.3									
CEC				16		23		19		22		25									
ESP				<1		3.0		7.0		15.0		17.0									
Ca/Mg				4.3		1.2		0.8		0.6		0.6									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg). Sampled standard 30 cm depths to 1.20 m - 40 cm to measure top of B horizon

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	84	McCJI	1-Mar-2012	Kc	TQab	648229 E	7513024 N	C	KS	vr, ca, so, ve		VE	AD	GS	BP	E	R	R	X	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS			3	2	4

Land use:

Land condition:

Notes: Cleared Eucs and Belah. Mostly HS but some pathc weak to occasionally mod SM as well. Very hard, Marly clay below 1.55 m.

Horizon	Boundry	Depth Upper (m)	Depth Lower (m)	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12	10 YR 4/1	0	MHC		0					
B 21		0.12	0.30	10 YR 4/1	0	MHC		0					
B 22		0.30	0.90	10 YR 4/1	0	MHC		0	S 5 LE		K 2 D		
B 23		0.90	1.20	10 YR 4/1	0	MHC		0	S 5 LE	2 K N 2	K 3 P		
B 24		1.20	1.55	10 YR 5/3	0	MHC		0	S 5 LE	1 K N 2	K 3 P		
BC k / C ?		1.55	1.60		0	MARL		0		4 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	8.6	8.8	8.8	8.8	8.8		
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	ASC: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	85	McCJI	1-Mar-2012	Kc	TQab	648125 E	7512610 N	C	KS	vr, ca, so, ve		VE	AE	GS	BP	E	R	R	X	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS			3	2	4

Land use | Land condition | Notes

Cleared Eucalypts - Brigalow comes in about 150 m to south of this site. Site located on lower HSL below site 84. Below 1.50 m is hard Marl similar to site 84.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12	10 YR 3/1	0	MC			S 3 AB				
B 21		0.12	0.35	10 YR 3/1	0	MHC			S 4 AB				
B 22		0.35	1.10	10 YR 3/1	0	MHC			S 5 LE				
B 23		1.10	1.50	10 YR 4/2	2 3 F R	MHC			S 5 LE	1 K N 2			
BCk / C ?		1.50	1.60			MARL		2 2 A SD		4 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	8.1	9.0	9.0	9.0	9.0		
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	86	McCJI	1-Mar-2012	Kc	TQab	648451 E	7512739 N	C	KS	vr, so, ca, ve		VE	AD	GS	BP	E	R	R	X	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.30	12	M	0				0				0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage

Land use		Land condition		Notes	

Vertosol with Eucs but also some Brigalow creeping in here as well. Good stands of Buffel and Blue grasses. Mostly HS but some weak SM - or is mostly surfce crust. ?

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12	10 YR 4/1	0	MC		0					
B 21		0.12	0.30	10 YR 4/1	0	MHC		0					
B 22		0.30	0.70	10 YR 4/1	0	MHC		0					
B 23		0.70	1.30	10 YR 5/2	0	MHC		0	2 K S 3				
B 24		1.30	1.70	10 YR 5/3	0	MHC		2 2 R GV	2 K N 2				

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.0	8.9	8.9	8.9	8.9	8.9		
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	WRB Reference Soil Group	WRB Qualifiers	ASC Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	87	McCJI	1-Mar-2012	Kk	TQab	649043 E	7514070 N	C	VR	mz, so, ca		VE	AD	GS	GM	E	Q	R	X	

Microrelief Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion Type	State	Degree	Gully Depth	Surface coarse fragments Abund	Size	Shape	Lith	Rock Outcrop Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
N	C	0.35	12	M	0				1	1	A	SD	0		4	G	99	99				
																H						

Elevation Eval	Height (m AHD)	Slope Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS			3	2	4

Land use: | Land condition: | Notes:

Brigalow clay this one has more carbonate than some of the others thouhg. Weak surface seal after recent rain. B horizon texture feels very sodic. Pieces of deco SD in soil matrix below 0.90 m.

Horizon	Boundry	Depth Upper (m)	Depth Lower (m)	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12	10 YR 4/2	0	FSLMC		0		0			
B 21		0.12	0.40	10 YR 4/2	0	FSLMC		0		0			
B 22		0.40	0.90	10 YR 5/3	0	MC		0	S 5 LE	3 K S 3			
B 3		0.90	1.40	10 YR 6/4	2 2 F R	MC		0	S 5 LE	3 K S 3			

Test depth (m)	0.02	0.10	0.30	0.60	0.90	1.20	1.50	1.80	2.10
pH - RP		7.8	8.7	9.9	9.9	9.9			
Field EC									
Field pH (1:5)									
CEC									
ESP									
Ca/Mg									

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	AMG Location 55 K: Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	World Reference Base: Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	88	McCJI	1-Mar-2012	Kc	TQab	649591 E	7514141 N	C	KS	vr, ca, so, ve		VE	AB	GS	BP	E	R	R	X	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		4	G	99	99				
																H						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					L	HSL		RIS			3	2	4

Land use		Land condition		Notes	

Not brigalow here - Buahinia, Emu apple and currant bush after clearing. Good stand of Buffel and Blue grasses. Site on similar flat/ gentle slope to site 77. Hard to tell surface condition here after recent rain - but looks more like HS than SM. Some carb. on surface of mounds.

Horizon	Boundry	Depth (m): Upper	Lower	Colour: Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A		0.00	0.12	10 YR 4/3	0	MHC		0		0			
B 21		0.12	0.30	10 YR 5/3	0	MHC		0		0			
B 22		0.30	0.60	10 YR 5/3	0	MHC		0	S 5 LE	0	K 3 P		
B 23		0.60	1.10	10 YR 5/3	0	MHC		0	S 5 LE	2 K N 2	K 3 P		
B 24		1.10	1.40	10 YR 5/4	0	MHC		0	S 5 LE	2 K N 2	K 2 D		
B 25		1.40	1.80	10 YR 6/4	0	MHC		0	S 5 LE	0	K 2 D		

Test depth (m)		0.02		0.10		0.30		0.60		0.90		1.20		1.50		1.80		2.10			
pH - RP				7.0		7.8		8.7		8.7		8.7		7.8		7.8					
Field EC																					
Field pH (1:5)																					
CEC																					
ESP																					
Ca/Mg																					

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K: Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	89	McCJI	2-Mar-2012	Pc	TQab	644332 E	7513673 N	C	VR	gm, ca, sow,pe		VE	AE	EI	CD	E	R	S	X	

Microrelief					Erosion				Surface coarse fragments				Rock Outcrop		Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation			
Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Type	State	Degree	Gully Depth	Abund	Size	Shape	Lith	Abund	Lith					Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		6	G	99	99				
																M						

Elevation		Slope		Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
Eval	Height (m AHD)	Eval	%										
		A	2.0		U	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Site in SCL AREA - sw corner of mine lease. Cultuvation with contour banks. Mod to strong medium SM. Some of this paddock may be > 3 % slope. Left as pasture - now blue grasses ? No plough pan or stuctural decline from ploughing evident in profile.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A11 p		0.00	0.02	10 YR 3/1	0	MHC			S 3 GR	0	0		
A12 p		0.02	0.12	10 YR 3/1	0	MHC			M 4 AB	0	0		
B 21		0.12	0.50	10 YR 3/1	0	MHC			S 4 LE	0	K 2 D		
B 22		0.50	1.00	10 YR 3/1	0	MHC			S 4 LE	0	K 3 P		
B 23		1.00	1.25	10 YR 4/2	0	MHC			S 4 LE	1 K S 2	K 3 P		
BC / B3 k		1.25	1.90	7.5 YR 5/3	2 2 D O	MHC		1 1 U SD	M 5 LE	3 K S 3	0		

Test depth (m)		0.02		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.20		1.50		1.80			
pH - RP																					
Lab EC				0.13	0.12	0.14	0.10	0.11	0.13	0.25	0.26	0.25	0.36	0.52		0.71		0.88			
Cl				35	18	20	25	18	15	83	55	70	226	520		830		1150			
Lab pH (w)				8.2	8.1	8.6	8.6	8.6	8.8	8.8	8.9	8.9	8.8	8.8		8.6		8.5			
CEC				47		48			56			55		54		56		47			
ESP				1.0		2.0			6.0			9.0		9.0		9.0		9.0			
Ca/Mg				2.4		2.0			1.4			1.2		1.1		1.0		0.9			

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg). Sampled every 0.1 m to 1.00m, plus 1.20, 1.50 and 1.80 m

Survey	Site	Desc by	Date	Soil Name	Geology	AMG Location 55 K Accuracy	Datum GDA 94	Observation Type	World Reference Base: Reference Soil Group	Qualifiers	Australian Soil Classification: Conf	Order	S.Ord	G Grp	S Grp	Fam 1	Fam 2	Fam 3	Fam 4	Fam 5
VER	90	McCJI	2-Mar-2012	Pc	TQab	644325 E	7512494 N	C	VR	gm, sow, pe		VE	AE	EI	CD	E	R	S	X	

Microrelief: Type	PROP	V.I. (m)	H.I. (m)	Prop Sample	Erosion: Type	State	Degree	Gully Depth	Surface coarse fragments: Abund	Size	Shape	Lith	Rock Outcrop: Abund	Lith	Site Disturbance	Surface Condition	R hor depth (m)	Free water depth (m)	Vegetation: Formation (Level 1 & 2)	Broad floristic formation (Level 3)	Broad floristic subformation (Level 4)	Wetland Type & Gr.form
Z					0				0				0		5	G	99	99				
																M						

Elevation: Eval	Height (m AHD)	Slope: Eval	%	Aspect	Morph Type	Landform Element	Location	Landform Pattern	RMS	Flooding	Run-Off	Permeability	Drainage
					M	HSL		RIS		0	3	2	4

Land use		Land condition		Notes	

Site in SCL AREA - sw corner of mine lease. Same strongly SM clay as in ultuvation nearby. Nearby looks like pure Belah woodland No plough pan or stuctural decline from ploughing evident in profile.

Horizon	Boundry	Depth (m) Upper	Lower	Colour Hue : Value / Chroma	Mottles	Field Texture	Qual	Coarse Fragments	Structure	Segregations	Cutans or Voids	Pans	SWS & Consistence
A 11		0.00	0.03	10 YR 3/1	0	MHC			S 3 GR				
A 12		0.03	0.15	10 YR 3/1	0	MHC			S 4 AB				
B 21		0.15	0.40	10 YR 3/1	0	MHC			S 5 AB				
B 22		0.40	0.90	10 YR 3/1	0	MHC			S 5 LE	1 K N 2	K 3 P		
B 23		0.90	1.30	10 YR 4/2	0	MHC		1 2 U Qz	S 5 LE	1 K N2	K 3 P		

Test depth (m)		0.02		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.20		1.50		1.80			
pH - RP																					
Lab EC				0.18	0.10	0.11	0.08	0.10	0.11	0.21	0.28	0.38	0.50	0.78							
Cl				30	12	10	12	12	20	70	125	235	420	870							
Lab pH (w)				8.1	8.0	8.2	8.4	8.7	8.7	8.9	9.0	8.9	8.9	8.8							
CEC				46		49			53			53		50							
ESP				2.0		3.0			8.0			10.0		11.0							
Ca/Mg				1.6		1.7			1.3			1.0		0.9							

pH Rp (Raupach field pH); Field EC (1:5 soil:water - ds/m)

Cl (mg/kg). Sampled every 0.1 m to 1.00m, plus 1.20

Agricultural Chemistry Pty Ltd (ASPAC approved)

For Info Refer ESSA Pty Ltd
PO Box 442 Sunnybank Q 4109

Phone: 0403245560

email: e.s.s.a@bigpond.net.au

Reference: **12/12** Sheet: 1 of 4

Date Received: 12/3/2012
Date Completed: 23/3/2012

FINAL REPORT

Project:

Project Dysart Area No 2

All results in this report relate only to the items tested. Results are expressed on an "as received basis".

Client Name: NQSA

Contact: Mr James Mc Clurg

Sample Type: Soil

Number of samples: 36

Agricultural Chemistry Pty Ltd **(ASPAC Approved)**

Soil Analysis Report
Batch Number: 12/12

Date Received: 12/03/2012
Date Completed:23/3/2012

Client: NQSA Dysart

D Baker

ESSA Ref	field ref	Soil pH	Soil EC	Soil Cl	P(Colwell)	Exch.Ca	Exch. Mg	Exch.K	Exch. Na	CEC	ESP	Total N
	depth (cm)		dS/m	mg/kg	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%Na/CEC	%
148	**22** 0 - 10	6.9	0.099	10		5.5	1.8	0.17	<0.1	9	<1	
149	30 - 40	8.5	0.068	10		5.5	6.0	0.05	0.74	12	6	
150	50 - 60	9.0	0.083	5		4.1	6.7	0.03	1.27	12	11	
151	80 - 90	9.6	0.163	5		1.8	7.5	0.05	3.37	12	28	
152	110 - 120	10.0	0.371	30		1.4	7.6	0.05	5.63	13	43	
153	140 - 150	10.0	0.452	150		1.7	9.7	0.05	7.93	18	44	
154	**83** B0 - 10	7.9	0.115	10	24	13.9	3.2	0.24	<0.1	16	<1	0.130
155	0 - 10	8.3	0.096	8		10.8	2.3	0.16	<0.1	12	<1	
156	30 - 40	8.6	0.090	5		12.4	10.6	0.05	0.65	23	3	
157	50 - 60	9.0	0.145	8		7.8	10.2	0.04	1.29	19	7	
158	80 - 90	9.5	0.314	75		7.8	13.3	0.04	3.19	22	15	
159	110 - 120	9.3	0.556	370		8.0	14.4	0.03	4.14	25	17	
160	**89** 0 - 10	8.2	0.131	35		31.6	13.4	0.12	0.37	47	1	
161	10 - 20	8.1	0.121	18								
162	20 - 30	8.6	0.135	20		31.4	15.5	0.08	0.97	48	2	
163	30 - 40	8.6	0.096	25								
164	40 - 50	8.6	0.111	18								
165	50 - 60	8.8	0.133	15		30.2	21.2	0.09	3.56	56	6	
166	60 - 70	8.8	0.246	83								
167	70 - 80	8.9	0.258	55								
168	80 - 90	8.9	0.249	70		26.0	21.6	0.06	4.89	55	9	
169	90 - 100	8.8	0.357	226								
170	110 - 120	8.8	0.515	520		24.9	23.7	0.06	4.95	54	9	
171	140 - 150	8.6	0.710	830		24.7	24.8	0.09	4.87	56	9	
172	170 - 180	8.5	0.877	1150		19.7	22.4	0.08	4.23	47	9	
173	**90** 0 - 10	8.1	0.184	30		28.7	14.7	0.13	0.91	46	2	
174	10 - 20	8.0	0.100	12								
175	20 - 30	8.2	0.107	10		29.8	17.4	0.08	1.57	49	3	
176	30 - 40	8.4	0.083	12								
177	40 - 50	8.7	0.097	12								
178	50 - 60	8.7	0.108	20		27.2	20.9	0.09	4.04	53	8	
179	60 - 70	8.9	0.206	70								
180	70 - 80	9.0	0.284	125								
181	80 - 90	8.9	0.384	235		24.8	24.0	0.06	5.27	53	10	
182	90 - 100	8.9	0.501	420								

183	110 - 120	8.8	0.777	870		22.3	24.4	0.06	5.29	50	11	

Lab No	Sample No	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	Disp Ratio	ADMC
	Depth (cm)	%	%	%	%	R1	%
148	**22** 0 - 10	55	29	4	12	0.72	3.5
149	30 - 40	46	26	6	25	0.86	2.8
150	50 - 60	48	25	9	20	0.93	2.5
151	80 - 90						
152	110 - 120						
153	140 - 150						
154	**83** B0 - 10						
155	0 - 10	49	31	6	16	0.82	2.3
156	30 - 40	38	20	5	40	0.74	6.8
157	50 - 60	47	20	5	32	0.87	4.1
158	80 - 90						
159	110 - 120						
160	**89** 0 - 10	18	17	13	53	0.40	9.3
161	10 - 20						
162	20 - 30	17	15	12	61	0.42	13.8
163	30 - 40						
164	40 - 50						
165	50 - 60	12	12	13	66	0.53	10.1
166	60 - 70						
167	70 - 80						
168	80 - 90	13	14	10	66	0.55	12.3
169	90 - 100						
170	110 - 120						
171	140 - 150						
172	170 - 180						
173	**90** 0 - 10	20	19	12	50	0.37	10.8
174	10 - 20						
175	20 - 30	19	18	11	54	0.44	10.0
176	30 - 40						
177	40 - 50						
178	50 - 60	18	17	10	57	0.54	9.5
179	60 - 70						
180	70 - 80						
181	80 - 90	20	17	9	57	0.52	10.7
182	90 - 100						
183	110 - 120						

All results for particle size analysis and R1 are reported on oven-dried basis (no pre-treatment applied to test samples)

Agricultural Chemistry Pty Ltd (ASPAC Approved)

METHOD DESCRIPTIONS

Soil

Methods used to Analyse Samples

Analyte	ALHS*	Uncertainty %	LOQ	Unit	Name	Method Description
pH	4A1	1.1	0.1	pH	pH	1:5 water extr, pH meter
EC	3A1	5.4	0.01	dS/m	Electrical conductivity	1:5 water extr, EC meter
Cl	5A2	10.0	10.0	mg/kg	Chloride	1:5 water extr, (AA) colorimetric
NO3-N	7C2	6.7	1.0	mg/kg	Nitrate-nitrogen	1:5 water extr, (AA) colorimetric
NH4-N	7C2	7.8	0.6	mg/kg	Ammonium-nitrogen	1M KCl extr, (AA) colorimetric
Bicarb.P	9B2	16.8	1.0	mg/kg	Bicarb.ext.phosphorus	0.5M NaHCO3 @ pH 8.5, (AA) colorimetric
Ca (Alc)	15C1	7.2	0.18	meq/100g	Exchangeable calcium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
Mg (Alc)	15C1	4.7	0.31	meq/100g	Exchangeable magnesium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
Na (Alc)	15C1	9.6	0.09	meq/100g	Exchangeable calcium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
K (Alc)	15C1	4.8	0.02	meq/100g	Exchangeable calcium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
CEC	15I3	5.7	1.0	meq/100g	Cation Exchange Capacity	KNO3 + Ca(NO3)2 extr, (AA) colorimetric
DTPA-Cu	12A1	17.1	0.26	mg/kg	DTPA ext. copper	DTPA extraction, AAS
DTPA-Zn	12A1	16.4	0.10	mg/kg	DTPA ext. zinc	DTPA extraction, AAS
DTPA-Mn	12A1	9.0	0.32	mg/kg	DTPA ext. manganese	DTPA extraction, AAS
DTPA-Fe	12A1	13.0	0.23	mg/kg	DTPA ext. iron	DTPA extraction, AAS
ADMC	2A1	11.9	0.4	%	Air Dried Moisture Content	Gravimetric oven dry @ 105C
R1	NA	20.2	NA		Dispersion Ratio	Ratio [Aqueous dispersible (Silt + Clay):Total (Silt + Clay)]
SO4-S	10B3	11.5	0.6	mg/kg	Sulfate sulfur	Ca(H2PO4)2 @ pH 4.0 extractable sulfate-sulfur, ICPOES
Sand	no ref	22.1	1.0	%	Particle size, sand	Hydrometer, gravimetric
Silt	no ref	16.6	1.0	%	Particle size, silt	Hydrometer, gravimetric
Clay	no ref	12.7	1.0	%	Particle size, clay	Hydrometer, gravimetric
TN	7A2	12.9	0.01	%	Total Kjeldahl Nitrogen	Sulphuric acid digest, (AA) colorimetric

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)**

For Manager Analytical Services: **D E Baker BSc MASSSI**

Agricultural Chemistry Pty Ltd(ASPAC Approved)

QUALITY CONTROL DATA

Soil

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)**

Test Method	Units		Actual Value	Acceptance Criteria [Range]
pH	pH	B		5.0 - 5.3
EC	dS/m	B		0.27 - 0.32
Cl	mg/kg	B		10 - 35
NO3-N	mg/kg	B		10 - 16
NH4-N	mg/kg	NA		NA
Bicarb.P	mg/kg	B		51 -75
Total Kjeldahl N	%	ASPAC 34	0.110	.100 - .120
Total P	%	ASPAC 34	0.02	.019 - .021
Organic Carbon	%	B		1.82 - 2.3
Ca (Exch. cations)pH7	meq/100g	B		6.96 - 8.04
Mg (Exch. cations)pH7	meq/100g	B		1.88 - 2.22
Na (Exch. cations)pH7	meq/100g	B		.057 - .182
K (Exch. cations)pH7	meq/100g	B		1.209 - 1.411
Exch. Acidity	meq/100g			NA
ECEC	meq/100g	A		NA
CEC	meq/100g	S12		58 - 73
ESP	%	A		NA
Coarse sand	%	B	17.0	17.3 - 22.4
Fine Sand	%	B	22.0	20.0 - 25.7
Silt	%	B	16.0	10.5 - 19.8
Clay	%	B	44.0	37.9 - 48.9
R1		B		0.23 - 0.38

Test Method	Units	Test Soil	Actual Value	Acceptance Criteria [Range]
DTPA-Cu	mg/kg	SB		2.37 - 3.25
DTPA-Zn	mg/kg	SB		3.15 - 3.81
DTPA-Mn	mg/kg	SB		97.7 - 149.0
DTPA-Fe	mg/kg	SB		24.3 - 32.6
0.33 Bar	%	G		32 - 51
15 Bar	%	G		23 - 30
Ca (Exch. cations)pH8.5	meq/100g	S12		27.7 - 35.4
Mg (Exch. cations)pH8.5	meq/100g	S12		22.88 - 24.5
Na (Exch. cations)pH8.5	meq/100g	S12		2.0 - 2.28
K (Exch. cations)pH8.5	meq/100g	S12		1.64 - 2.09

Appendix 5 Lake Vermont Northern Extension Soil and Land Suitability Assessment (AARC 2013)




Lake Vermont Northern Extension

Soil and Land Suitability Assessment

Prepared for:

Bowen Basin Coal Pty Ltd

AustralAsian Resource Consultants

October 2013

Document History and Status

Issue	Rev.	Issued To	Qty	Date	Reviewed	Approved
1	0	BBC	1	29/10/13	GB	GB

Author:	Steve Griffiths
Project Manager:	Gareth Bramston
Name of Client :	Bowen Basin Coal Pty Ltd
Name of Project:	Lake Vermont Northern ML Project
Title of Document:	Soil and Land Suitability Assessment
Document Version:	Draft

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LIST OF ABBREVIATIONS

%	Percentage
AARC	AustralAsian Resource Consultants Pty Ltd
ALC	Agricultural Land Classes
BBC	Bowen Basin Coal Pty Ltd
Ca/Mg	Calcium/Magnesium Ratio
CEC	Cation Exchange Capacity
CHPP	Coal Handling and Preparation Plant
cm	centimetre
Ct	Comet
DEHP	Department of Environment and Heritage Protection
DNRM	Department of Natural Resources and Mines
dS/m	deciSiemens per metre
EC	Electrical Conductivity
ERD	Effective Rooting Depth
ESP	Exchangeable Sodium Percentage
GPS	Global Positioning System
GQAL	Good Quality Agricultural Land
ha	hectares
km	kilometre
km^2	square kilometres
m	metre
m^2	square metre
meq/100g	milliequivalents per 100 grams
mg/kg	milligram per kilogram
MLA	Mining Lease Application

mm	millimetre
NATA	National Association of Testing Authorities
PAWC	Plant Available Water Capacity
PMU	Preliminary Mapping Units
PSA	Particle Size Analysis
R1	Dispersion Ratio
SLSA	Soil and Land Suitability Assessment
SMU	Soil Management Units
Sv	Sodic Variant
USLE	Universal Soil Loss Equation
Wp	Wet Phase
Yv	Yellow Variant

EXECUTIVE SUMMARY

Introduction

AustralAsian Resource Consultants Pty Ltd was commissioned by Bowen Basin Coal Pty Ltd to conduct an environmental assessment of the proposed Lake Vermont Northern Extension Project. As part of this assessment, a “Soil and Land Suitability Assessment” was undertaken to assess the environmental values of the soils, with particular reference to the physical and chemical properties of the soils that will influence erosion potential, stormwater run-off quality, rehabilitation and agricultural productivity of the land.

Method

A free soil survey at a scale of 1:50,000 was undertaken to determine the physical and chemical properties of the soil types on-site. These physical and chemical properties were used to determine the suitability of these soils to pre-mine land use, including cattle grazing and rainfed broadacre cropping. Both Land Suitability and Good Quality Agricultural Land Classes were determined across the site. This information was also used to determine topsoil stripping depths and the erosion susceptibility of the various soils.

Baseline Soil and Land Resource Assessment

Nine soil types were identified within the study area. These soils were delineated based on vegetation type, nature of parent material, soil profile morphology, laboratory analyses and surface soil characteristics. A brief description of each soil type is presented below.

Knockane (Kk)	Dark Brown/Black Dermosols and Vertosols
Mayfair Sodic Variant (MFSv)	Deep to very deep, alkaline, grey or brown sodic texture soil with thick, clay loamy topsoil
Kirkcaldy (Kc)	Light brown Non-texture contrast soils
Knockane Wet Phase (KkWp)	Gradational and texture contrast Black/Brown clays with pale brown subsoil sometimes with mottles at depth
Foxleigh (Fx)	Texture contrast coarse sandy soils over grey medium to medium heavy clay subsoil with orange mottles
Foxleigh (Yellow Variant) (FxYv)	Texture contrast coarse sandy soils over yellow, whole coloured medium clay subsoils
Booroondarra Bn	Black topsoils over red/brown subsoils
Langly (Lg)	Black clays throughout profile
Norwich (Nw)	Deep to very deep, alkaline, grey or brown, cracking clay with moderately to strongly self-mulching surface

The major limitations for various land uses for each soil type include the physical characteristics of the topsoil which inhibits its workability, nutrient deficiencies, low Plant Available Water Capacity and curtailed Effective Plant Rooting Depths caused by subsoil constraints. Subsoil constraints include salinity, sodicity and highly alkaline pH. At the majority of sites analysed subsoil constraints were present below a depth of 50 cm. Soil erodibility was also an issue for soils with texture contrast horizons or sodic subsoils. These soils have high runoff rates due to their relatively low permeability.

Pre-Mine Land Suitability Assessment

The site is currently used for Beef Cattle Grazing mostly of improved pastures of Buffel grass, native pastures and legumes. Results from the land suitability assessment conclude that:

- Booroondarra, Knockane, Kirkcaldy, Knockane (wet phase), Langly, and Norwich Soil Management Units are suitable for beef cattle grazing with moderate limitations (Class 3) which either lower productivity or require more than the management practices of Class 2 to maintain economic production;

- Mayfair (sodic variant), Foxleigh, and Foxleigh (yellow variant) Soil Management Units are considered marginal lands for the grazing of beef cattle having severe limitations to this land use (Class 4) which make it doubtful whether the benefits from the activity will outweigh the inputs/costs required to achieve and maintain production in the long-term.

Plant Available Water Capacity, alkalinity and sodicity are considered to be significant constraining factors on the Project site. No evidence of past cropping within the target survey area was observed. Land within the proposed extension area contains no Strategic Cropping Land Trigger mapping.

The table below shows the land suitability classes for beef cattle grazing and rainfed broadacre cropping for all SMUs represented within the Project site.

Soil Management Unit	Important Limitations	Land Suitability Classes	
		Beef Cattle Grazing	Broadacre Cropping
Knockane	Physical condition, workability	3	5
Mayfair (SV)	PAWC, Physical condition, workability	4	5
Kirkcaldy	PAWC, nutrient deficiencies	3	4
Knockane (WP)	PAWC, nutrient deficiencies	3	5
Foxleigh	PAWC, erosion, nutrient deficiencies	4	5
Foxleigh (YV)	PAWC, erosion, nutrient deficiencies	4	5
Booroondarra	Physical condition, workability	3	4
Langly	PAWC, nutrient deficiencies	3	4
Norwich	Physical condition, workability	3	4

Post–Mine Land Suitability

Post-mine land suitability should aim to return the land back to light cattle grazing of improved or native pastures. Where the final landform does not support such land use, the land should be isolated and returned to a native habitat land use. To return the mined areas back to a fully functioning ecosystem, erosion must be reduced to acceptable levels, organic matter levels achieved, soil biota, plant nutrients and repairing soil physiochemical conditions such as soil structure stability managed. Over time ecosystem processes will return and the ecosystem is expected to become functional again.

Topsoil Stripping Depths

The stripping depths of all soils found within the Project site were assessed in this study. Stripping depths were determined based on the physical and chemical properties of the soil. Stripping depths were calculated by the depth within the soil profile where these properties become limiting factors to plant growth. Maximum recommended stripping depths ranged from 400 mm through to 700 mm. Average maximum topsoil stripping depth was 500 mm. Stripping depths were calculated so that there was a buffer between the freshly stripped soil surface to the depth at which constraints were determined.

Erosion Control and Management

Due to the relatively flat nature of the alluvial plains and rises within the Project site, slope does not significantly affect the erodibility of the in-situ soil. Erosion may naturally occur due to occasional flooding events that can inundate parts of the site. Mine rehabilitation on an ongoing basis may require topsoil reserves to be used on landforms that exceed the natural slope levels prior to disturbance. These sites should be stabilised quickly to avoid loss of topsoil. Prioritisation of stripped material is recommended to achieve the agreed final land use. Contour ripping, seeding and good water management are recommended to achieve a stable post-mine landform.

1.0 INTRODUCTION

AustralAsian Resource Consultants Pty Ltd (AARC) was commissioned by Lake Vermont Resources Pty Ltd (Lake Vermont Resources) to conduct an environmental assessment of the proposed Lake Vermont North mine extension. A "Soil and Land Suitability Assessment" (SLSA) was undertaken to assess the environmental values of the soils, with particular reference to the physical and chemical properties of the materials that will influence erosion potential, stormwater run-off quality, rehabilitation and agricultural productivity of the land.

This SLSA documents the nature and distribution of major soil types on the target area and assesses them for their suitability for land uses such as cattle grazing and rainfed broadacre cropping. An assessment of Good Quality Agricultural Land is also provided. This assessment makes recommendations for management of soil resources and provides a pre-mining benchmark for comparison with future rehabilitation.

1.1 BACKGROUND

The Lake Vermont Coal Mine is a medium sized open-cut coal mine located approximately 15 kilometres (km) north-east of the town of Dysart and about 15 km south-east of Saraji Mine. The mine is located within the Isaac Regional Council about 170 km south-west of Mackay and about 230 km north-west of Rockhampton. The Mine holds Mining Lease (ML) 70331 issued under the *Minerals Resources Act 1989* and a Level 1 Environmental Authority (EA) MIN100736808 issued under the *Environmental Protection Act 1994.* Figure 1 shows the location of Lake Vermont in a regional context.

The Lake Vermont Mine produces coking and PCI coal for the export market to be used in steel production. Mining operations at the Project site commenced in September 2008 with first coal production in January 2009. The current production rate is approximately 8 Million tonnes per annum (Mtpa) of product coal, and is approved for increase to 12 Mtpa.

The proponent has advised AARC of their intent to apply for additional MLs to the north of the current project boundary (Figure 1). Prior to granting of the MLs, an EA amendment application must be made to the Department of Environment and Heritage Protection (EHP). This report is intended to form supporting information to the EA amendment application.

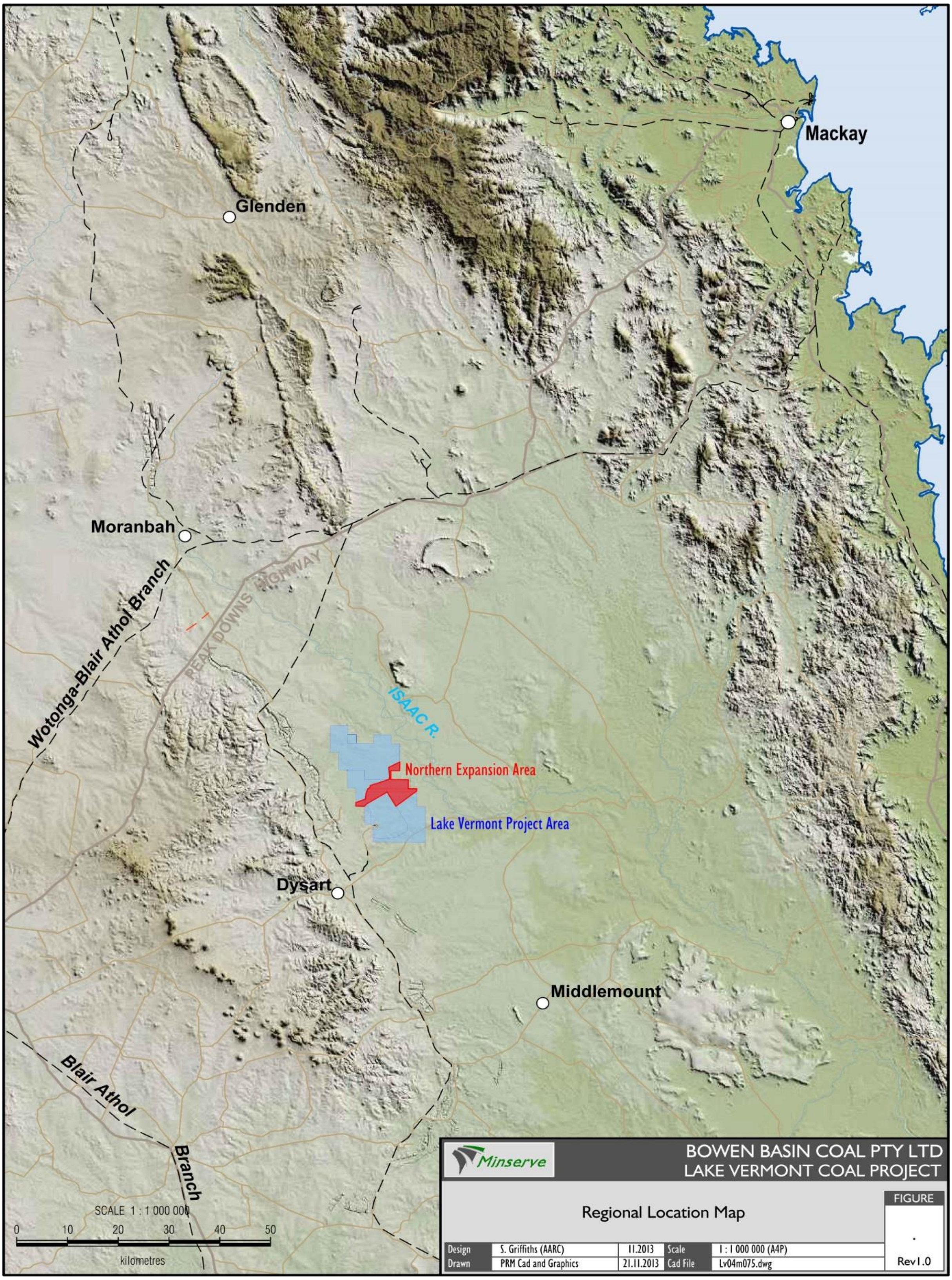

Figure 1 Regional Location of Lake Vermont North Extension

1.2 LOCAL TOPOGRAPHY, LANDFORMS AND REGIONAL GEOLOGY

The Lake Vermont Northern Extension (Project Site) is made up of alluvial plains and gently undulating rises. Lake Vermont in the eastern area of the Project Site occupies a lowland area that provides a water source for both cattle and native fauna. Thousands of years of deposition have resulted in many metres of unconsolidated sediments accumulating due to the erosion of Tertiary and Quaternary rock types in upper catchment areas. These sediments can be categorised into three groups:

- Tertiary/Quaternary sediments derived from basaltic parent material;
- Tertiary/Quaternary sediments derived from sedimentary parent material; and
- Recent Quaternary alluvium derived from younger (fresh) sediments close to creeks and rivers.

The Project Site is dominated by basaltic sediments which are expressed within the soil profile as soft calcareous layers. This calcium and magnesium carbonate is inherited from feldspars present in the original basaltic parent material.

Soils developed from deposited sedimentary alluvial material make up smaller areas within the Project site. These soils can be identified by a lack of these "secondary" carbonates and by the presence of coarser sandy material which is often present in the topsoil.

Areas of the Project Site are characterised by soils made up of recent, Quaternary alluvial material which flanks Phillips Creek and minor drainage lines within the Project site. These soils are often developed from a mixture of basaltic and sedimentary alluvial material.

The Project site is a landscape of deposited alluvial sediments consisting of channels, alluvial plains, floodplains, scroll plains, back plains, back swamps, sand ridges and occasional terraces. The extent and distribution of soils within this landscape is largely controlled by landscape position and the age and nature of the sediments from which the soils are derived. Soil distribution along alluvial plains is dependent on a range of factors which include:

- Stream size and catchment position
- Landform position within the alluvial plain
- Flooding regime – frequency, severity and duration;
- Depositional environment
- Age of deposits
- Sediment source; and
- Nature of sediment and provenance lithology

Soils flanking Phillips Creek are subject to occasional flooding indicating that they are still actively aggrading and eroding. Figure 2 shows the local surface geology within the Project site.

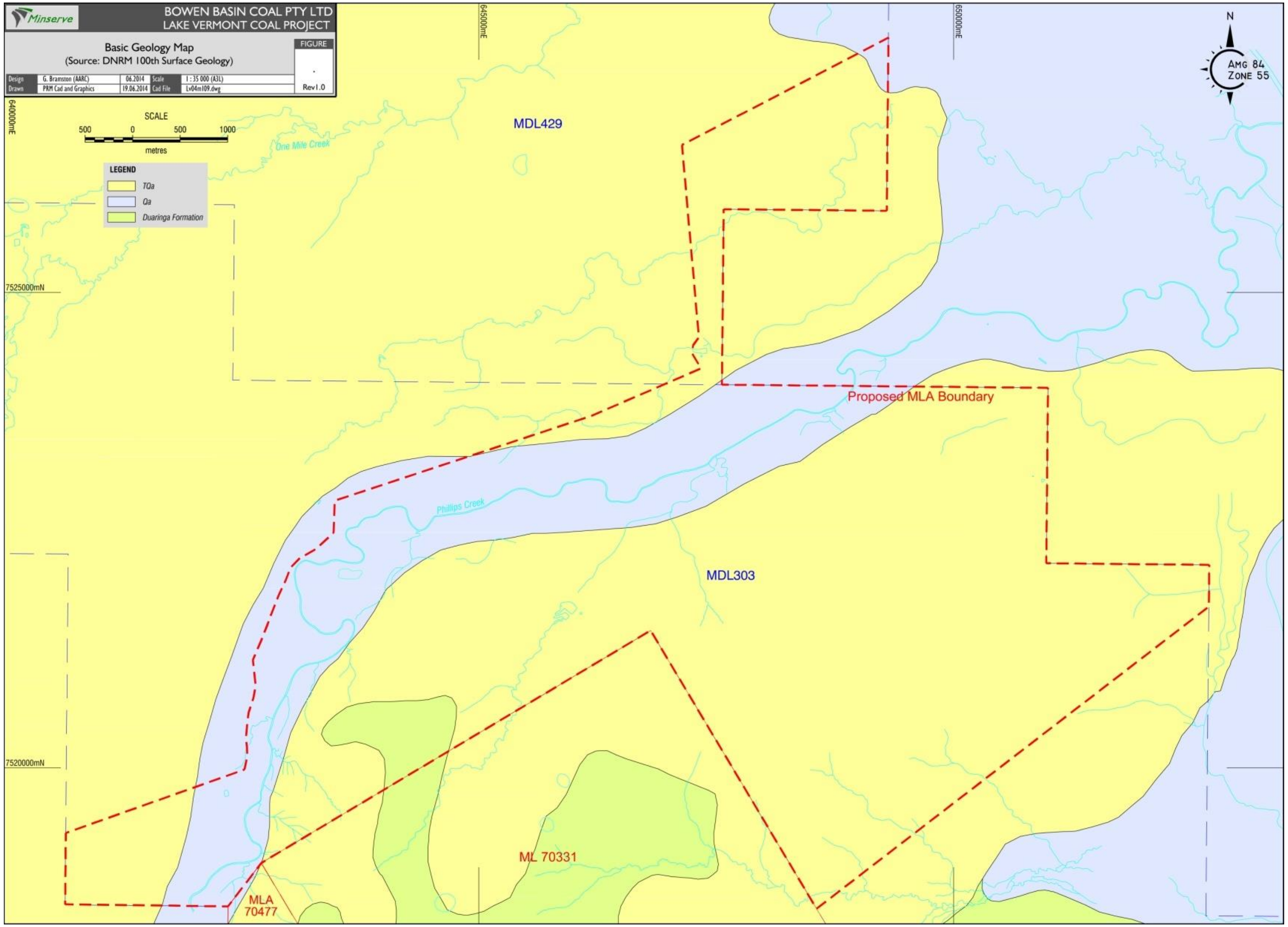

Figure 2 Map of Project site showing surface geology

2.0 METHODOLOGY

2.1 DESKTOP ASSESSMENT

A Desktop Assessment was conducted prior to the field work phase. The following publications were consulted to develop Preliminary Mapping Units (PMU) which would later be assessed and refined in the field:

- The Digital Atlas of Australian Soils (Bureau of Rural Science, 1991), which provides 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 broader scale to accurately assess the distribution of soil types and management units within the Lake Vermont North MLA;

- The CSIRO publication "*Australian Soils and Landscapes*" (McKenzie et. al. 2004). This document provided an illustrated compendium of soils Australia wide including examples of soils that would be present in the region of the project;

- Land System Mapping at a scale of approximately 1:500,000 within the CSIRO Report, *Lands of the Isaac-Comet Area* (Story et al 1967). This report delineates three Land Systems that express themselves within the Lake Vermont North Project site:

    - Connors - Alluvial plains with Box on texture contrast soils throughout the area;

    - Comet – Alluvial plains with Brigalow and cracking clay soils often flooded along major streams.

    - Funnel – Flood plains with Coolibah, along major streams and in basalt areas; cracking clay soils.

- Burgess (2003), 1:100,000 soils mapping from the Windeyers Hill area, surveyed by the Department of Natural Resources and Mines. The survey area is located seven kilometres to the south-east of the Project site. This survey identified 56 soil profile classes, 10 soil phases and 3 soil variants based on geology, landscape position, native vegetation and soil morphology. This classification system formed the basis for the soil classification and nomenclature used in this report;

- McClurg (2012) Soils, pre-mining Land Suitability and stripping recommendations for the Lake Vermont Coal mining lease, Central Queensland. This report provides soil characterisation and land suitability assessment for the existing Lake Vermont Mining Lease and proposed Western Extension area. The Burgess 2003 report also formed the basis for nomenclature and classification of the McClurg 2012 report.

- Emmerton (2004) mapped the soil and land suitability for rainfed cropping and grazing over the existing Mining Lease area to the south;

- Existing geological survey maps of the area Olgers (1969) were reviewed to identify relevant geology changes that influence soil characteristics.

- Contour data, produced at 2m intervals captured from an aerial survey (provided by Minserve 2013), was used to refine mapping boundaries, particularly in areas where soil types were a function of relief and slope gradient;

- Satellite imagery assisted in delineating features within the landscape, particularly vegetation changes which often were consistent with changes in soil types. Satellite imagery was also used as a base map for preliminary mapping and for navigation whilst in the field; and

- Aerial photo interpretation was used to delineate areas of changing relief and provide raw preliminary mapping units for further interpretation out in the field.

2.2 SURVEY DESIGN AND SCALE

The soil survey design was based on a free-survey technique. It is suited to detailed-scale surveys and has been the method used for mapping in most developed countries (McKenzie et al 2008). A free survey technique is one that relies on the surveyor appreciating landscape processes and soil forming factors so that the surveyor can develop a conceptual model and predict where various soil types are likely to exist within the landscape. Soil sample sites are located to best represent all soil types.

The survey was undertaken at a scale of 1:50,000, which is considered to be a medium, semi-detailed scale survey (Mckenzie et al 2008) suitable for moderately intensive uses at farm level, semi-detailed project planning, district level planning.

2.3 FIELD INVESTIGATION

Field sampling across the Project Site was undertaken from the 17/06/2013 to the 28/06/2013 by a qualified senior soil scientist from AARC.

Site locations were identified based on their ability to represent the dominant landform and soil properties within the Project Area. Secondary visual assessments were conducted continuously across the study area while traversing the landscape. These assessments were useful to confirm the presence of major soil types and to confirm boundaries between different soils.

Sampling strategies and survey plans were developed in accordance with the *"Guidelines for Surveying Soil and Land Resources"*, McKenzie et al (2008). Primary sampling was conducted at 50 locations within the boundary of the Study Area. The location of each site was recorded using a Global Positioning System (GPS) with an accuracy of +/- 10m. Using a trailer mounted soil core sampler, holes were excavated to a depth of up to 160 cm. Soil morphological characteristics were described using the "*Australian Soil and Land Survey Field Handbook*", the National Committee on Soil and Terrain (2009).

At each site soil morphological characteristics were described, including:

- Horizons;

- Texture;

- Colour;

- Structure;

- Presence/absence of coarse fragments;

- Segregations;
- Consistence; and
- pH.

In addition to this site information was collected including:

- Eastings and Northings;
- Elevation;
- Relief;
- Landform element and pattern; and
- Slope.

Soil samples were collected at a maximum of six depths throughout each profile; typically 0-10, 20-30, 50-60, 80-90, 110-120 and 140-150 cm. Care was taken to ensure clean samples were taken from each of the depth increments in order to avoid cross-contamination. A sub-set of 12 sites were sampled from a total of 50 whilst in the field. At each of these 12 sites, samples were taken to the maximum possible depth which was determined by the depth to which the push tube could be rammed into the soil. In some cases three samples were selected, whilst at others a full complement of six samples was attained. This resulted in a total of 58 samples selected for laboratory analysis. At the completion of the field survey, these bagged soil samples were packaged for transportation to a National Association of Testing Authorities (NATA) registered laboratory for chemical analysis.

Preliminary Mapping Units (PMU) devised in the Desktop Assessment and modified during the field assessment phase are further characterised using the soil chemical data from laboratory tested samples. This technique 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 (herein referred to as the Technical Guidelines) (DME 1995).

Figure 3 shows the location of primary sites within the Project Area.

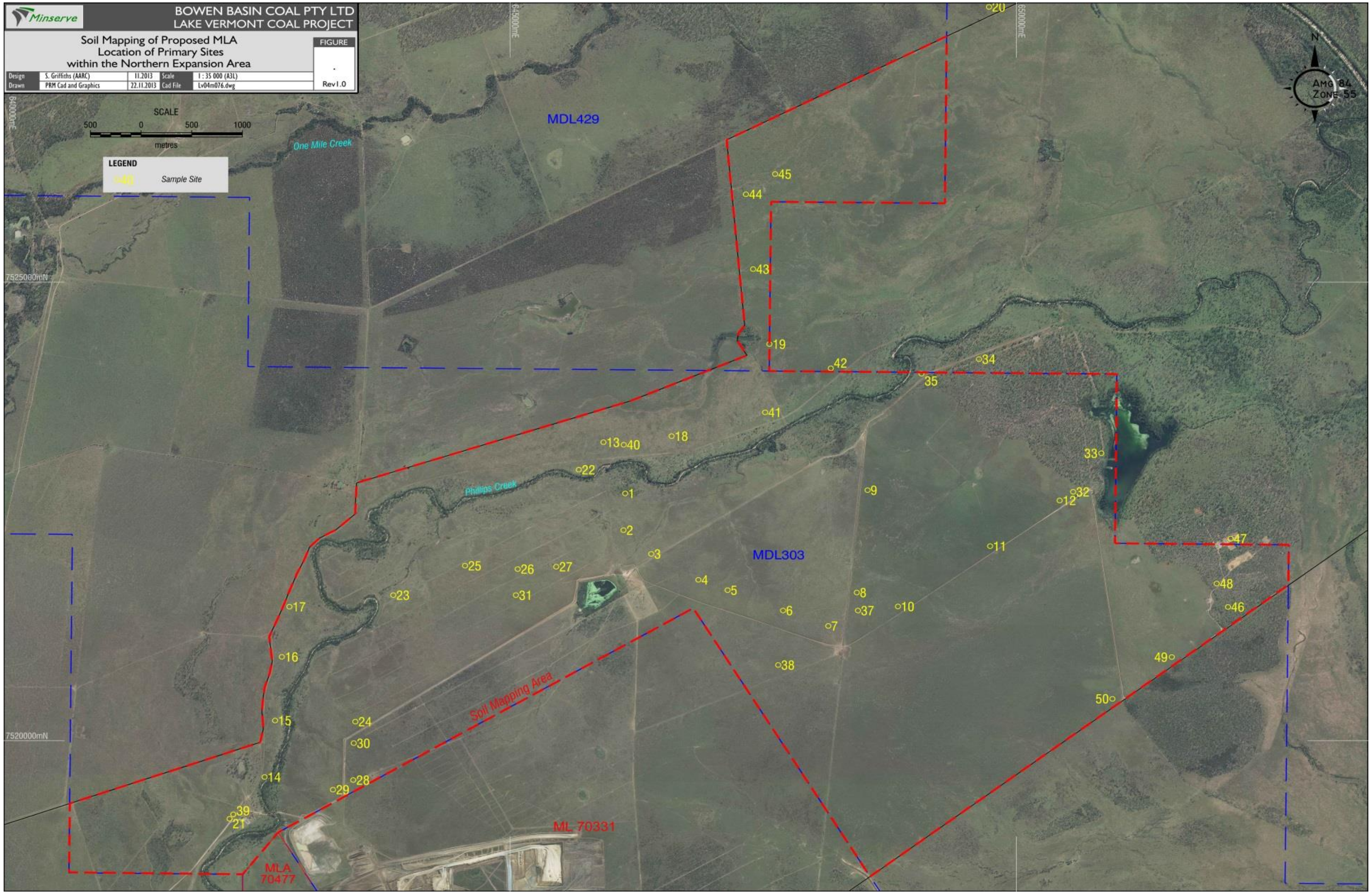

Figure 3 Location of Primary sampling sites within the Lake Vermont North Extension

2.4 LABORATORY ANALYSIS

Soil samples were laboratory tested for the following parameters:

- pH (Water);
- Major Elements (Nitrate Nitrogen, available Phosphorus – Colwell extraction);
- Secondary Elements (Calcium, Magnesium, Sodium), Sulphur;
- Trace Elements (Boron, Copper, Iron, Manganese, Zinc);
- Organic Carbon;
- Electrical Conductivity (EC), sodium and chloride;
- Exchangeable Cations (Aluminium, Calcium, Magnesium, Potassium, Sodium);
- Soil analysis also included calculation of the following parameters;
- Cation Exchange Capacity (CEC);
- PSA (Particle Size Analysis); and
- R1 (Dispersion Index).

Soil chemical data analysed described soil attributes such as soil fertility, potential subsoil constraints such as salinity, sodicity and pH, and soil structural stability including Exchangeable Sodium Percentage (ESP), Ca/Mg ratio, and PSA.

2.5 CHARACTERISATION OF SOIL MANAGEMENT UNITS

Final characterisation of Soil Management Units (SMU) was based on the physical and chemical attributes of the soils, as recorded in the field survey and determined from the representative laboratory results.

The SMUs are differentiated based on attribute/s that have significance when comparing them for suitability for different land uses. These “attributes” can be features of the soil that are limiting to plant growth. Such features are also referred to as limitations within this report.

2.6 ASSESSMENT OF EROSION POTENTIAL OF EACH SOIL MANAGEMENT UNIT

Assessment of erosion potential can be determined by the attributes of a soil that make it vulnerable to slaking and dispersion. Overall soil loss can be calculated using the Universal Soil Loss Equation (USLE). The USLE was developed from erosion plot and rainfall simulator experiments. The USLE is composed of six factors to predict the long-term average annual soil loss (A). The equation includes the rainfall erosivity factor (R), the soil erodibility factor (K), the topographic factors (L and S) and the cropping management factors (C and P). The equation takes the simple product form: A=RKLSCP.

K (soil erodibility) can be ranked based on soil type. Soil erodibility for water erosion reflects the susceptibility of the soil to detachment and transport by water. It is influenced by soil texture and the strength of bonds between soil particles (aggregate stability). Soils with low infiltration rates accelerate erosion because of high runoff rates. Typical soils with these properties include:

- Soils high in fine silt and sand and having low organic matter levels;
- Self-mulching clays; and
- Dispersible clay soils (usually sodic).

Depending on what sort of landform the soil is occupying, slope length (L) and slope gradient (S) will be a factor in each SMU. Soils that disperse upon wetting are very prone to erosion as are soils with dispersive subsoils. High levels of fine sand and silt and low organic matter levels will predispose a soil to erosion as will high levels of sodium and magnesium relative to calcium.

Morphological and chemical attributes described for each SMU will be assessed against the aforementioned criteria and be given a rating of between 1 and 5 (DME 1995).

2.7 SOIL AND LAND SUITABILITY 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 (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).

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 (DME 1995) as:

Class 1 Suitable land with negligible limitations which is well suited to a proposed use.

Class 2 Suitable land with minor limitations which is suited to a proposed use but which may require minor changes in management to sustain use.

Class 3 Suitable land with moderate limitations which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use.

Class 4 Marginal land with severe 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 extreme limitations which preclude its sustainable use for the proposed purpose

Land is considered less suitable as the severity of limitations for a land use increase. Increasing limitations may reflect either:

- Reduced potential for production; and/or
- Increased inputs to achieve an acceptable level of production; and/or

- Increased inputs required to prevent land degradation.

Suitability classes 1 to 3 are considered suitable for a specified land use because the benefits from using the land for that use outweigh the inputs required to initiate and maintain production. Typically, the benefits from using Class 4 land approximate the inputs required for production and its long-term suitability for the specified land use is doubtful, due either to increasing costs and/or increasing land degradation.

Class 4 is also used in situations where reducing the effect of a particular limitation may suggest production is possible, but additional studies are needed to determine the feasibility of such actions (e.g. levelling of melonholes may assist cultivation and wetness problems but subsoil salinity levels may require investigation).

In contrast, Class 5 land has limitations that in aggregate are so severe that the benefits are unlikely to ever justify the inputs required to initiate and maintain production. It would require a major change in economics, technology or management expertise before Class 5 land could be considered suitable for a particular land use. Many Class 5 lands generally have physical characteristics that totally preclude any form of development (e.g. mountains or eroded areas).

2.7.1 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; and
- Flooding.

Water Availability

Plant Available Water Capacity (PAWC) cut-off levels for each of the land suitability classes are detailed in Table 1. Plant Available Water Capacity for the SMUs identified on the Project Site have been estimated in reference to Table 2.3 of the Technical Guidelines (DME 1995) and are presented in Table 1.

Table 1 Limitation Levels for Cattle Grazing – Effects of PAWC

Limitation Level	Class 1	Class 2	Class 3	Class 4	Class 5
Moisture	PAWC>125mm	PAWC 100-125mm	PAWC 75-100mm	PAWC 50-75mm	PAWC <50mm

The Effective Rooting Depth (ERD) was calculated for each soil in the survey by:

- Depth to hardpan or weathered or hard rock;
- Depth to high salinity (EC >0.8 dS/m or Cl > 800 mg/kg);
- Depth to high sodicity or ESP (Exch.Na >20% of CEC;
- Depth to magnesium dominant clays (Ca/Mg ratio <0.5 if CEC > 5 meq/100g and/or Mg+Na >80% of CEC); and
- Where there is no restriction, the maximum rooting depth considered in this survey for pasture is 600 mm, based on the assumption that Buffel grass is the main pasture species supporting beef cattle grazing. Rainfed broadacre crops have been allocated a rooting depth of 1,000 mm as most crops can exploit soil water to this depth if soil properties allow.

The final land suitability classification (Class 1-5) arrived at for each soil type is based on the most restrictive limitation subclass of all the potential limiting factors above.

2.7.2 Rainfed Broadacre Cropping

The limitations that were used to assess land 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.

Water Availability

PAWC for the soil types of the Project Site have been estimated in reference to Table 2.3 of the *Technical Guidelines* (DME 1995) and are presented in Table 2. PAWC cut-off levels for rainfed broadacre cropping are different to grazing thresholds based on the increased water needs of a crop compared to the water use needs of pasture production.

Table 2 Limitation Levels for Rainfed Broadacre Cropping – Effects of PAWC

Limitation Level	Class 1	Class 2	Class 3	Class 4	Class 5
Moisture (m)	PAWC>150mm	PAWC 125-150mm	PAWC 100-125	PAWC 75-100	PAWC <75mm

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

2.8 GQAL ASSESSMENT OF SOIL MANAGEMENT UNITS

State Planning Policy 1/92 – Development and Conservation of Agricultural Land, Gazetted 18th December, 1992 seeks to protect Good Quality Agricultural Land (GQAL) from development. *Planning Guidelines - The Identification of Good Quality Agricultural Land, (*January 1993) provides the definition of GQAL in terms of four Agricultural Land Classes (ALC). A brief Definition of each of the four Agricultural Land Classes as defined in the Planning Guidelines (1993) is:

- Class A – Crop Land – Land that is suitable for current and potential crops with limitations to production which range from none to moderate levels;
- Class B – Limited Crop Land – Land that is marginal for current and potential crops due to severe limitations and suitable for pastures. Engineering and / or agronomic improvements may be required before the land is considered suitable for cropping;
- Class C – Pasture Land – Land that is suitable only for native or improved pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment; and
- Class D – Non-Agricultural Land – Land not suitable for agricultural uses due to extreme limitations. This land may be undisturbed land with significant habitat, conservation and / or

catchment values or land may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

The classification of “good quality agricultural land” (GQAL) provides an indication of the quality of the land resource to maintain a sustainable level of productivity for a given land use (DHLGP 1993).

Within the Isaac Regional Council Area, lands classified as Class A, and Class C1 are considered to be ‘good quality agricultural land’. Generally crop land (both Class A and Class B) is designated as GQAL. However, in local authorities where the pastoral industry is the dominant form of land use and income generation, Class C1 is often designated as GQAL as well.

2.9 TOPSOIL STRIPPING DEPTHS

Once SMUs were developed from the soil physical and chemical information derived from the desktop, field and laboratory information, topsoil stripping depths were calculated.

The stripping depths were based around the availability and depth of relatively inert topsoil material and in some locations unconstrained upper subsoil material. Favourable material will have superior physical and chemical characteristics relative to potentially constrained subsoil material. Suitable stripping material will possess the following soil attributes:

- Favourable levels of organic matter;
- Low to moderate levels of fine sand and silt;
- Low sodium and salt levels;
- Moderate pH;
- Acceptable soil fertility; and
- Some biological component.

Unsuitable material or material with constraints may only have a limited usefulness with regard to rehabilitation of post mine landforms. Landforms with steep gradients and potentially dispersible soils will quickly be compromised due to erosive summer rainfall events. Stripping depths should be calculated in such a way as to maintain a buffer between stripped material and the poorer quality subsoil material.

Each SMU within the Project Area has been assessed for its potential to be stripped prior to disturbance. The results of this assessment can be found in Section 5. Volumes of viable growth media for each SMU can be calculated using the known area of each SMU and depth to which it can be stripped.

2.10 EROSION POTENTIAL

The erosion potential of each SMU is based on its physical and chemical characteristics. Different soil types typically have varying degrees of erosion susceptibility.

The erodibility of soil is determined by the rate of infiltration at its surface, permeability of the soil profile and coherence of the soil particles. Coherence and permeability are related to structure, texture and chemical properties. These properties often vary between the surface layer and the subsoil. Thus, the overall potential of a soil profile to erode is a combination of the inherent erodibility for its surface layer and the erodibility of any underlying subsoil.

Even coherent and structured soils can be highly erodible due to clay dispersion. Dispersion of clay particles can damage soil structure by destroying large, flocculated aggregates and filling the voids between these aggregates with much smaller dispersed material.

A direct measure of erodibility is difficult to obtain and this attribute is usually estimated through identification of soil features such as texture, surface condition, consistence, colour and structure. Laboratory analyses are also used to determine surrogate chemical and physical properties for dispersion.

SMU attributes that will impact on soil erodibility include physio-chemical properties such as:

- ESP (Exchangeable Sodium Percentage);
- Ca/Mg ratio;
- Sodium and magnesium levels compared to calcium; and
- PSA.

These factors will be discussed in detail with reference to each SMU in Section 3.0.

3.0 RESULTS AND DISCUSSION

3.1 CHARACTERISATION OF SOIL MANAGEMENT UNITS

Soils derived from basaltic parent material tend to occupy level clay plains and low lying back plains and have variable surface soil characteristics. Within the Lake Vermont North site gently undulating rises on back plains and terraces also possess large areas of these basaltic alluvial soils. Some soils exhibit cracking or hardsetting surfaces whilst others have self-mulching surfaces of varying degrees with or without surface cracks. All of these soils possess subsoils that are high in clay with gradational or texture contrast soil profiles. These soils are typically high in clay and often exhibit horizons full of secondary carbonates derived from the original basalt parent material. Due to the nature of the basaltic parent material, these soils are often higher in plant available nutrients. Clay formed from the basalt possesses shrink/swell properties that enable water to readily drain through the soil profile. These clays have large surface areas with correspondingly high cation exchange capacities (CEC) which allow these soils to readily store plant available moisture and relatively large quantities of cations and anions.

Soils formed on more recent Quaternary alluvium are much more uniform in their variability. These soils typically possess darker black and brown surface horizons tending to lighter browns and reds in the subsoil. These soils have developed on unconsolidated parent material including undifferentiated sands, silts and gravels of Quaternary age. Parent material has been deposited from Phillips Creek with rudimentary soils formed on levees close to the margins of the creek. As distance increases away from the Creek the soils tend to increase in clay content and become more reactive due to the nature of this clay material. Soils developed on the recent alluvium follow the creek line as it traverses the mining lease. These soils are often saline and sodic at depth.

Soils formed on alluvial material of sedimentary origin (TQa) are restricted to the eastern portion of the Project site. These areas are made up of terrestrial wetlands and Lake Vermont. Texture contrast soils are common with coarse sandy A horizons present over heavier clay subsoils. These subsoils often possess orange and red mottles within a grey clay matrix. Surface horizons are often bleached indicating that permeability and drainage is restricted. Another feature of these landscapes is the absence of brigalow. Vegetation predominantly consists of Poplar Gum and Bloodwood species with buffel grass conspicuous by its absence. These soils often have low levels of essential plant nutrients which is a feature inherited from the sedimentary parent material.

The distribution of the soil types within the Project site are shown in Figure 4.

The soil types delineated from the baseline soil survey include soils developed on the three aforementioned geological units.

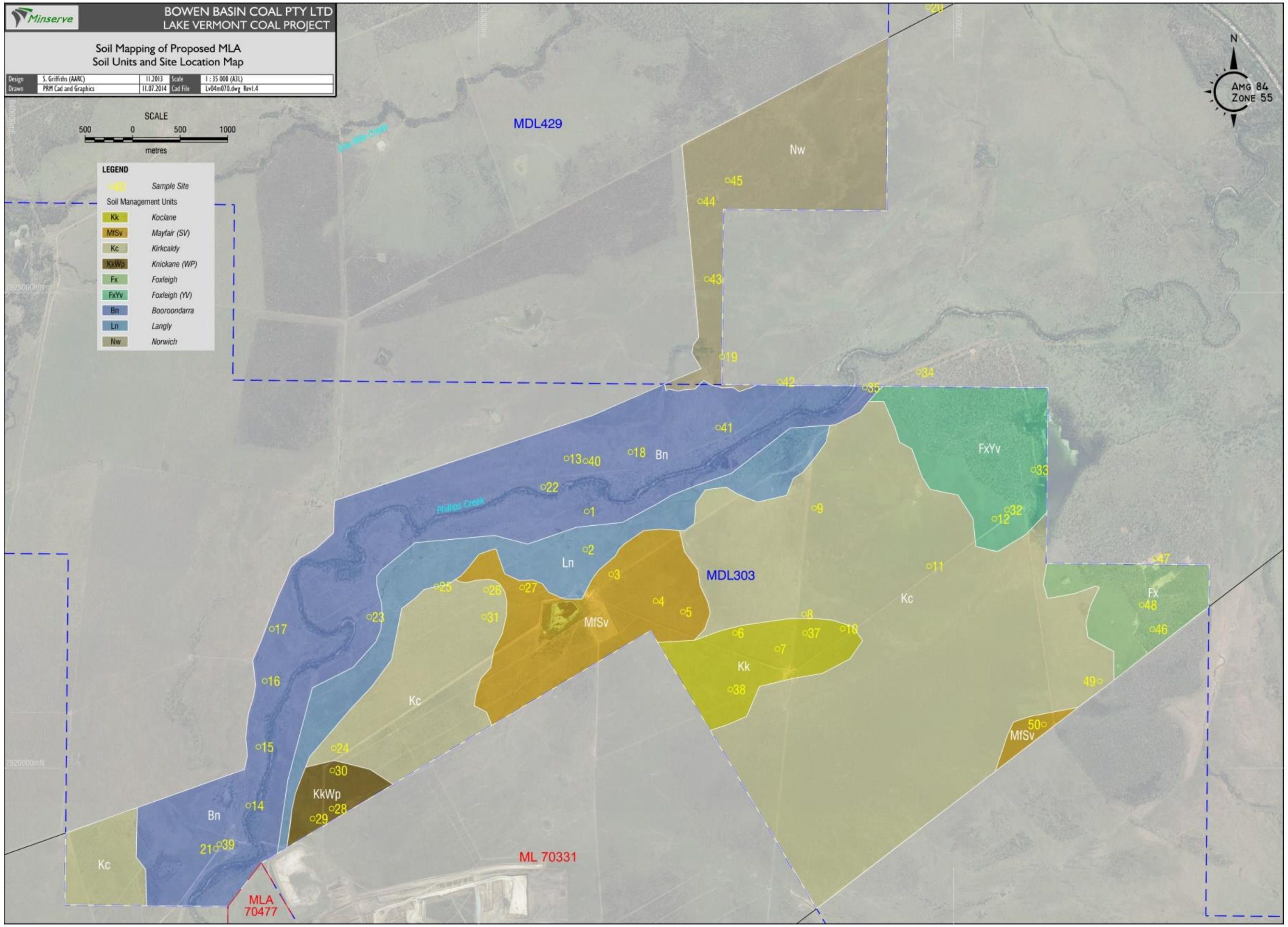

Figure 4 Soil Management Units for the Lake Vermont Northern Extension

Table 3 List of Soil Types found on Basaltic Alluvium

Basaltic SMUs	
Description	**SMU**
Dark Brown/Black Dermosols and Vertosols	Knockane (Kk)
Deep to very deep, alkaline, grey or brown sodic texture soil with thick, clay loamy topsoil	Mayfair Sodic Variant (MFSv)
Light brown Non-texture contrast soils	Kirkcaldy (Kc)
Gradational and texture contrast Black/Brown clays with pale brown subsoil sometimes with mottles at depth	Knockane Wet Phase (KkWp)
Deep to very deep, alkaline grey or brown cracking clay with moderately to strongly self-mulching surface	Norwich (Nw)

Table 4 List of Soil Types found on Sedimentary Alluvium

Sedimentary SMUs	
Description	**SMU**
Texture contrast coarse sandy soils over grey medium to medium heavy clay subsoil with orange mottles	Foxleigh (Fx)
Texture contrast coarse sandy soils over yellow, whole coloured medium clay subsoils	Foxleigh (Yellow Variant) (FxYv)

Table 5 List of Soil Types found on Recent Alluvium

Recent SMUs	
Description	**SMU**
Black topsoils over red/brown subsoils	Booroondarra Bn
Black clays throughout profile	Langly (Lg)

Knockane (Kk) Soil Management Unit

Distinguishing features: Moderately to very deep, alkaline, grey or brown cracking clay with hardsetting surface.

Australian Soil Classification: Grey/Brown Vertosols

Topography and Landform Attributes: Gently undulating rises and older alluvial terraces.

Geology Unit: Tertiary Basaltic Alluvium (Tqab)

Native Vegetation: Completely cleared; with improved pastures of Buffel grass.

Physical Attributes: The Knockane SMU is made up of deep to very deep black, light to light medium clay surface with moderately to strongly blocky structure through to grey or brown subsoils consisting of light to medium clays with lenticular structure. The soil profile is highly calcareous with soft carbonates found throughout the profile. These soils are slowly permeable and moderately well drained. These soils are hardsetting and have a weak patchy self-mulch.

Chemistry: Knockane soils exhibit subsoil constraints below 50 cm. Electrical conductivity (EC) and Chloride levels (762 ppm) as well as Exchangeable Sodium Percentages (18%) become limiting factors for plant growth below this depth. Extremely acidic pH may affect deep rooting plants below 110 cm. Ca/Mg ratios are below parity at depth with subsoil becoming magnesic at depth. High levels of sodium and magnesium in subsoil material may predispose these soils to slaking and dispersion. These soils have relatively high levels of plant available nutrients with the exception of Nitrate Nitrogen and the trace element Boron which is at very low levels.

Photo Plate 1 Knockane Soil Profile

Mayfair Sodic Variant (MfSv) Soil Management Unit

Distinguishing features: Deep to very deep, alkaline, grey or brown sodic texture contrast soil with thick clay loamy topsoil.

Australian Soil Classification: Brown/Grey Sodosols

Topography and Landform Attributes: Gently undulating low rises on older alluvial material.

Geology Unit: Tertiary Basaltic Alluvium (Tqab)

Native Vegetation: Completely cleared; with improved pastures of Buffel grass.

Physical Attributes: The Mayfair Sodic Variant SMU is made up of alluvium derived from basaltic landscapes. The Mayfair soil is found on gently undulating rises and occasionally on crests similar to the Kirkcaldy soil type. As such it is high in clay and has a correspondingly high CEC. This soil is differentiated from the Kirkcaldy by the presence of a texture contrast between the A and B horizons. This coarser topsoil layer may reflect poor permeability of the subsoil with water having a tendency to move laterally within the landscape leaching clay material out of the topsoil. Another explanation could be that a relatively large flood within recent geological history, when watercourses were much more active, topsoil material was aggraded due to alluvial processes. These soils are light brown/yellow throughout their profiles and have vertic properties including slickensides and lenticular structure. Surfaces are typically hardsetting but appear to be relatively permeable with good drainage associated with their landscape position. These soils are moderately to highly alkaline throughout their profiles. Bands of soft calcareous segregations are notable in subsoil horizons.

Chemistry: The sodic Mayfair soils exhibit subsoil constraints below 50 cm like the Kirkcaldy SMU. Electrical conductivity (EC) and Chloride levels as well as Exchangeable Sodium Percentages become limiting factors for plant growth below this depth. Extremely alkaline pH is likely to have a caustic effect on plant roots as well as restricting nutrient availability. Ca/Mg ratios are below parity at 50 cm depth with subsoil becoming magnesic below this depth. High levels of sodium and magnesium in subsoil material may predispose these soils to slaking and dispersion. These soils have relatively high levels of plant available nutrients with the exception of Nitrate Nitrogen, Potassium and Boron.

Photo Plate 2 Mayfair (sodic variant) Soil Profile

Kirkcaldy (Kc) Soil Management Unit

Distinguishing features: Moderately deep to very deep, brown cracking clay with hardsetting surface.

Australian Soil Classification: Brown/Yellow Dermosols/Vertosols

Topography and Landform Attributes: Gently undulating rises and older alluvial terraces.

Geology Unit: Tertiary Basaltic Alluvium (Tqab)

Native Vegetation: Completely cleared; with improved pastures of Buffel grass.

Physical Attributes:

The Kirkcaldy SMU is made up of moderately deep to very deep brown cracking clays with hardsetting surfaces. These soils are found on the side slopes of gently undulating rises and occasionally on crests on these same rises. These soils have high clay contents with correspondingly high CECs. These soils possess vertic properties including surface cracking, lenticular structure and slickensides. Permeability and drainage is high due to their relatively permeable profiles and high landscape position. Surface cracks allows for the movement of water throughout the profile below the soil surface. These soils are highly alkaline and often possess bands of calcium and magnesium carbonates in subsoil layers.

Chemistry: Kirkcaldy soils exhibit subsoil constraints below 50 cm. Electrical conductivity (EC) and Chloride levels (862 ppm) as well as Exchangeable Sodium Percentages (21%) become limiting factors for plant growth below this depth. Extremely alkaline pH (> 9.0) is likely to have a caustic effect on plant roots as well as restricting nutrient availability. Ca/Mg ratios are below parity at 50 cm depth with subsoil becoming magnesic below this depth. High levels of sodium and magnesium in subsoil material may predispose these soils to slaking and dispersion. These soils have relatively high levels of plant available nutrients with the exception of Nitrate Nitrogen, Potassium and Boron.

Photo Plate 3 Kirkcardy Soil Profile

Knockane Wet Phase (KkWp) Soil Management Unit

Distinguishing features: Moderately to very deep, alkaline, mottled brown cracking clay with hardsetting surface.

Australian Soil Classification: Grey Vertosols

Topography and Landform Attributes: Lower lying areas on alluvial plains and drainage lines flowing into Phillips Creek.

Geology Unit: Tertiary Basaltic Alluvium (TQab)

Native Vegetation: Completely cleared; with improved pastures of Buffel grass.

Physical Attributes: The Knockane Wet Phase SMU is made up of moderately deep to very deep brown, cracking clays with hardsetting surfaces. These soils are found on lower lying areas on alluvial plains and drainage depressions. These soils often have bands of soft calcareous segregations throughout their subsoils indicating that they are highly alkaline. Pale brown to yellow subsoil merges into a grey horizon containing orange and red mottles indicating permeability and drainage issues for those soils occupying lower landscape positions.

Chemistry: Detailed analytical data was not collected for the Wet Phase variant. These soils are likely to possess similar soil chemistries to those exhibited by the Knockane SMU, which exhibit subsoil constraints below 50 cm. Electrical conductivity (EC) and Chloride levels (762 ppm) as well as Exchangeable Sodium Percentages (18%) become limiting factors for plant growth below this depth. Ca/Mg ratios are below parity at depth with subsoil becoming magnesic at depth. High levels of sodium and magnesium in subsoil material may predispose these soils to slaking and dispersion. Knockane soils have relatively high levels of plant available nutrients with the exception of Nitrate Nitrogen and the trace element Boron which is at very low levels.

Photo Plate 4 Knockane Wet Phase Soil Profile

Foxleigh (Fx) Soil Management Unit

Distinguishing features: Texture contrast coarse sandy soils over grey, medium to medium heavy clay subsoils, with prominent orange mottles;

Australian Soil Classification: Grey Chromosols/Sodosols;

Topography and Landform Attributes: Lower lying areas on alluvial plains, swamps and wetlands developed on coarse grained sedimentary alluvium.

Geology Unit: Tertiary Sedimentary Alluvium (TQa)

Native Vegetation: Poplar Gum, Bloodwoods, native pastures.

Physical Attributes: The Foxleigh SMUs are texture contrast soils with coarse conspicuously bleached sandy surface horizons lying above grey, medium to medium heavy clay subsoils with orange mottling. These soils are rigid and are non-reactive due to the presence of kaolinite clay in the subsoil. Profiles are imperfectly to moderately well drained with strongly to extreme sodic subsoils and moderate to strong, coarse, columnar structure. Subsoil salinities are, however, low throughout.

Chemistry: The Foxleigh soils are deficient in most plant nutrients, especially N, P, K and some trace elements including Boron, Copper and Zinc. These soils are highly sodic below 60 cm but only have low levels of salinity present. These soils have low levels of calcium and magnesium relative to sodium. However, Ca/Mg ratios are greater than one indicating that the exchange is dominated by calcium. Below 80 cm magnesium becomes the dominant cation. High levels of sodium and magnesium relative to calcium is known to lead to soil structural degradation, causing soil peds to degrade when wet up with water. Low levels of sodium and chloride are a feature of these soils. These soils also have low CEC giving them a low buffering capacity against any chemical change that might be instigated by soil disturbance by mine infrastructure.

Photo Plate 5 Foxleigh Soil Profile

Foxleigh (Fx) (Yellow Variant) Soil Management Unit

Distinguishing features: Texture contrast coarse sandy soils over whole coloured yellow, medium to medium heavy clay subsoils.

Australian Soil Classification: Yellow Chromosols/Sodosols;

Topography and Landform Attributes: Gently undulating rises on alluvial plains, swamps and wetlands developed on coarse grained sedimentary alluvium.

Geology Unit: Tertiary Sedimentary Alluvium (TQa)

Native Vegetation: Poplar Gum, Bloodwoods, native pastures.

Physical Attributes: The Foxleigh (YV) SMUs are texture contrast soils with coarse conspicuously bleached sandy surface horizons lying above whole coloured, yellow, medium to medium heavy clay subsoils. These soils are rigid and are non-reactive due to the presence of kaolinite clay in the subsoil. Profiles are moderately well drained with strongly sodic subsoils and moderate to strong, coarse, columnar structure. Subsoil salinities are, however, low throughout. These soils possess superior permeability and drainage to the mottled Foxleigh SMU.

Chemistry: The Foxleigh soils are deficient in most plant nutrients, especially N, P, K and some trace elements including Boron, Copper and Zinc. These soils are highly sodic below 60 cm but only have low levels of salinity present. These soils have low levels of calcium and magnesium relative to sodium. However, Ca/Mg ratios are greater than one indicating that the exchange is dominated by calcium. Below 80 cm magnesium becomes the dominant cation. High levels of sodium and magnesium relative to calcium is known to lead to soil structural degradation, causing soil peds to degrade when wet up with water. Low levels of sodium and chloride are a feature of these soils. These soils also have low CEC giving them a low buffering capacity against any chemical change that might be instigated by soil disturbance by mine infrastructure.

Photo Plate 6 Foxleigh (Yellow variant) Soil Profile

Booroondarra Soil Management Unit

Distinguishing features: Loamy surfaced, sporadically bleached, red non-sodic texture contrast or gradational soils on level or gently undulating alluvial plains and occasional terraces adjacent to larger stream channels.

Australian Soil Classification: Red, Brown Dermosols;

Topography and Landform Attributes: Alluvial plains on lower tributaries and floodplains, consisting of recent Quaternary alluvium.

Geology Unit: Quaternary sands, clays and gravels (Qa)

Native Vegetation: Moreton Bay Ash, occasional Poplar Box, bloodwood, Blue Gum, buffel.

Physical Attributes: The Booroondarra SMUs possess dark brown or black surface horizons overlying reddish brown lower subsoils. The distinguishing feature of the Booroondarra is the red subsoil colour. It indicates the alluvium has been in-situ for some time and profile development is relatively mature. These soils are characterised by their blocky or lenticular subsoil structure. Subsoil sodicity and salinity can be present or absent with some sites moderately high in sodium and salts. These soils are notable for their soft consistence and sand content in their sub-surface horizons. Coarse sandy material is often found within pore spaces between soil peds at depth. These soils can be gradational or texture contrast with topsoils ranging from sandy loams through to light clays and subsoils ranging from light medium clays through to medium heavy clays. These soils are moderately well to well drained.

Chemistry: Depending on their age and landscape position the Booroondarra soils can be highly sodic. These soils are typically extremely alkaline with plant available nutrients restricted by high pH (pH>9.0). High levels of hydroxyl ions may be caustic to plant roots and root hairs. These soils have relatively high Ca/Mg ratios indicating that calcium ions dominate the cation exchange sites. Due to the flocculating effect of calcium these soils have well developed soil structure with some examples expressing strong lenticular structure, slickensides/cutans and other vertic properties. These soils are low in Nitrate Nitrogen and the trace element Boron indicating that they have low fertility levels with existing vegetation adapted to these conditions.

Photo Plate 7 Booroondarra Soil Profile

Langly (Lg) Soil Management Unit

Distinguishing features: Very deep, black cracking clay with strongly self-mulching surface.

Australian Soil Classification: Black Vertosols;

Topography and Landform Attributes: Alluvial plains on lower tributaries and floodplains, consisting of recent Quaternary alluvium.

Geology Unit: Quaternary sands, clays and gravels (Qa)

Native Vegetation: Brigalow, eucalypts, mostly cleared, pastures of buffel grass in cleared areas.

Physical Attributes: This soil is black throughout its profile and has a light to moderate consistence with a friable and porous soil structure. These soils have high clay contents with low silt content. High CEC/clay ratios as well as lenticular structure in the subsoil suggest the clay fraction is reactive, has shrink/swell properties and contains significant proportions of montmorillonite. These soils have superior soil physical characteristics.

Chemistry: Subsoil constraints become limiting below 40 cm. The dispersion index, sodicity and salinity levels all increase significantly below this depth. Subsoil material below 0.4m should be avoided due to the likely dispersive nature of the subsoil.

Photo Plate 8 Langly Soil Profile

Norwich (Nw) Soil Management Unit

Distinguishing features: Deep to very deep, alkaline, grey or brown cracking clay with moderately to strongly self-mulching surface.

Australian Soil Classification: Grey/Brown Vertosols;

Topography and Landform Attributes: Old alluvial plains and gently undulating rises comprised of sediments derived from basaltic parent material.

Geology Unit: Unconsolidated calcareous sediments (TQab)

Native Vegetation: Completely cleared with buffel grass pastures. Pre-cleared Brigalow vegetation.

Physical Attributes: These soils are older alluvial soils with high clay contents. These soils are made up of montmorillonite 2:1 lattice clays giving them a highly reactive character. The 2:1 clays produce soils that have vertic properties including lenticular structure, slickensides, and a moderately to strong self-mulching surface. High levels of calcium are present throughout the profile and are sometimes expressed as soft segregations throughout subsoil horizons. These soils are gradational with medium to medium heavy topsoils through to medium heavy to heavy clay subsoils. These soils often have a firm consistence with topsoil layers having hardsetting and cracking attributes in addition to the surface mulch. These soils are slowly permeable and moderately well drained.

Chemistry: These soils are highly alkaline with pH > 9.0 throughout most of the soil profile. This extreme pH may reduce the availability of trace elements to growing plants. These soils have extremely high levels of calcium in both topsoil and subsoil. These high levels may interfere with the uptake of other nutrients by plant roots. Soils are high in sodium and salts below 60cm. Chloride levels at 80 cm are as high as 1172 ppm, whilst ESP is in excess of 19.5%. The extremely high levels of calcium may counteract the dispersive properties normally associated with high sodium levels. Soil analyses show that these soils are relatively fertile with relatively high levels of macro and micro nutrients. High nitrate nitrogen and Boron levels are a feature of these soils.

Photo Plate 9 Norwich Soil Profile

3.2 ASSESSMENT OF EROSION POTENTIAL OF SOIL MANAGEMENT UNITS

As the terrain at the Project Site has less than 4% slope, the main driving factors behind soil erosion are soil erodibility (K factor) and rainfall erosivity (R). The site has a summer dominant rainfall pattern with highly erosive thunderstorms whilst flooding has the capacity to entrain soil particles.

The Lake Vermont North Project area exists within a largely depositional landscape associated with the meandering Phillips Creek, a lower tributary of the Isaac River. During flood events the creek is a source of fresh alluvium derived from sedimentary and basaltic sources from upper catchment areas.

Soil erodibility is often dependant on soil permeability and internal drainage. Once the storage capacity of the soil is exceeded any additional water will be removed as surface runoff. The amount of water that a soil can store is dependent on soil attributes such as texture, structure, surface soil condition, soil depth, depth to hardpan or other subsoil constraints that reduce the ability of the soil to absorb water. Attributes such as soil strength, which determines how easily surface soil material is detached and entrained by runoff is often determined by how strongly soil particles are bonded to one another. Physiochemical properties such as organic carbon content, Ca/Mg ratio, ESP, and particle size analysis determine how readily soil particles are detached from the soil surface. Permeability and hence, soil water holding capacity is basically determined by the most restrictive horizon. Often soils with subsoil constraints which lead to slaking and dispersion will seal and limit the amount of water that the soil could otherwise store.

The R1 (Dispersion Ratio) is a measure of the amount of silt and clay that disperses during testing compared with the total amount of silt and clay present. As such, it is a direct laboratory measure of soil dispersion and is useful when used in conjunction with ESP and Ca/Mg ratio for predicting soil physical behaviour. The following ratings were used to interpret the R1 ratios (Baker and Eldershaw 1993).

Rating	R1 Ratio
Low	<0.6
Moderate	0.6-0.8
High	0.8-0.95
Very High	>0.95

The values obtained from PSA analysis need to be interpreted in terms of their chemical and physical effects. While there is no ideal soil, soils will have many advantages if they have about 35% clay : 20-35% silt : <40% sand. The extent to which a particular particle size dominates the soil is basic to interpretation. Soils with higher clay contents generally have a capacity to store more PAWC. Particle size distribution is a major determinant of pore size distribution. Fore a pure sand, pores will be large and of the same order of size as the particles themselves. Similarly, for a pure, non-aggregated clay, pores will be very small. For mixtures of sand/silt/clay, the finer particles will pack into pores created by larger particles, reducing porosity until the pores are full. Minimum porosity of non-aggregated soils occurs when clay is 30-40%. Pore space is intimately related to the physical environment. It affects mechanical impedance of roots, soil compaction and soil crusting. High levels of fine sand and silt are unstable to rapid wetting. This process can result in the formation of hard surface crusts on drying, limited seedling emergence and water infiltration.

The velocity and hence energy of runoff water is dependent upon the amount of runoff water and the slope gradient and slope length that it is traversing. Existing slope gradients (<4%) that exist currently are well stabilised by buffel grass and Brigalow and Eucalypt species. Upon disturbance by mine infrastructure these soils will behave very differently if their subsoils are exposed to air and water.

The most vulnerable soils to disturbance are those with self-mulching surfaces. This surface mulch is easily entrained by surface runoff. Texture contrast soils are also prone to degradation and erosion if their topsoils are compromised due to the likelihood of these soils having sodic subsoils. Upon wetting these horizons slake and disperse leading to sediment losses within runoff water. These soils are also vulnerable due to the fact that their subsoils are often impermeable. Here, water tends to flow laterally rather than vertically increasing the likelihood of soil erosion.

Knockane

Knockane soils exhibit subsoil constraints below 50 cm. Electrical conductivity (EC) and Chloride levels (762 ppm) as well as Exchangeable Sodium Percentages (18%) become limiting factors for plant growth below this depth. Acidic pH may affect deep rooting plants below 110 cm. Ca/Mg ratios are below parity at depth with subsoil becoming magnesic at depth. High levels of sodium and magnesium in subsoil material may predispose these soils to slaking and dispersion. The Knockane soils have relatively high levels of fine sand and silt, especially in the top 100 mm. The dispersion index (R1) is 0.63 in the topsoil of these soils which suggests these soils are only moderately dispersive from a soil physical perspective.

Mayfair Sodic Variant

Mayfair soils exhibit subsoil constraints below 50 cm. Electrical conductivity (EC) and Chloride levels as well as Exchangeable Sodium Percentages become limiting factors for plant growth below this depth. Ca/Mg ratios are below parity at 50 cm depth with subsoil becoming magnesic below this depth. High levels of sodium and magnesium in subsoil material may predispose these soils to slaking and dispersion. These soils have a favourable PSA with high levels of course and fine sand. R1 value indicates that it is moderately to highly dispersible.

Kirkcaldy

Kirkcaldy soils exhibit subsoil constraints below 50 cm. Electrical conductivity (EC) and Chloride levels (862 ppm) as well as Exchangeable Sodium Percentages (21%) become limiting factors for plant growth below this depth. Alkaline pH (> 9.0) is likely to have a caustic effect on plant roots as well as restricting nutrient availability. Ca/Mg ratios are below parity at 50 cm depth with subsoil becoming magnesic below this depth. High levels of sodium and magnesium in subsoil material may predispose these soils to slaking and dispersion. R1 is low in both topsoil and subsoil. Silt and fine sand dominate the soil matrix which makes them susceptible to soil structural issues and hence, erosion.

Knockane Wet Phase

No specific analytical data exists for the Knockane Wet Phase soils. These soils are likely to possess similar soil chemistries to those exhibited by the Knockane SMU. However, as these soils are commonly shallower the depth to any subsoil constraints may be less. The presence of mottling in subsoil horizons indicates that redoxic subsoil conditions are occurring due to rises and falls of groundwater. Like the Knockane, electrical conductivity (EC) and Chloride levels as well as

Exchangeable Sodium Percentages are likely to make subsoil vulnerable to dispersion. These soils have a similar R1 and PSA to the Knockane soils.

Foxleigh

These soils are highly sodic below 60 cm. Below 80 cm magnesium becomes the dominant cation. High levels of sodium and magnesium relative to calcium is known to lead to soil structural degradation, causing soil peds to degrade when wet up with water. Soils are constrained below 60 cm. The PSA of this soil is predominantly composed of fine and coarse sand with the exception of the subsoil which contains a significantly higher amount of clay. R1 is high, particularly in the subsoil.

Foxleigh (Yellow Variant)

The Foxleigh (Yellow Variant) will have similar constraints as the Foxleigh with one exception. The whole coloured subsoil indicates that permeability and drainage is superior to that of the Foxleigh SMU. Hence, the depth to subsoil constraints may be greater than its mottled cousin. These soils have a similar R1 and PSA to the Foxleigh soil type.

Booroondarra

Depending on their age and landscape position the Booroondarra soils can be sodic and saline. These subsoil constraints, when present, become limiting below 80 cm. Slaking and dispersion will lead to soil erosion at or below 80 cm. These soils have high levels of fine sand and moderate to high levels of clay with low silt levels. These soils may develop a relatively solid matrix of finer and coarser particles leading to soil structural issues. However, due to low silt levels this issue will have on minor significance. R1 values on average are approximately 0.56 which indicates a low dispersion ratio.

Langly

Subsoil constraints become limiting below 40 cm. The dispersion index, sodicity and salinity levels all increase significantly below this depth. Langly soils have a moderate dispersion ratio indicating that they will partially disperse when wet up. PSA indicates high levels of fine and coarse sand with low levels of silt indicating that the soil is highly permeable and relatively stable re. erosion susceptibility.

Norwich

Soil chemistry indicates that these soils have subsoil constraints below 60 cm. High levels of chloride exist below 60 cm. Sodicity is also high below this depth. Subsoil attributes suggest that material to this depth will be relatively stable and resilient following disturbance. These soils are high in both clay and fine sand and have a low R1 value. These results indicate that these soils are stable and unlikely to erode under normal conditions.

3.3 SOIL AND LAND SUITABILITY ASSESSMENT

3.3.1 Land Suitability for Beef Cattle Grazing

The suitability of beef cattle grazing on the Project Site is most limited by nutrient deficiencies, extremely alkaline pH and PAWC with subsoil constraints such as sodicity and salinity reducing the rooting depth from which plants can draw water. Effective Rooting depths of pastures in many cases are restricted to 60 cm or less due to these constraints. SMUs rely on favourable climatic conditions or "good seasons" to be viable for the growth of good pastures. In these conditions the soil profile is repeatedly topped up by reliable rainfall thus allowing plant roots to extract their water needs from horizons located above any subsoil constraints.

The various soil types mapped within the Project site and their associated land classes are highlighted in Table 6. Figure 5 shows the distribution of the Land Suitability Classes for each soil type within the Project site.

The Knockane, Kirkcaldy, Knockane (Wet Phase), Langly, Booroondarra and Norwich SMUs are classified as Class 3 land which is suitable for cattle grazing with moderate limitations (Class 3).

The Foxleigh, Foxleigh (YV) and (Mayfair Sodic Variant) SMUs are classified as Class 4 land which is marginal with severe limitations.

Table 6 Land Suitability Limitations for Beef Cattle Grazing

Soil Management Unit	Knockane	Mayfair Sodic Variant	Kirkcaldy	Knockane Wet Phase	Foxleigh	Foxleigh (yellow variant)	Langly	Booroondarra	Norwich
PAWC	2	4	1	1	4	4	3	3	1
Nutrient deficiency	3	3	1	3	4	4	2	2	3
Soil Physical Factors	3	2	2	2	1	1	3	2	2
Salinity	2	1	2	2	1	1	1	2	2
Rockiness	1	1	1	1	1	1	1	1	1
Microrelief	1	1	1	1	1	1	1	1	1
pH	3	3	3	3	2	2	3	3	3
ESP	1	1	1	1	1	1	1	1	1
Wetness	1	1	1	3	3	1	1	1	2
Topography	1	1	1	3	1	1	1	1	1
Water Erosion	1	1	1	1	1	1	1	1	1
Flooding	1	1	1	1	1	2	2	2	2
Overall Suitability Rating	**3**	**4**	**3**	**3**	**4**	**4**	**3**	**3**	**3**

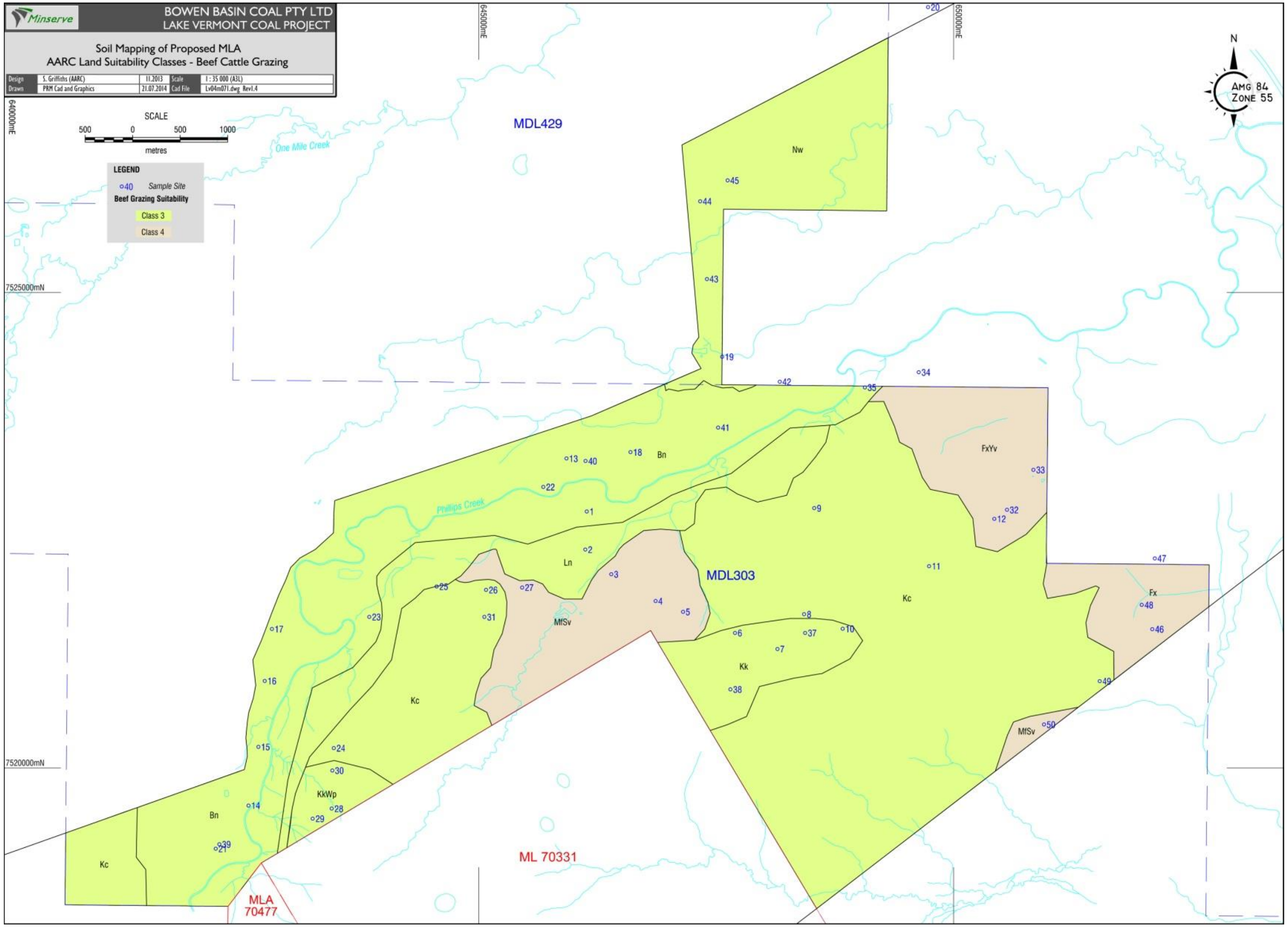

Figure 5 Land suitability for Beef Cattle Grazing

3.3.2 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 soil's physical condition and workability. Those soils with hardsetting or coarse cracking clay surfaces will become cloddy and massive and will provide a poor seed bed for cultivation. These soils are likely to have small "windows" of opportunity in which tilling the soil can be undertaken without degrading soil structure. Sites with alkaline pH (>9.0), will have lower levels of nutrients available to plant roots. Sodicity and salinity will affect the availability of water to plant roots with high levels of soluble salts having the potential to burn root hairs and disrupt plant nutrition. These constraints also reduce the PAWC by reducing the effective rooting depths of plants thus limiting the depth to which they can seek soil moisture. Flooding may be a limitation to cropping particularly in lower lying areas where aggradation or erosion is still occurring. All of these limitations are summarised in Table 7.

The Booroondarra, Kirkcaldy, Langly, and Norwich soils are classified as Class 4 land which has severe limitations to rainfed broadacre cropping. These SMUs are mostly limited by low PAWC and nutrient deficiencies. Soil workability issues are also limiting factors.

The Knockane, Knockane (wet phase), Mayfair (Sodic Variant), Foxleigh, and Foxleigh (yellow variant) have been classified as Class 5 land which has extreme limitations to rainfed broadacre cropping. The main limiting factors are alkaline pH, low PAWC, nutrient deficiencies and water erosion.

The distribution of these land suitability classes is shown in Figure 6.

The SMUs within the Project site that are marginally suitable for rainfed broadacre cropping (Class 4) as a land use are heavily reliant on favourable climatic conditions which only occur in better years. Hence, water supply is an overriding issue when considering suitability of the land to rainfed broadacre cropping. Opportunity cropping as the name suggests may be able to be conducted in some years if the soil profile is topped up with rainfall over the growing season. However, it is important to note that satellite imagery over the last 10 years shows no evidence of cultivation which indicates that there is no cropping history.

Table 7 Land Suitability Limitations for Rainfed Broadacre Cropping

Soil Management Unit	Knockane	Mayfair Sodic Variant	Kirkcaldy	Knockane Wet Phase	Foxleigh	Foxleigh (yellow variant)	Langly	Booroondarra	Norwich
PAWC	5	5	4	5	5	5	4	4	2
Nutrient deficiency	1	2	4	4	4	4	2	4	3
Soil Physical Factors	3	3	3	3	3	3	3	3	3
Soil Workability	2	3	3	3	1	1	3	3	3
Salinity	3	1	3	3	2	2	1	3	4
Rockiness	1	1	1	1	1	1	1	1	1
Microrelief	1	1	1	1	1	1	1	1	1
Wetness	1	1	1	2	3	3	1	2	2
Topography	1	1	1	3	1	1	1	2	1
Water Erosion	2	3	2	3	4	4	3	3	2
Flooding	1	1	1	3	2	2	3	3	3
Overall Suitability Rating	**5**	**5**	**4**	**5**	**5**	**5**	**4**	**4**	**4**

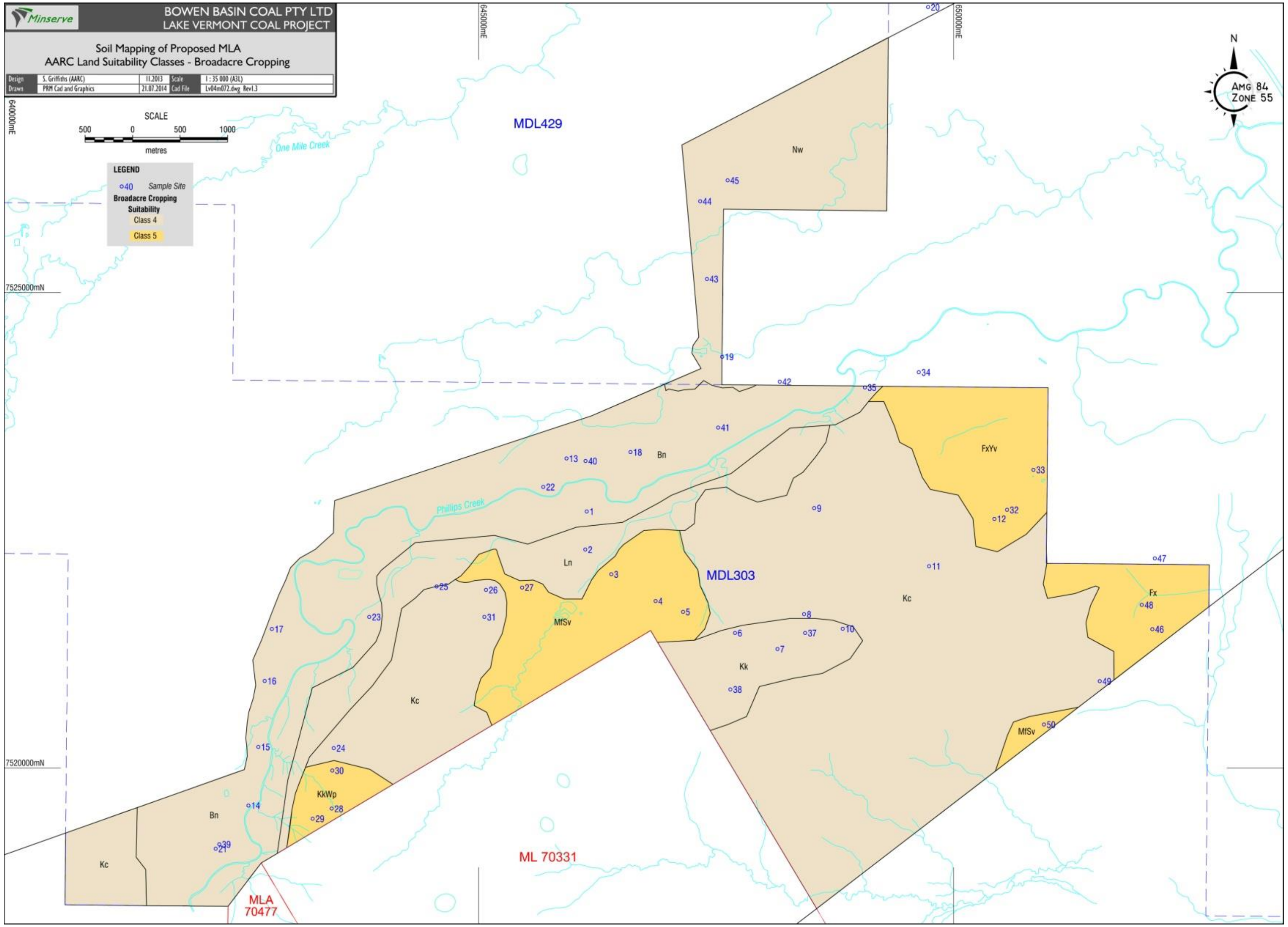

Figure 6 Land Suitability for Rainfed Broadacre Cropping

3.4 GQAL ASSESSMENT

In the Isaac Regional Council area, Class A Land is land that is suitable for rainfed broad acre crops. Class C pasture land is commonly split into subclasses, to reflect differences in grazing potential. In this survey Class C is split as:

- Class C1 – Land suitable for production of 2-3 year old grass-fed export quality cattle in most seasons. (Class 2 for Gazing Suitability in this survey).

- Class C2 – Land suitable for production of 2-3 year old grass-fed export quality cattle only in good seasons. (Class 3 for Gazing Suitability in this survey).

- Class C3 – Marginal land for production of export quality cattle but suitable as breeding country all year round (Class 4 for Gazing Suitability in this survey).

- Class C4 – Unsuitable land for production of export quality cattle and marginal as breeding country all year round.

GQAL analysis of each soil mapped in this survey is given in Table 8 below.

The Knockane, Kirkcaldy, Knockane (Wp), Langly, Booroondarra and Norwich SMUs have been classified as Class C2 land which is Non Good Quality Agricultural Land but which is suitable for the production of 2-3 year old grass-fed export quality cattle only in good seasons.

The Mayfair (sodic variant), Foxleigh and Foxleigh (YV) SMUs have been classified as Class C3 land which is marginal land for the production of export quality cattle but suitable as breeding country all year round.

The most common limitations which determined the above classes included:

- PAWC;

- Nutrient deficiencies;

- Soil Alkalinity

- Soil physical and workability issues; and

- Erosion.

Nutrient deficiencies may be overcome by the addition of fertilisers and an acidifying agent such as elemental sulphur so that nutrients become available to plant roots. The addition of gypsum would also be beneficial and would help to improve physical condition and workability of soils high in clay. The inclusion of organic matter would also be recommended as it improves soil structure and hence, improves soil permeability and drainage.

Figure 7 shows the distribution of GQAL across the Lake Vermont North MLA. Table 8 shows the land suitability classes and GQAL classes derived for all SMUs within the Lake Vermont North Project site.

Table 8 Land Suitability and Good Quality Agricultural Land Class Comparison

Soil Management Unit	Important Limitations	AARC Land Suitability Classes (derived from this assessment)		GQAL Class
		Beef Cattle Grazing	Broadacre Cropping	
Knockane	Physical condition, workability, nutrient deficiency	3	4	C2
Mayfair (SV)	PAWC, Physical condition, workability	4	5	C3
Kirkcaldy	PAWC, nutrient deficiencies	3	4	C2
Knockane (WP)	PAWC, nutrient deficiencies, wetness	3	5	C2
Foxleigh	PAWC, erosion, nutrient deficiencies	4	5	C3
Foxleigh (YV)	PAWC, erosion, nutrient deficiencies	4	5	C3
Langly	PAWC, nutrient deficiencies	3	4	C2
Booroondarra	PAWC, soil alkalinity, nutrient deficiency, workability	3	4	C2
Norwich	Physical condition, workability, nutrient deficiency	3	4	C2

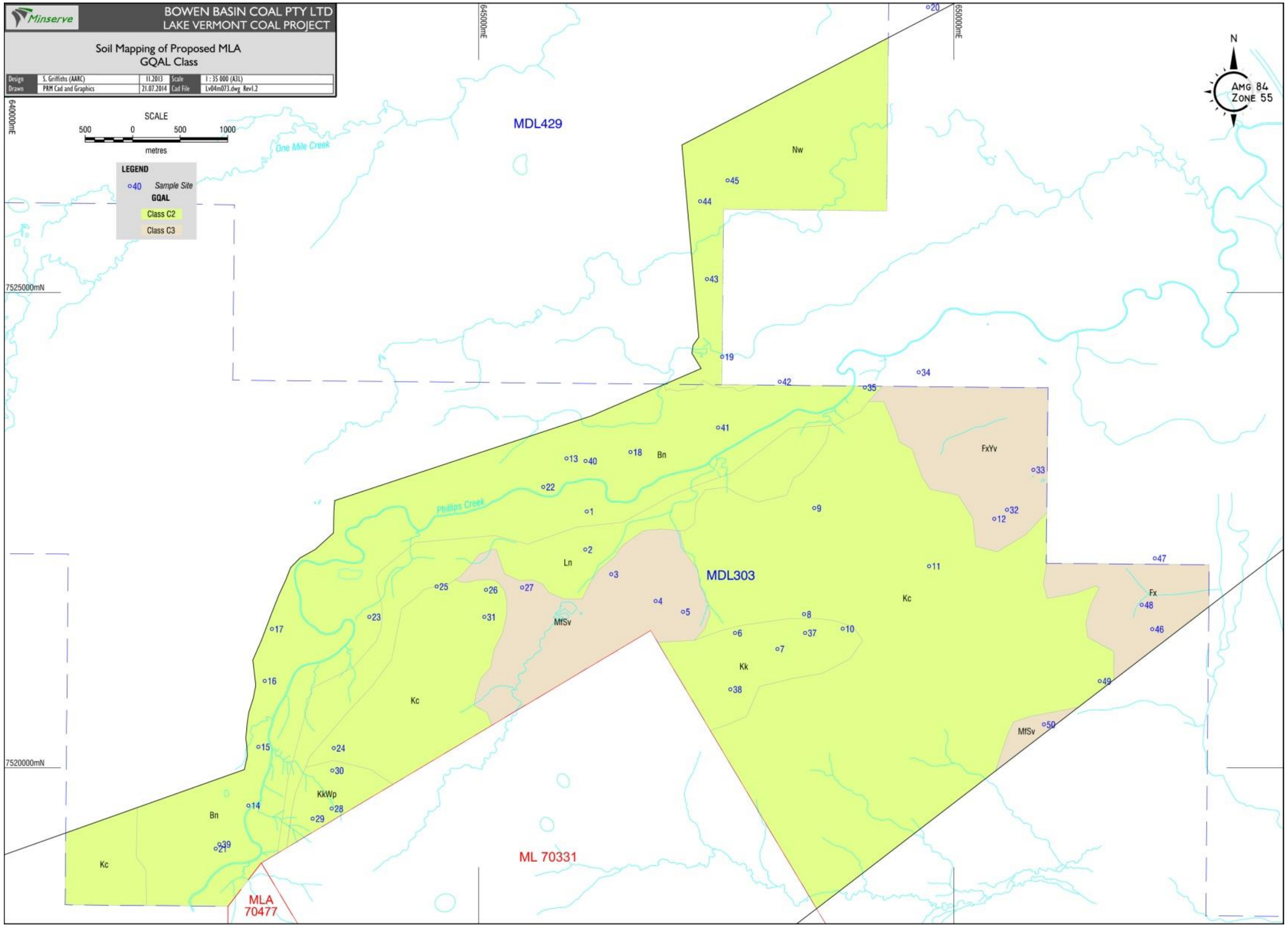

Figure 7 Good Quality Agricultural Land Classes for soils mapped within the Lake Vermont Northern Extension

4.0 POTENTIAL IMPACTS OF THE PROJECT.

4.1 LAND SUITABILITY

Proposed mining activities will impact the suitability of the land for all land uses during the mine life and into the future.

Pre-mining land suitability of the Project site has been described in Section 3 and is summarised Table 9 below. Most SMUs are potentially impacted by the proposed mine extension, however, the exact disturbance area of each was unable to be calculated, as the final mine design was not available at the time of this report.

Table 9 Classification of SMUs into their Land Suitability Classes and their extent within the Project site

SMU	Land Suitability Class (Grazing)	Land Suitability Class (Cropping)	Area (ha) MLA
Knockane	3	4	133.92
Mayfair (Sv)	4	5	266.84
Kirkcaldy	3	4	1536.32
Knockane (Wp)	3	5	50.7
Foxleigh	4	5	119.94
Foxleigh (YV)	4	5	209.57
Booroondarra	2	3	853.63
Langly	3	4	254.08
Norwich	3	3	328.87
Total Mining Lease Area (ha)			**3753.87 ha**

Post-mining rehabilitation will aim to return the land to its pre-mining land use of cattle grazing. It is anticipated that a land suitability Class of 4 will be achieved post rehabilitation which will enable cattle grazing of native and exotic pasture species to be conducted. Exotic species will include buffel, Rhodes grass and other grasses that perform well in local conditions. Colonisation of disturbance areas by these species although providing valuable feed and ground cover are not in any way considered as pasture improvement. The final void is intended to be left as a lake and will likely have a land suitability class of 5.

4.2 EROSION

Mining activities have the potential to destabilise the site and increase the risk of erosion. Specifically, the following activities may lead to increased erosion at Lake Vermont North if not properly managed:

- Clearing of vegetation;
- Topsoil stripping and stockpiling;
- Construction of infrastructure;
- Exposed slopes;
- Rehabilitated surfaces; and
- Concentration of run-off water flow from disturbed areas.

Soil erosion can cause land instability and may lead to increased sediment loads in runoff, which can in turn impact on the environmental values of the receiving waterways.

4.3 SOIL PHYSIOCHEMICAL IMPACTS

Stripping, stockpiling and handling of topsoil can potentially impact on the chemical and physical attributes of the soil, reducing its ability to support vegetation. Although it is noted that the high CEC of soils provides buffering capacity to some chemical changes.

Specifically, the following physical and chemical impacts may occur as a result of mining activities:

- Exposure of saline or sodic subsoils during soil stripping;
- Loss of soil physical structure due to excavation and handling; and
- Impacts on soil fertility due to mixing with subsoils or resulting from changes in chemistry when sub-soils are exposed to oxygen.

Such physiochemical impacts can impact on the viability of the soil seed bank and reduce the likelihood of successful rehabilitation if not managed properly.

4.4 SOIL CONTAMINATION

Mining activities can result in the contamination of surface and subsoil through;

- Spills of fuel, oil and other hazardous chemicals;
- Release of contaminated water;
- Release of effluent to land; and
- Seepage of contaminated water from spoil.

Such contamination can cause the impacted soil to become unsuitable for supporting plant growth.

5.0 RECOMMENDATIONS

5.1 LAND SUITABILITY

Most rehabilitated landforms are expected to achieve a grazing land use of native pasture species with a corresponding land suitability Class of 4 post mining. Rehabilitation can be extremely successful if sufficient quantities of topsoil are conserved for later rehabilitation. Without topsoil, vegetation establishment is difficult with the degree of success or failure based on the characteristics of the subsoil (spoil). To ensure rehabilitation success and to minimise impacts on land suitability it is recommended that topsoil be stripped prior to the development of mining and infrastructure areas and stockpiled for later use in rehabilitation activities.

5.2 TOPSOIL STRIPPING AND STOCKPILING

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 maximum stripping depths for the identified SMUs are listed in Table 10 below.

Table 10 Usable Soil Resources from each Soil Management Unit

SMU	Max. Topsoil Stripping Depth (mm)
Knockane	500
Mayfair (Sodic Variant)	500
Kirkcaldy	500
Knockane (Wet Phase)	400
Foxleigh	500
Foxleigh (yellow variant)	500
Booroondarra	700
Langly	400
Norwich	500

Stockpiles should be placed away from drainage areas, roads, machinery, and stock grazing areas. If the period of stockpiling is greater than one growing season or six months, the stockpiles may need to be ripped and seeded to limit erosion, and maintain a viable seed bank. It is recommended that topsoil stockpiles do not exceed 2 m in height.

5.3 EROSION MANAGEMENT

The following 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 at any point in time;
- Runoff from more elevated undisturbed areas should be directed around disturbed areas and topsoil stockpiles;
- Topsoil stockpiles should be 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;
- Where possible, direct placement of topsoil is preferential for preservation of the seed bank;
- Slopes of elevated landforms should be contoured, in order to minimise slope lengths and runoff velocities. If required, rock-lined drains should be installed on elevated final landforms to reduce erosion;
- Runoff from disturbed areas should be directed to sediment dams and settling ponds in order remove suspended sediment prior to release to the environment.

5.4 SOIL CONTAMINATION

The following control measures are recommended to minimise potential for soil contamination during the proposed mining activities:

- The stormwater management system should be designed to capture potentially contaminated water, such as runoff from industrial and stockpile area, avoiding release to the receiving environment;
- Septic systems or Sewage treatment facilities will treat effluent to sufficient quality for release to evaporation trenches or for irrigation, such that land contamination does not result;
- All hazardous chemical, fuel and oil storages should be bunded in accordance with current Australian Standards; and
- Accidental spills, such as fuel, oil, other chemicals, will be cleaned up immediately, with contaminated soil being treated as a regulated waste. Spill kits should be provided at refuelling areas and workshops.

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