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Mount Pleasant Operation

A JOINT VENTURE WITH JCDA Japan Coal Development Australia

Appendix I

Agricultural and Land Resources Assessment

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1 INTRODUCTION

The Mount Pleasant Operation Development Consent DA 92/97 was granted under the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 December 1999. The Mount Pleasant Operation was also approved under the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) in 2012 (EPBC 2011/5795).

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation from Coal and Allied Operations Pty Ltd on 4 August 2016. MACH Energy commenced construction activities at the Mount Pleasant Operation in November 2016 and commenced mining operations in October 2017, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

MACH Mount Pleasant Operations Pty Ltd manages the Mount Pleasant Operation as agent for and on behalf of the unincorporated Mount Pleasant Joint Venture between MACH Energy (95 percent [%] owner) and J.C.D. Australia Pty Ltd (5% owner)[1].

The approved Mount Pleasant Operation includes the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure located approximately three kilometres (km) north-west of Muswellbrook in the Upper Hunter Valley of NSW (Figures 1 and 2).

The mine is approved to produce up to 10.5 million tonnes per annum of run-of-mine (ROM) coal. Up to approximately 9 trains per day of thermal coal products from the Mount Pleasant Operation are transported by rail to the Port of Newcastle for export, or to domestic customers for use in electricity generation.

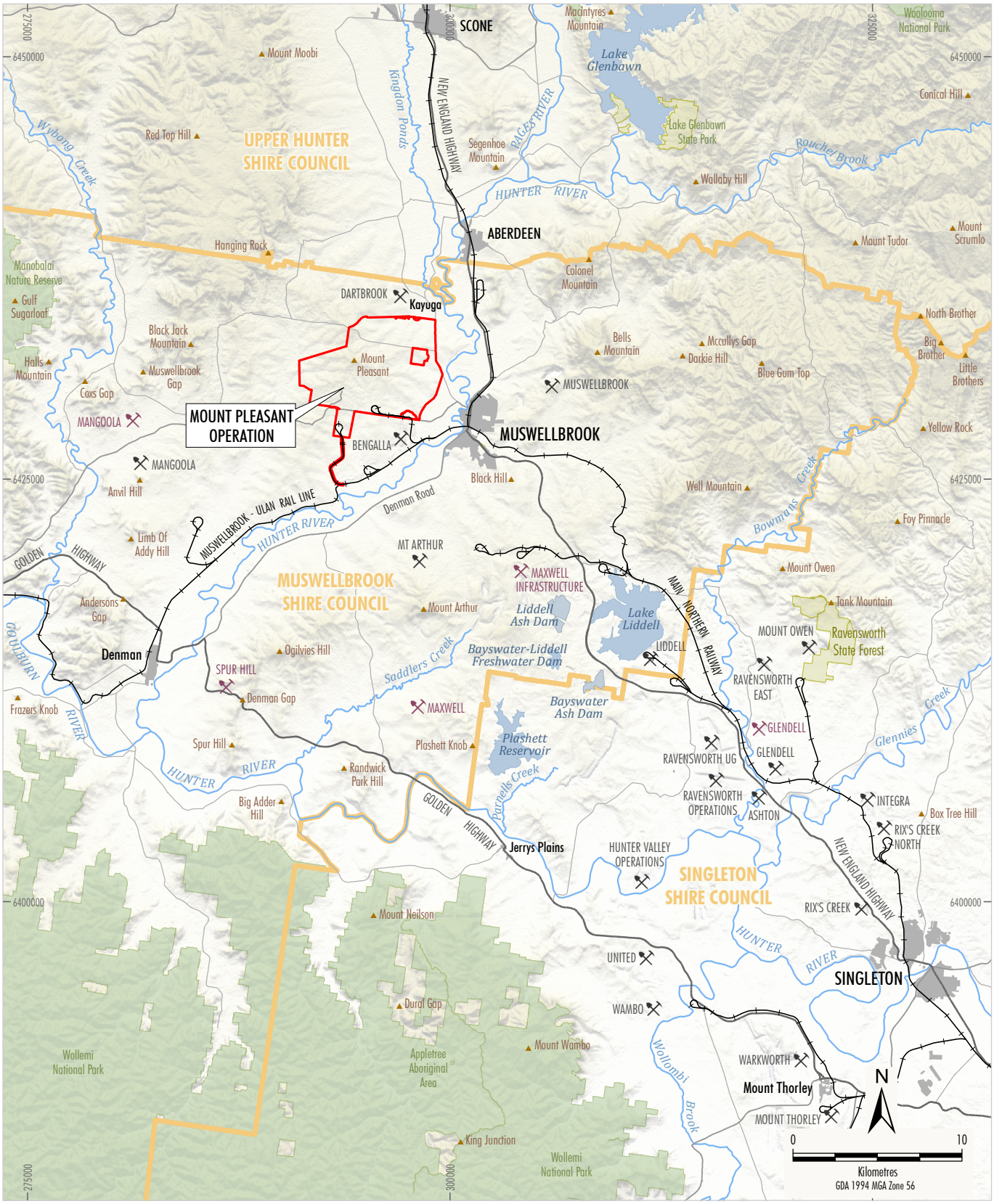
This Agricultural and Land Resources Assessment forms part of an Environmental Impact Statement (EIS) which has been prepared to accompany a Development Application for the Mount Pleasant Optimisation Project (the Project) in accordance with Part 4 of the EP&A Act. The Project proposes extraction of additional coal reserves within Mount Pleasant Operation Mining Leases and an increase in the rate of coal extraction without significantly increasing the total disturbance footprint. The extraction of additional Project coal reserves would be supported by the use and augmentation of existing and approved infrastructure at the Mount Pleasant Operation (Figure 2).

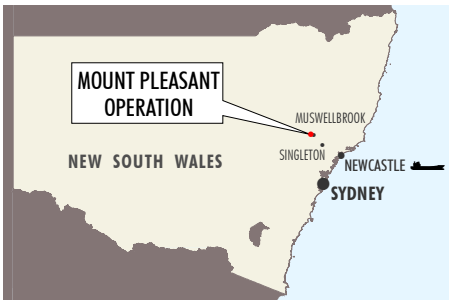
This Agricultural and Land Resources Assessment provides a consolidated summary of the potential impacts of the Project on agricultural resources, drawing on the relevant findings of technical assessments prepared by subject matter experts.

This Agricultural and Land Resources Assessment for the Project draws on assessments in the following technical reports:

- *Mount Pleasant Optimisation Project – Soil Resource Assessment* (GT Environmental, 2020) (Attachment 1).
- *Mount Pleasant Optimisation Project – Noise and Blasting Assessment* (Wilkinson Murray, 2020) (Appendix A of the EIS).
- *Mount Pleasant Optimisation Project – Air Quality Assessment* (Todoroski Air Sciences [TAS], 2020) (Appendix B of the EIS).
- *Mount Pleasant Optimisation Project – Groundwater Assessment* (Australasian Groundwater and Environment Consultants [AGE], 2020) (Appendix C of the EIS).
- *Mount Pleasant Optimisation Project – Surface Water Assessment* (Hydro Engineering Consultants, 2020) (Appendix D of the EIS).
- *Mount Pleasant Optimisation Project – Road Transport Assessment* (The Transport Planning Partnership, 2020) (Appendix J of the EIS).
- *Mount Pleasant Optimisation Project – Visual and Landscape Assessment* (Visual Planning and Assessment, 2020) (Appendix M of the EIS).
- *Mount Pleasant Optimisation Project – Economic Assessment* (AnalytEcon, 2021) (Appendix O of the EIS).

[1] Throughout this Agricultural and Land Resources Assessment, MACH Mount Pleasant Operations Pty Ltd and the unincorporated Mount Pleasant Joint Venture will be referred to as MACH.





LEGEND

- Mining Operation
- Proposed Mining Operation (Application Lodged)
- Railway
- Local Government Boundary
- State Forest/Reserve
- National Parks and Wildlife Estate
- Mining Lease Boundary (Mount Pleasant Operation)

Source: NSW Spatial Services (2020)

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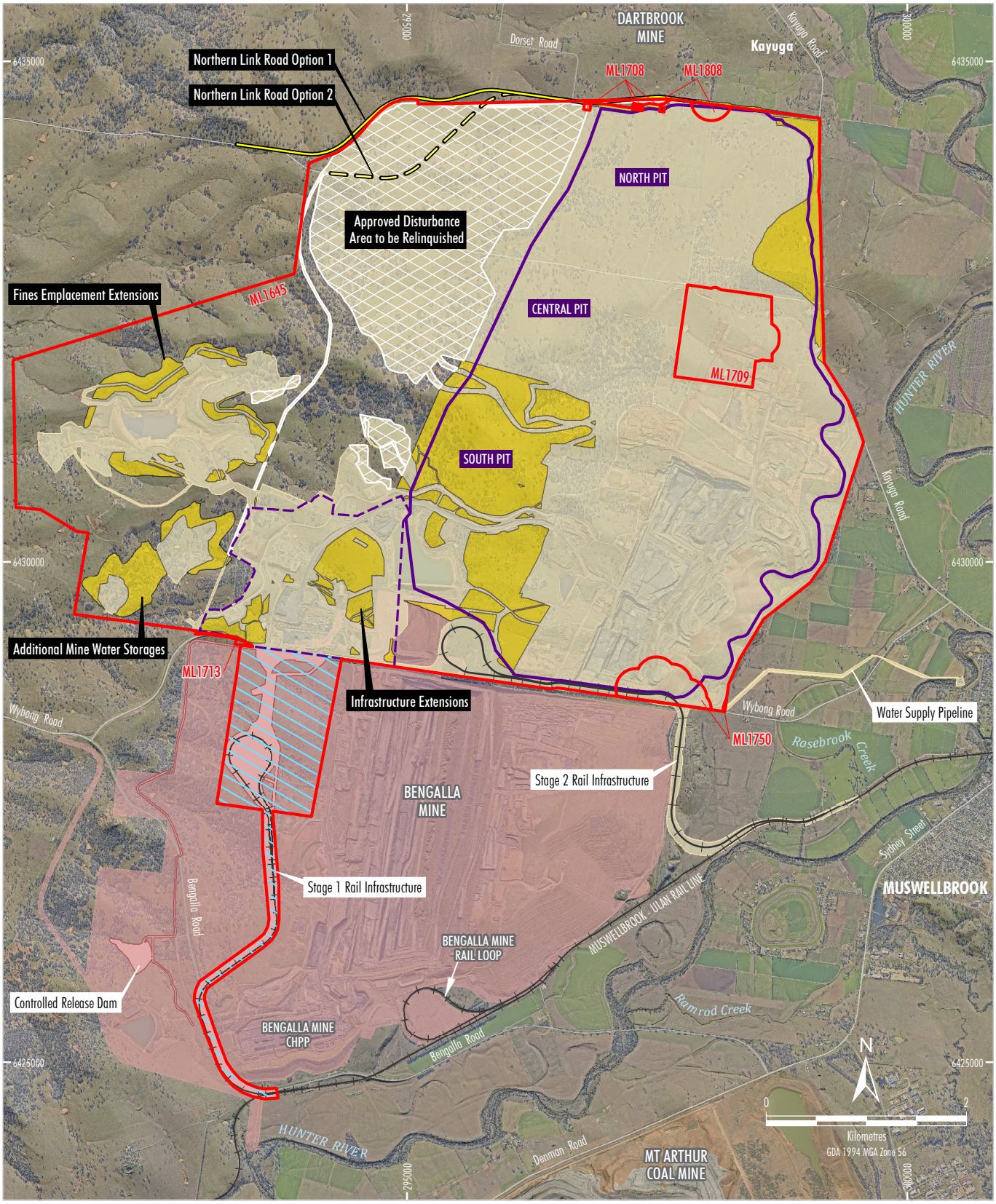
MOUNT PLEASANT OPTIMISATION PROJECT

Project Location

Figure 1

MAC-18-02 SSD_EIS_App Figure 1_Rev E



MAC-18-02 SSD_EIS_App Figure 2_Rev M

LEGEND

Existing Mine Elements

- Mining Lease Boundary (Mount Pleasant Operation)
- Approximate Extent of Existing/Approved Surface Development (DA92/97) [1]
- Infrastructure to be removed under the Terms of Condition 37, Schedule 3 (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170) [1]

Additional/Revised Project Elements

- Approved Disturbance Area to be Relinquished [2]
- Approximate Additional Disturbance of Project Extensions [1]
- Northern Link Road Option 1 Centreline [3]
- Northern Link Road Option 2 Centreline
- Approximate Extent of Project Open Cut and Waste Rock Emplacement Landforms
- Revised Infrastructure Area Envelope

NOTES

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.
2. Subject to detailed design of Northern Link Road alignment.
3. Preferred alignment subject to landholder access.

Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

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MOUNT PLEASANT OPTIMISATION PROJECT

Project General Arrangement

Figure 2

2 REGULATORY REQUIREMENTS

The Secretary's Environmental Assessment Requirements (SEARs) for the Project were issued by NSW Department of Planning, Industry and Environment (DPIE) on 17 February 2020. DPIE also wrote to MACH (dated 2 October 2020) to clarify the requirements for the Agricultural and Land Resources Assessment, as follows:

> *The Department acknowledges that some impacts on CICs and agricultural operations may be addressed to varying extents in the technical assessments for air quality, noise and blasting, groundwater and surface water and visual impacts. Nonetheless, the Department considers that a consolidated summary and analysis of these impacts should be provided in a single chapter or appendix to the Environmental Impact Statement. This assessment does not necessarily need to be a standalone specialist assessment, but should bring together the above potential sources of impacts into a considered and consolidated assessment of the Project's potential to impact on agricultural and land resources.*

As described in Section 1, this Agricultural and Land Resources Assessment draws on and consolidates the findings from various technical assessments.

This Agricultural and Land Resources Assessment has also been prepared in consideration of the *Strategic Regional Land Use Policy: Guideline for Agricultural Impact Statements* (NSW Government, 2012) (AIS Guideline) and *Agricultural Impact Statement Technical Notes* (Department of Primary Industries [DPI], 2013). A summary of where the information requirements in the AIS Guideline have been addressed in this Agricultural and Land Resources Assessment is provided in Table 1.

Table 1
AIS Guideline Requirements

Requirement	Report Section
Information Relating to the Site and Region	
Detailed assessment of the agricultural resources and agricultural production of the project area.	Sections 4 and 5
Identification of the agricultural resources and current agricultural enterprises within the surrounding locality of the project area.	Section 5
Assessment of Impacts	
Identification and assessment of the impacts of the project on agricultural resources or industries	Section 6
Account for any physical movement of water away from agriculture	Sections 6.3 and 6.4
Assessment of socio-economic impacts	Section 6.2
Mitigation Measures	
Identification of options for minimising adverse impacts on agricultural resources, including agricultural lands, enterprises and infrastructure at the local and regional level	Section 6
Consultation	
Document consultation with adjoining landusers and Government Departments	Section 3

3 CONSULTATION

3.1 MOUNT PLEASANT COMMUNITY CONSULTATIVE COMMITTEE

The Community Consultative Committee (CCC) was formed in 2004 and has since met regularly. The CCC is an important communication and engagement tool, as the group acts as the point of contact to provide feedback between MACH and the community. The CCC is made up of community members, including those involved in local agricultural enterprises.

The CCC meetings provide an opportunity for MACH to keep the local community informed about its activities and to seek community views and feedback. Meetings are typically held quarterly and all minutes for the CCC meetings are made publicly available on MACH's website.

MACH has consulted with the CCC in relation to the Project, in accordance with the revised SEARs issued on 2 October 2020.

3.2 PROJECT STAKEHOLDER CONSULTATION

MACH has undertaken a number of engagement activities in relation to the Project, including opportunities for direct stakeholder feedback. Key consultation activities of particular relevance to this Agricultural and Land Resources Assessment include:

- Consultation with a range of government agencies (including the DPI – Agriculture and Hunter Local Land Services) and documentation of relevant assessment considerations identified by key government agencies in the SEARs. During consultation for the Project, the DPI – Agriculture did not raise any specific issues or concerns in relation to the Project.
- Consultation with neighbouring landholders and surrounding mines (some of which own significant areas of agricultural land – including Bengalla Mine, Dartbrook Mine, Mt Arthur Coal Mine, Mangoola Coal and Muswellbrook Coal) regarding the Project.
- Community and landholder engagement as part of the Social Impact Assessment. This included a community survey distributed through local newspapers, flyers, the MACH website and text message to all to phone numbers registered on the MACH suppliers and sponsor database.
- Community consultation, including (but not limited to) distributing community newsletters to local residents and other stakeholders, providing multiple Project briefings to the CCC, consulting with local community groups and direct consultation with proximal private landowners.

Further details of the consultation program conducted for the Project are provided in Section 6 of the EIS and the Social Impact Assessment (Appendix N of the EIS).

Key stakeholder concerns related to agriculture raised during consultation for the Social Impact Assessment include:

- Increased competition in the local labour market for skilled workers, making it more difficult for agricultural businesses to attract workers with similar skills.
- Costs associated with loss of agricultural land and associated loss of employment opportunities.
- Impacts to agricultural culture, including a decrease in the proportion of people working in the agriculture sector, loss of rural communities and the loss of the built environment that is significant to local agricultural people.
- Decreased access to water for agricultural businesses.
- Time costs associated with mitigating impacts of the Project on neighbouring land (e.g. additional weed and pest management requirements).

These potential impacts and relevant management and mitigation strategies are described in the Social Impact Assessment (Appendix N of the EIS) and other relevant EIS assessments (e.g. weed and pest management is discussed in the Preliminary Rehabilitation and Mine Closure Strategy [Attachment 8 of the EIS]).

4 REGIONAL AGRICULTURAL OVERVIEW

The Project is located in the Muswellbrook Local Government Area (LGA) which is part of the Hunter region. The purpose of this section is to provide:

- Contextual information about the broader Hunter region and the Muswellbrook LGA.
- An overview of the agricultural resources identified in the *Upper Hunter Strategic Regional Land Use Plan* (NSW Government, 2012b).
- A summary of key agricultural land uses in the vicinity of the Project.

4.1 HUNTER REGION

The Hunter region is the leading regional economy in NSW. The Hunter region population is approaching 1 million people and supports major sectors that include agriculture, coal mining, tourism, defence, energy and transport. It contains 10 LGAs and covers a total area of 32,870 square kilometres (km^2). The Hunter River Valley (21,400 km^2) occupies over half of this area and most economic activity in the region is stimulated by assets located within the river valley (Department of Planning and Environment [DP&E], 2016).

The coastal city of Newcastle is the regional capital for the Hunter region. Newcastle's port is a vital hub for export of coal and local rural produce to various markets across the Asia-Pacific. In 2014-15 a total of $15.8 billion of exports was shipped from the Port of Newcastle, 90% of which was coal (DP&E, 2016).

Within the Hunter region, the Upper Hunter is recognised as a major supplier of coal, energy, wine and thoroughbred horses, to national and international markets. These industries have driven investment in transport and energy infrastructure and will continue to underpin the growth and diversification of the Hunter's economy and employment base (DP&E, 2016).

The Project is located in the Muswellbrook mining precinct in the Upper Hunter Valley. The Mount Pleasant Operation is located west of the Hunter River floodplain and is immediately to the north of the Bengalla Mine and to the south of the Dartbrook Mine. Other mines within a 20 km radius of the Mount Pleasant Operation include the Mt Arthur Coal Mine, Mangoola Coal, and the Muswellbrook Coal Mine. Looking further towards the southeast, there are open-cut and underground coal mines located towards Singleton. Both the Muswellbrook and Singleton are considered mining towns (Just Add Lime, 2020).

Chart 1 shows employment by industry in Muswellbrook Shire, Singleton Shire and the Upper Hunter Shire from the most recent Australian Bureau of Statistics (ABS) Census (2016) (AnalytEcon, 2021).

In all three LGAs, more than 50% of people are employed in the services sector. Particularly in Muswellbrook and Singleton LGAs, the mining sector is an important employer, employing 22% and 23% of the workforce, respectively (AnalytEcon, 2021).

Employment in agriculture, forestry and fishing (which also includes horse breeding and horse studs) plays less of a role in these two LGAs (7% in Muswellbrook and 4% in Singleton), but is important in the Upper Hunter LGA where 19% of people were employed in agriculture in 2016. Employment in accommodation and food services – services typically associated with tourism – accounted for around 7% in Muswellbrook LGA, 8% in Singleton LGA, and 6% in the Upper Hunter LGA (AnalytEcon, 2021).

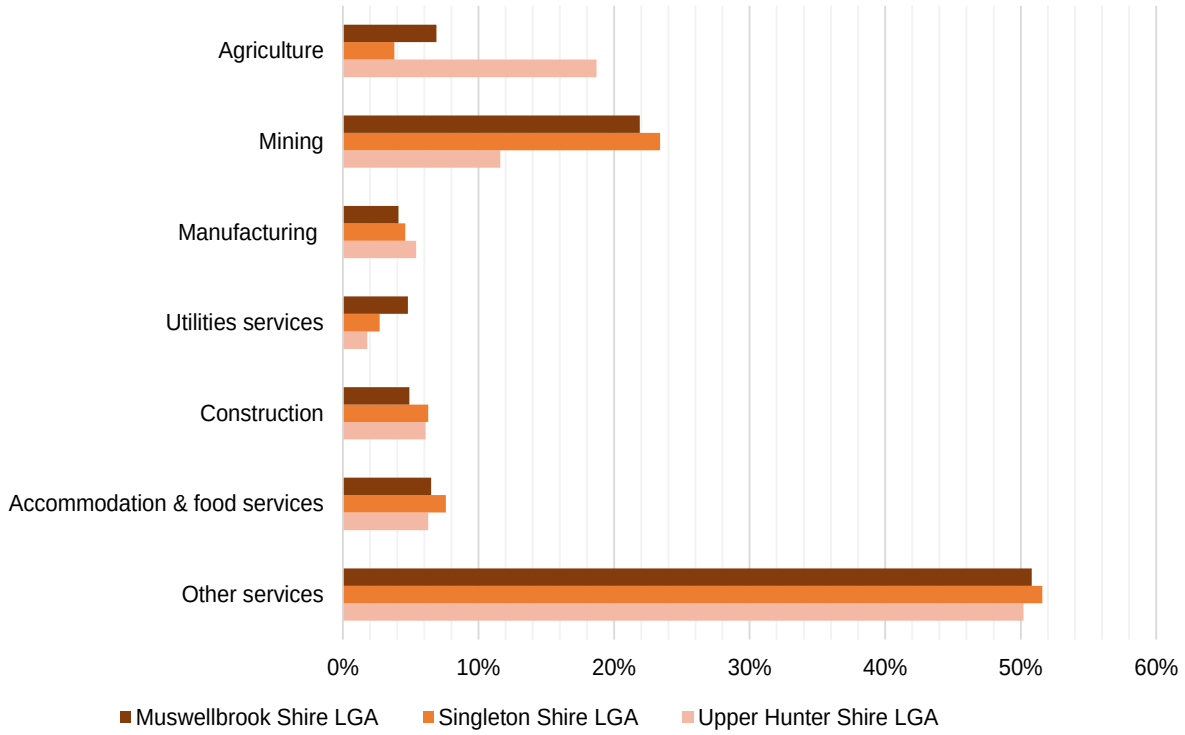


Chart 1 Employment by Industry in the Local Region
Source: AnalytEcon (2021).

4.2 MUSWELLBROOK LOCAL GOVERNMENT AREA

Muswellbrook Shire covers 3,402 km², of which 1,455 km (43%) is national parks. Muswellbrook Shire supports a population of approximately 17,000 people (Muswellbrook Shire Council, 2016).

Muswellbrook Shire consists of two larger towns, Muswellbrook and Denman, as well as a number of outlining rural communities including Sandy Hollow, Wybong, Baerami, Martindale, McCullys Gap, Widden and Muscle Creek (Muswellbrook Shire Council, 2015).

Industry in Muswellbrook includes agriculture, viticulture, equine industry, power generation and coal mining. Muswellbrook is the main centre for NSW's power generation capacity. The area has also become the major centre of Upper Hunter coal mining with the largest concentration of open cut mining operations (Muswellbrook Shire Council, 2015).

Muswellbrook Shire is home to a significant proportion of the wine industry in the Upper Hunter Region. Many of the larger wineries are centred in and around the township of Denman (Muswellbrook Shire Council, 2015). Major viticulture establishments in the Muswellbrook LGA include (Muswellbrook Shire Council, 2018):

- Hollydene (approximately 20 km south of the Project);
- James Estate Wines (approximately 30 km south-west of the Project);
- Small Forest (approximately 17 km south, south-west of the Project); and
- Two Rivers (approximately 20 km south, south-west of the Project).

Muswellbrook Shire is home to the largest critical mass of thoroughbred rearing in Australia, located in an arc from Widden Valley through Sandy Hollow to Jerry's Plains. Over 20 individual stud farms are located in the Muswellbrook LGA (Muswellbrook Shire Council, 2018).

The Coolmore and Godolphin Woodlands Studs are recognised as the “central players” and “epicentre” of the thoroughbred breeding industry in the Hunter Valley (Hunter Thoroughbred Breeders Association, 2019). These two studs are located in the Muswellbrook LGA, approximately 20 km south of the Project. The existing Bengalla Mine and Mt Arthur Coal Mine are located between the two key studs and the Project.

4.3 UPPER HUNTER STRATEGIC REGIONAL LAND USE PLAN

The Upper Hunter Strategic Regional Land Use Plan (NSW Government, 2012) was developed to describe and help protect Strategic Agricultural Land in the Upper Hunter region of NSW (comprising Biophysical Strategic Agricultural Land [BSAL] and Critical Industry Clusters [CICs]). The region’s economy is underpinned by:

- coal mining;
- agriculture (particularly dairy and beef cattle and pasture production);
- agriculture associated services;
- horse breeding;
- electricity production;
- tourism; and
- viticulture and wine making.

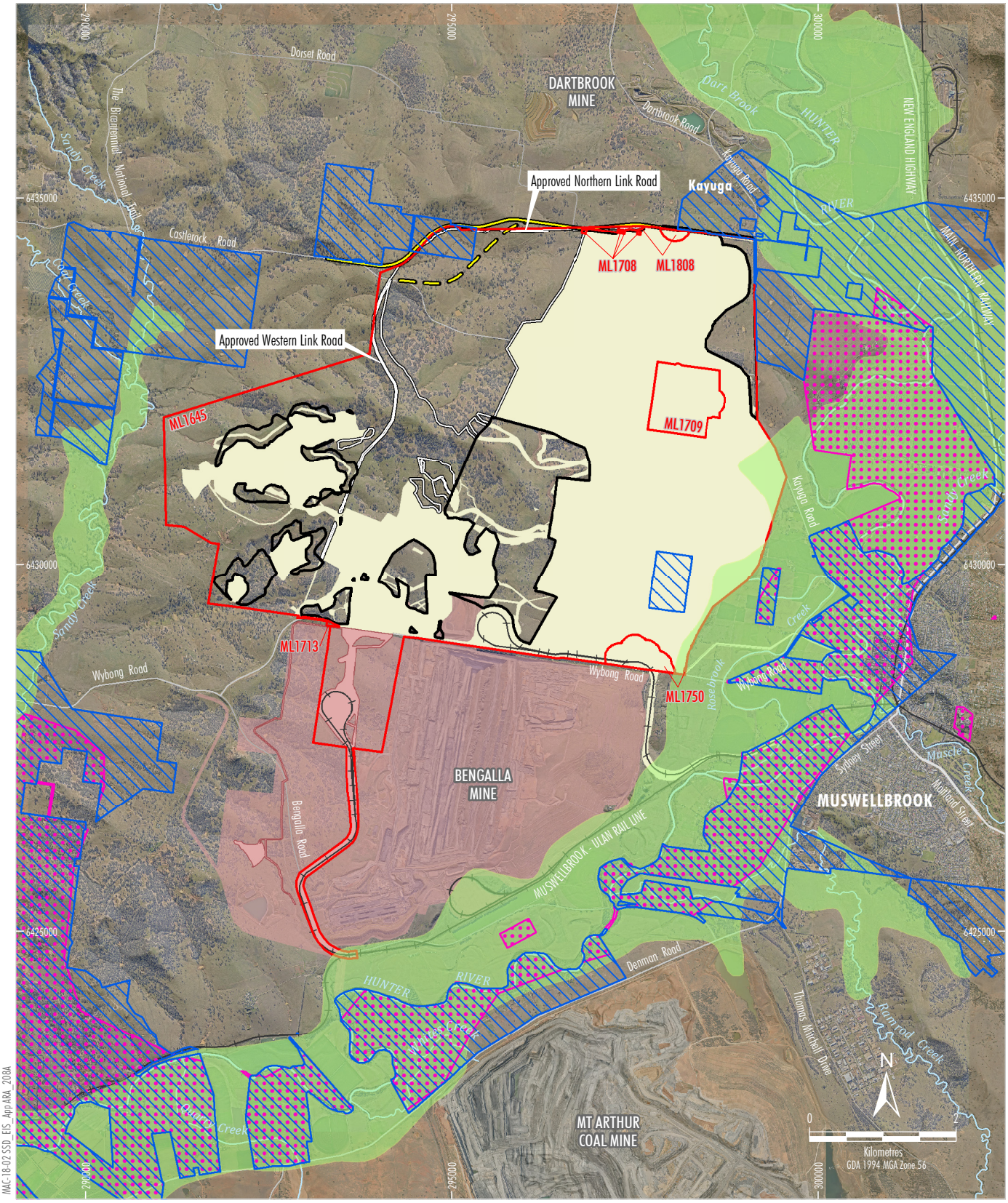
The Upper Hunter Strategic Regional Land Use Plan (NSW Government, 2012) recognises two agricultural CICs in the Upper Hunter, including:

- the Equine CIC, which is focused on producing thoroughbred horses for the racing industry (although also includes horse agistment and breeding horses for other purposes); and
- the Viticulture CIC, which is focused primarily on wine production, along with associated tourism.

The location of regionally mapped BSAL and CICs in the vicinity of the Project is shown on Figure 3.

The thoroughbred horse breeding industry is focused around Scone in the Upper Hunter Shire and includes a highly integrated concentration of horse breeding facilities and related infrastructure covering thoroughbred and stock horse breeding centres and numerous other equine developments and support services, such as a specialised veterinary centre. The equine CIC is spatially defined as land (excluding National Park and State Forest) having a slope of equal to or less than 18 degrees and falling within the following buffers (NSW Government, 2012):

- in the Upper Hunter LGA - within 15 km of the New England Highway;
- in the Muswellbrook LGA - within 2 km of the Muswellbrook Denman Road or the New England Highway north of Muswellbrook;
- in the Muswellbrook and Upper Hunter LGAs - within 2 km to the north and 10 km to the south of the Golden Highway between Sandy Hollow and the Muswellbrook/Singleton LGA boundary;
- in the Mid Western Regional, Muswellbrook and Upper Hunter LGAs - within 5 km of the Bylong Valley Way or Martindale Road or the Baerami Creek Road or Widden Valley Road; or
- in the Singleton LGA - within 2 km to the north and 10 km to the south of the Golden Highway between Jerrys Plains and the Muswellbrook/ Singleton LGA boundary.



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LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline*
- Northern Link Road Option 2 Centreline
- Regionally Mapped Biophysical Strategic Agricultural Land
- Equine Critical Industry Cluster
- Viticulture Critical Industry Cluster

* Preferred option subject to landholder access.

Source: MACH (2020); NSW Spatial Services (2020)
Orthophoto: MACH (2020)

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Regional Biophysical Strategic Agricultural Land and Critical Industry Cluster Mapping

Figure 3

The viticulture cluster includes a highly integrated concentration of vineyards and associated wineries and tourism infrastructure in a rural landscape. The region's unique terrain and climate, its heritage vines and diversity of soil types all contribute to the specific quality and characteristics of grapes produced in the area, especially Hunter semillon and shiraz. Also of importance is the Hunter Valley wine tourism branding based on its natural environment and visual landscape attributes and its proximity to metropolitan areas. The viticulture CIC is spatially defined as the following land (excluding State Forests and National Park) (NSW Government, 2012):

- the Broke-Fordwich and Pokolbin Geographical Indicators (GI) sub-regions;
- the parish of Belford and the suburbs of Lovedale, Nulkaba, Mount View and Rothbury;
- properties proximate to the Hunter Wine Country Private Irrigation District pipeline to the east of Lovedale road as well as those properties bounded by Mears Lane, Majors Lane and the Suburb of Lovedale; and
- land (excluding National Park and State Forest) within 20 km of Denman, and that falls under soil fertility classes 'high', 'moderately high', 'moderate' or 'moderately low' under the Draft Inherent General Fertility of NSW Office of Environment and Heritage [OEH], and land capability classes (LSC Classes) 1, 2, 3, 4 or 5, and is within 2 km of a mapped alluvial water source.

5 AGRICULTURAL RESOURCES IN THE VICINITY OF THE PROJECT

5.1 AGRICULTURAL LAND USE IN THE VICINITY OF THE PROJECT

MACH currently leases non-mining MACH-owned agricultural land to original landowners or other local farmers for ongoing productive use, and this practice would continue for the Project. This agricultural land is subject to a number of uses including cattle grazing, dairying, turf farming, horse breeding, and fodder cropping.

A range of agricultural enterprises are also located on private land in the vicinity of the Mount Pleasant Operation and the proposed Project. Proximal private agricultural land is largely subject to cattle grazing in the north and west, and a variety of more intensive land uses on the Hunter River floodplain to the east (including dairy farming and irrigated cropping).

The *Upper Hunter Country Touring Map* (Hunter Valley Visitor Centre, 2015) does not identify any tourism sites in the immediate vicinity of the Mount Pleasant Operation. The nearest identified tourist sites are:

- Hunter Belle Cheese and Karoola Wetlands in and around Muswellbrook, approximately 3 km east of the Mount Pleasant Operation;
- the recreation area, river walk, golf course and horse facilities in and around Aberdeen, approximately 5 km north of the Mount Pleasant Operation; and
- Muswellbrook Race Course, located approximately 2.5 km to the south, south-east of the Mount Pleasant Operation.

The Muswellbrook Race Club is one of the oldest continuous race clubs in Australia, having been established in 1862. The racecourse was established at its current location by the land owner of the time Edward 'Hunter' Bowman who owned major parcels of land in the South Muswellbrook area known as Skellatar Estate. The racecourse precinct was named Skellatar Park shortly after its establishment. Skellatar Park has five tracks being utilised including the course proper, B-grass, sand, cinders and dirt. This makes Muswellbrook Race Club one of the most significant regional training centres in Country NSW (Muswellbrook Race Club, 2017).

There are no viticulture enterprises within the immediate vicinity of the Project. With respect to equine industries, the most proximal horse stud is located on MACH-owned land to the east of the Mount Pleasant Operation and produces stock horses (Figure 4). The largest privately-owned studs in the vicinity of the Project are the Kelvinside and Newgate Studs, located over 5 km north-east and outside the Primary Visual Catchment of the Project (Figure 4). There is also one smaller privately-owned stud located in the vicinity of the Muswellbrook Race Course (Figure 4).

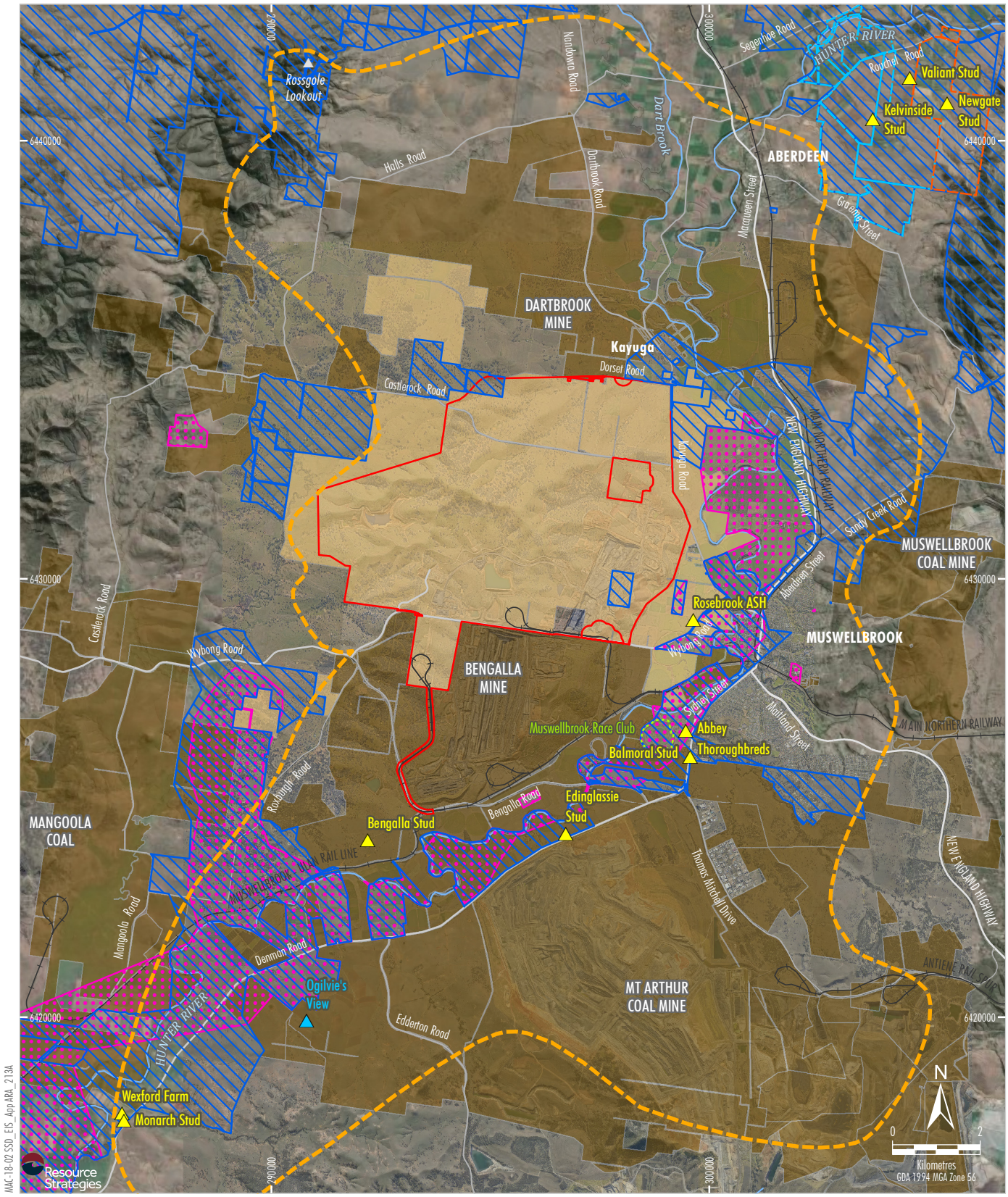
A number of equine enterprises and some viticulture enterprises have previously objected to, or commented on, the development of the approved Mount Pleasant Operation. Concerns have included potential visual effects viewed from the public road network, dynamic impacts, indirect impacts, or general concerns about the acceptability of predicted environmental impacts.

5.2 KEY AGRICULTURAL SUPPORT INFRASTRUCTURE

The New England Highway is part of the National Land Transport Network and provides an inland north-south route for freight between Hexham and the Queensland Border. It provides a means of regional freight distribution to the Northern Tablelands. The Gwydir, Oxley, Bruxner Highways and Waterfall Way provide east-west links between the New England and the Pacific Highway, although they are not easily accessible for freight with sections that are narrow, winding and steep (NSW Government, 2012).

The Hunter Expressway was opened in March 2014, reducing travel times and improving access between the Upper Hunter and Greater Newcastle (DP&E, 2016). The Golden Highway provides for regional freight distribution linking the Port of Newcastle to the Upper Hunter, Dubbo, central western and far western NSW (NSW Government, 2012).

The Hunter Valley rail network comprises track from Newcastle to Werris Creek and Ulan via Muswellbrook, including the Main Northern Railway line. The network carries coal, grain, intermodal freight, minerals and some passenger traffic and passes through the centre of several towns including Scone, Singleton, Muswellbrook, Dungog and Gloucester (NSW Government, 2012).



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Primary Visual Catchment Boundary
- Equine Enterprise
- Viticulture Enterprise
- Muswellbrook Race Club
- Kelvinside Stud (Darley Australia Pty Ltd)
- Newgate Stud (Newgate Farm Nominees Pty Ltd)

Strategic Agricultural Land

- Equine Critical Industry Cluster
- Viticulture Critical Industry Cluster

Relevant Mine Owned Land

- Mount Pleasant-controlled
- Other Mine-controlled

Source: MACH (2020); VPA (2020); NSW Spatial Services (2020)
Orthophoto: MACH (2020); Esri, DigitalGlobe (2020)

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Equine and Viticulture Enterprises in the Vicinity of the Project

Figure 4

The region also includes major water utilities (including a number of water treatment plants at power stations and dams), public hospitals (at Singleton, Dungog, Gloucester, Muswellbrook and Denman) and education facilities (NSW Government, 2012).

5.3 CLIMATE

Long-term meteorological data for the region are available from the following nearby Commonwealth Bureau of Meteorology (BoM) meteorological stations:

- Scone SCS (61089): 1950 to 2019;
- Muswellbrook (St. Heliers) (61374): 1992 to 2020;
- Aberdeen (Main Rd) (61000): 1894 to 2013;
- Aberdeen (Rossgole) (61065): 1926 to 2020;
- Denman (Palace Street) (61016): 1926 to 2014; and
- Jerrys Plains Post Office (61086): 1884 to 2014.

Short-term local meteorological data (from December 2016 onwards) are also available from the on-site M-WS4 weather station, which is operated in accordance with Development Consent DA 92/97 and EPL 20850.

Long-term average annual rainfall ranges from approximately 580 to 736 millimetres (mm), with the driest months being April, July and August and the wettest month typically being January. The average annual rainfall recorded on-site for the period December 2016 to October 2020 is approximately 457.4 mm. When compared to long-term average rainfall, the rate of evaporation exceeds rainfall on an annual average basis, as well as for all months.

The long-term average temperature ranges from a minimum of 3.4 degrees Celsius (°C) in July to a maximum of 31.9°C in January. The monthly average minimum and maximum temperatures recorded at M WS4 between December 2016 and October 2020 are 5.8°C (July) and 30.0°C (February), respectively.

5.4 TOPOGRAPHY

Landforms in the vicinity of the Mount Pleasant Operation are characterised by the broad floodplain of the Hunter River surrounded by the undulating foothills and ridges of the surrounding terrain (Plate 1), including more elevated areas within Muswellbrook.

Elevations in the vicinity of the Mount Pleasant Operation range from approximately 360 m Australian Height Datum (AHD) at Mount Pleasant to approximately 140 m AHD at the existing Hunter River pump station.

The development of the approved Mount Pleasant Operation and associated open cut mining and waste rock emplacements has resulted in alteration to the site's pre-mining topography. Modified landforms include open cuts, the Eastern Out-of-Pit Emplacement, coal and topsoil stockpiles, the Fines Emplacement Area, water management dams and other infrastructure.

The existing/approved mine landforms of the Bengalla Mine to the immediate south of the Project and Mt Arthur Coal Mine further to the south also modify the topography in the vicinity of the Project (Plate 2).

Plate 1 – Hunter River Floodplain Adjacent the Mount Pleasant Operation

Plate 2 – Other Mine Landforms Viewed from the Hunter River Floodplain

5.5 SOIL AND LAND CAPABILITY

A Soil Resource Assessment has been prepared for the Project by GT Environmental (2020) and is provided in Attachment 1.

The Soil Resource Assessment includes:

- Identification of soil management units in the Project area in accordance with the *Australian Soil Classification* (Isbell, 2002).
- Assessment of land and soil capability (LSC Class) in accordance with *The Land and Soil Capability Assessment Scheme – Second Approximation* (OEH, 2012).
- Assessment of agricultural suitability in accordance with *Agricultural Land Classification, Agfact AC.25* (NSW Agriculture, 2002).

A summary is provided in the following sub-sections.

5.5.1 Soil Management Units

Analysis of the soil management units included evaluation of 138 soil observation sites in or adjacent to the Project area. Soil management units have been classified in accordance with the *Australian Soil Classification* (Isbell, 2002) and grouped according to soil morphology, position in the landscape, and parent material (Attachment 1).

Mapping of soil management units was informed by review of regional soils data, satellite imagery and field surveys. Field surveys comprised two types of observation sites (detailed sites and check sites) (Attachment 1).

Detailed sites were undertaken at 30 locations for the Project. Additional data from detailed sites was also available from GSS Environmental (2013) and eSPADE (2020). The major information recorded for detailed sites included (Attachment 1):

- location (GDA94) and type of soil observation (e.g. erosion exposed cutting or hand auger);
- major vegetation types and density;
- landform type, position of the site and slope gradient;
- surface condition (e.g. presence of cracks, surface crust, rocks, stones and cobbles, erosion status, microrelief);
- types and vertical extent of soil horizons;
- colour (Munsell, 2009) and mottling of each horizon;
- observations of field texture, pH, presence and abundance of segregations, coarse fragments, structure, consistence, pedality and moisture content for each horizon;
- presence of organic matter, roots and prevalence of biological activity;
- presence of gleyed horizons, iron staining, and field pH; and
- photographs of the soil profile, surface and surrounding landscape.

Soil samples were collected from 12 of the detailed sites for laboratory analysis. The topsoil and subsoil from each of these sites were analysed for the following parameters (Attachment 1):

- pH (0.01 M CaCl2);
- Electrical Conductivity (EC [1:5]);
- chloride;
- Bicarbonate extractable Phosphorus (Bicarb Extr. P), buffering index;
- Exchangeable Cations (Calcium [Ca], Magnesium [Mg], Sodium [Na], Potassium [K]);
- Cation Exchange Capacity (CEC);

- Calcium/Magnesium (Ca/Mg) Ratio;
- Exchangeable Sodium Percentage (ESP);
- nitrates;
- organic matter content/carbon;
- Particle Size Analysis (PSA) – Hydrometer Method (Coarse Sand [CS], Fine Sand [FS], Silt, Clay);
- Emerson Aggregate Test (EAT);
- Dispersion ratio (R1);
- sulfate;
- metals – total (Manganese [Mn], Boron [B], Copper [Cu], Iron [Fe], Zinc [Zn]); and
- carbonate fizz test.

Check sites were undertaken at 93 sites and were used to confirm soil management units and refine mapped soil boundaries. Check sites documented attributes such as surface conditions including rock, slope percentage, landform type and position, major vegetation, land condition and boundary. These attributes also indicate useable topsoil stripping depth (Attachment 1).

The resulting soil management units are shown on Figure 5. A detailed description of each soil management unit is provided in Attachment 1.

5.5.2 Land and Soil Capability

The Land and Soil Capability Assessment Scheme – Second Approximation (OEH, 2012) uses the biophysical features of the land and soil including landform position, slope gradient, drainage, climate, soil type and soil characteristics to derive detailed rating tables for a range of land and soil hazards (OEH, 2012). The LSC Class gives an indication of the land management practices that can be applied to a parcel of land.

The LSC Classes are outlined in Table 2.

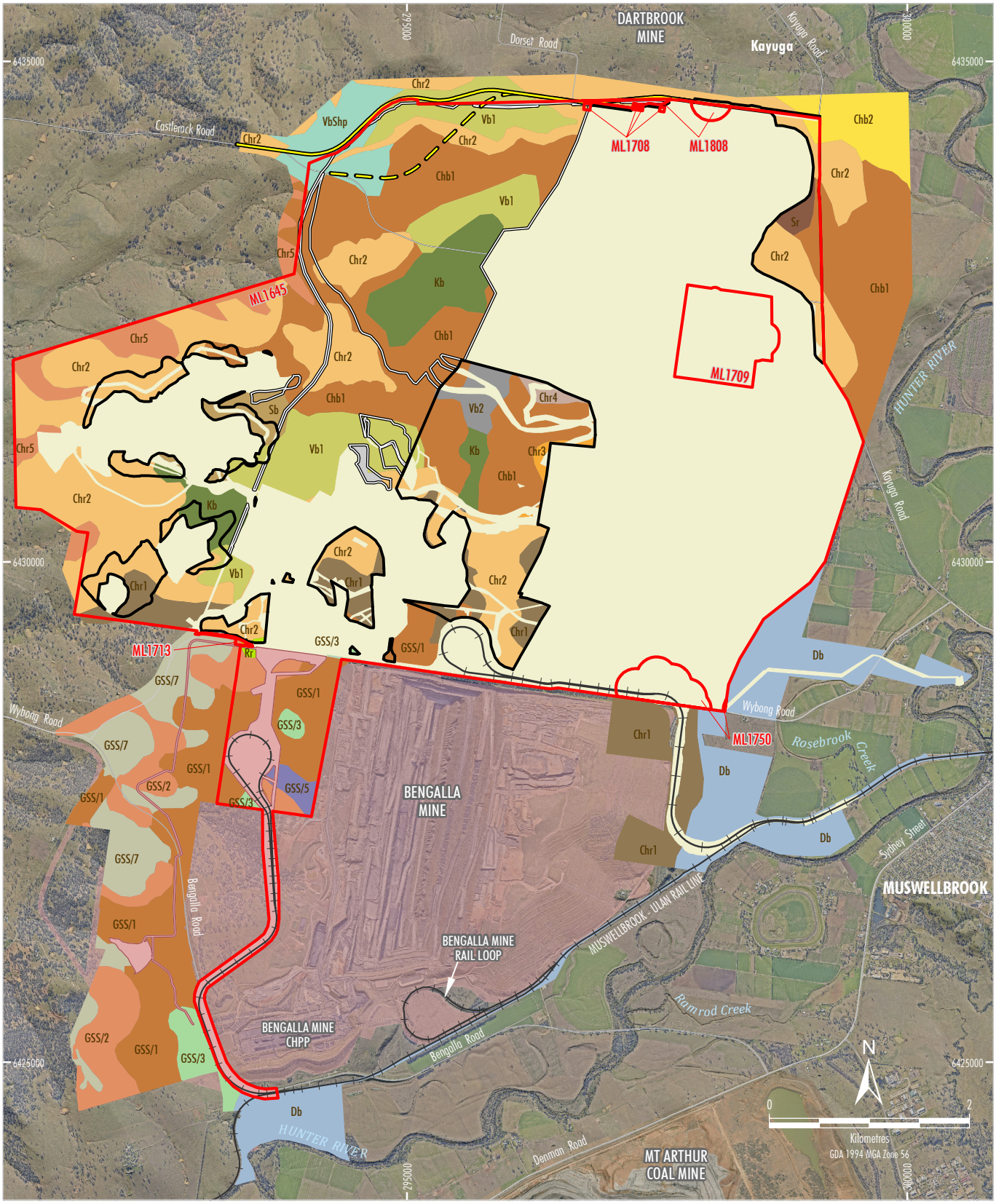
LSC Class has been mapped across the majority of the Project Area and surrounds, excluding the existing mining areas associated with the Mount Pleasant Operation (Figure 6). The land mapped within the infill disturbance areas associated with the Project and relinquishment areas has been mapped as LSC Class 3 and 4. The primary limiting factor in these areas is slope.

Part of the Hunter River alluvium to the north east of the Project is mapped as LSC Class 5. However, in practice this area is more agriculturally productive than the Project area. The limiting factor in this area is soil salinity, which exceeds 1,000 microSiemens per centimetre (µS/cm) in the surface layer but reduces lower in the soil profile (Attachment 1), potentially due to historical irrigation.

5.5.3 Agricultural Suitability

The Agricultural Suitability system is used to classify land in terms of its suitability for general agricultural use. Agricultural land is classified by evaluating biophysical, social and economic factors that may constrain the use of land for agriculture (Attachment 1).

The system is based on *Agricultural Land Classification, Agfact AC.25* (NSW Agriculture, 2002) and contains five classes of agricultural suitability (Table 3).



MAC-18-02 SSD_EIS_App ARA_204C

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline*
- Northern Link Road Option 2 Centreline

Soil Mapping Units

- Chb1 / GSS/1 - Medium Brown Chromosol on Upper to Mid-slopes
- Chb2 - Medium Brown Chromosol Variant on Gently Undulating Plains
- Chr1 - Thick Red Clayey Chromosol on Mid to Lower Slopes
- Chr2 - Medium Red Chromosol on Upper Slopes
- Chr3 - Thick Silty Red Chromosol on Upper/Simple Slopes
- Chr4 - Thick Red Clayey Chromosol on Simple Hill Slopes
- Chr5 / GSS/2 - Massive Silty Red Chromosol on Simple Slopes
- Db - Brown Dermosol
- GSS/3 - Brown Vertosol
- GSS/5 - Brown Kurosol
- GSS/7 - Rudosol
- Kb - Brown Kandosol on Upper Slopes
- Rr - Leptic Red Rudosol
- Sb - Brown Sodosol on Simple Slopes
- Sr - Red Sodosol on Mid-slopes
- Vb1 - Sodic Brown Vertosol on Mid to Upper Slopes
- Vb2 - Shallow Brown Vertosol on Simple Slopes
- VbShp - Shallow Phase of Vb1
- Area not Mapped due to Proximity to Existing Operational Area

Source: MACH (2020); GT Environmental (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

* Preferred option subject to landholder access.

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MOUNT PLEASANT OPTIMISATION PROJECT

Soil Mapping Units

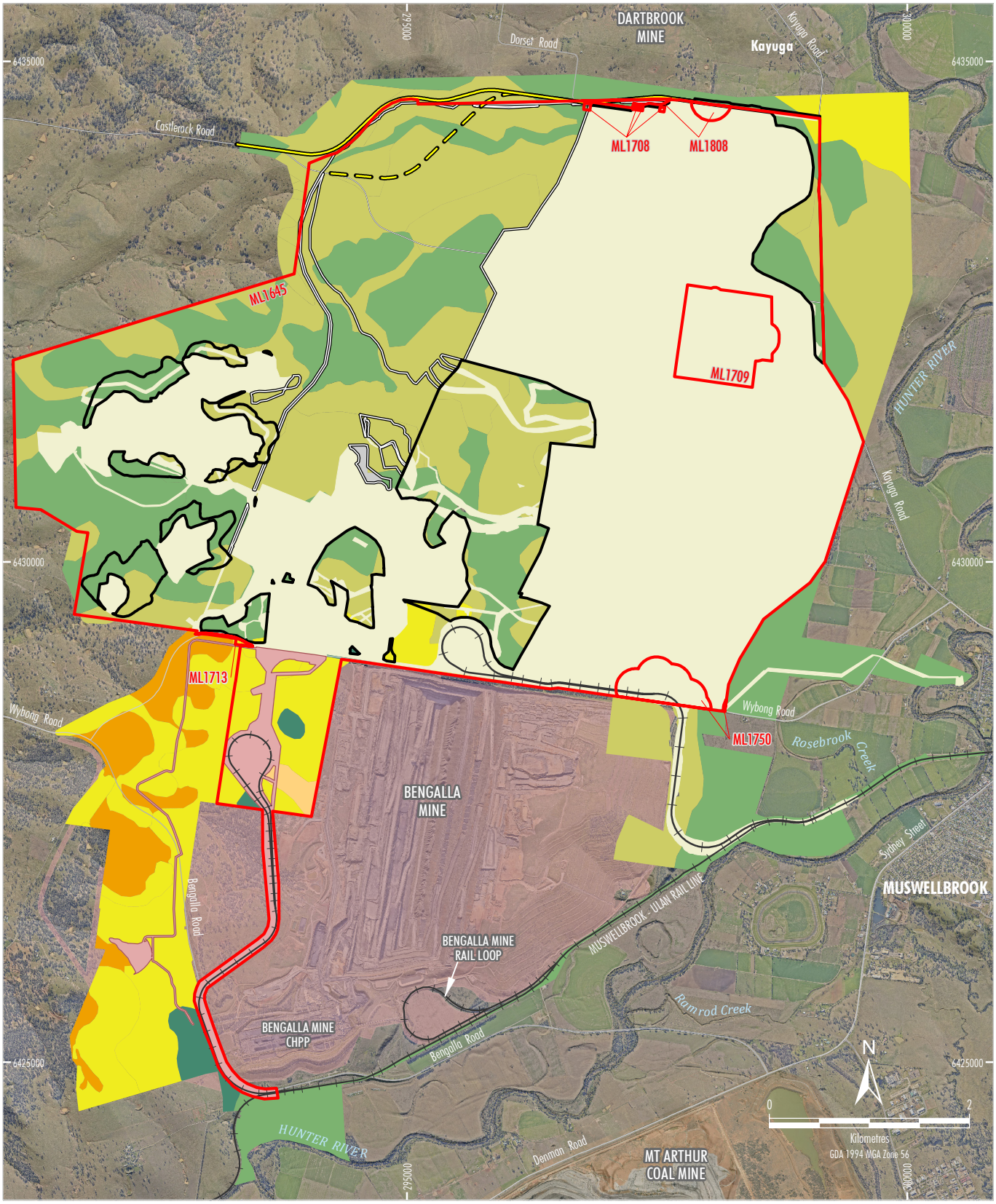
Figure 5

Table 2
Land and Soil Capability Classes

LSC Class	Definition
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	Extremely high capability land: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	Very high capability land: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	High capability land: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	Moderate capability land: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	Moderate–low capability land: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
6	Low capability land: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	Very low capability land: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	Extremely low capability land: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

Table 3
Agricultural Suitability Classes

Agricultural Suitability Class	Description
1	Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.
2	Arable land suitable for regular cultivation for crops but not suited to continuous cultivation. It has a moderate to high suitability for agriculture but edaphic (soil factors) or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures.
3	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture. The overall production level is moderate because of edaphic factors or environmental constraints. Erosion hazard, soil structural breakdown or other factors including climate may limit the capacity for cultivation, and soil conservation or drainage works may be required.
4	Land suitable for grazing but not for cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be seasonally high, but the overall production level is low as a result of major environmental constraints
5	Land unsuitable for agriculture or at best suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors which preclude land improvement.



MAC-18-02 SSD_EIS_App ARA_203C

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline*
- Northern Link Road Option 2 Centreline

Land and Soil Capability

- Class 2/4
- Class 3
- Class 4
- Class 5
- Class 6
- Class 7
- Area not Mapped due to Proximity to Existing Operational Area

Source: MACH (2020); GT Environmental (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

* Preferred option subject to landholder access.

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MOUNT PLEASANT OPTIMISATION PROJECT

Land and Soil Capability

Figure 6

Agricultural Suitability Classes have been determined using the field survey and remote sensing undertaken for the soil resource assessment. This does not include specific information on current agricultural productivity levels, social factors, economic factors, local or regional infrastructure or flooding. The agricultural suitability criteria used in the assessment are described in Attachment 1.

The Agricultural Suitability Classes in the vicinity of the Project are shown on Figure 7. The infill disturbance areas associated with the Project and relinquishment areas are mapped as Class 3 (grazing land or land well suited to pasture improvement). This is consistent with the existing and historical land use in these areas.

5.6 WATER RESOURCES

The Mount Pleasant Operation is located within the catchment of the Hunter River. The Hunter River is defined as a 'Major Regulated River', meaning that it contains a number of water storages constructed along its length, which are operated to supplement river flow (DPI – Water, 2016). These water storages include the Glenbawn Dam and the Glennies Creek Dam.

The Hunter River contains a number of significant tributaries upstream of Muswellbrook, including the Pages and Isis Rivers, as well as the Middle, Dart, Stewarts, Moonan and Rouchel Brooks. There are a number of ephemeral drainage lines which traverse the Mount Pleasant Operation area and drain into the Hunter River. The eastern portion of the mining area drains via Rosebrook Creek, as well as other unnamed drainages.

A conceptual hydrogeological model of the existing groundwater regime has been developed by AGE (Appendix C of the EIS), based on review of the available baseline groundwater data and relevant water sharing plans. The two main groundwater systems identified by AGE (Appendix C of the EIS) are:

- alluvium associated with the Hunter River and Sandy Creek; and
- Permian strata that host the coal measures.

The Project coal resource is located in the Permian Wittingham Coal measures of the Singleton Supergroup. Lithologies comprise mostly sandstones, siltstones and coal measures with minor conglomerates and tuffs.

5.6.1 Surface Water Use

Surface water use in the vicinity of the Project is regulated under the following water sharing plans under the *Water Management Act, 2000* (Figure 8):

- *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources, 2009.*
- *Water Sharing Plan for the Hunter Regulated River Water Source, 2016.*

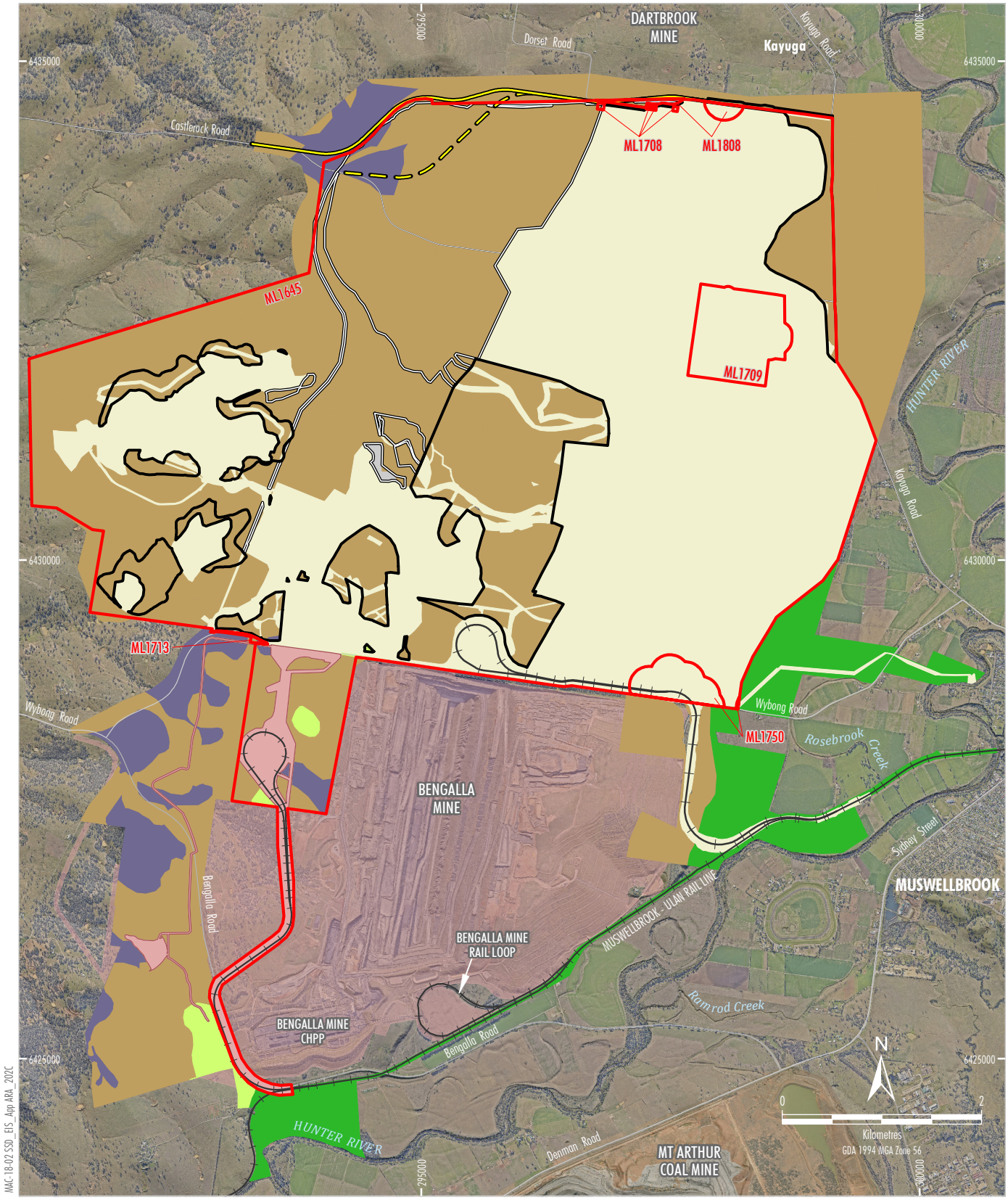
Hunter Regulated River

Water use from the Hunter River is regulated under the *Water Sharing Plan for the Hunter Regulated River Water Source, 2016.* The Mount Pleasant Operation is located adjacent to the Hunter Regulated River Water Source Management Zone 1A, which extends from Glenbawn Dam to the Goulburn River confluence.

A summary of the water access licences in the Hunter Regulated River Water Source is provided in Table 4.

To provide an understanding of the use of the regulated flows of the Hunter River, the Upper Hunter Mining Dialogue (UHMD) publish the Upper Hunter Water Balance annually. In 2018, 188.1 gigalitres (GL) entered the Hunter River system upstream of Singleton, comprising 183.7 GL of environmental flows and dam releases and 4.4 GL of net rainfall runoff (i.e. rainfall runoff less evaporation). This water was used as follows (UHMD, 2018):

- 52.0 GL (28%) flowed past Singleton, including environmental flows.
- 14.6 GL (8%) was used for mining, including incidental take.
- 121.5 GL (65%) was extracted for power station use, agriculture, town water supply and other uses.



MAC-18-02 SSD_EIS_App ARA_202C

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline*
- Northern Link Road Option 2 Centreline

Agricultural Land Classification

- Class 2/3
- Class 2
- Class 3
- Class 4
- Area not Mapped due to Proximity to Existing Operational Area

Source: MACH (2020); GT Environmental (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

* Preferred option subject to landholder access.

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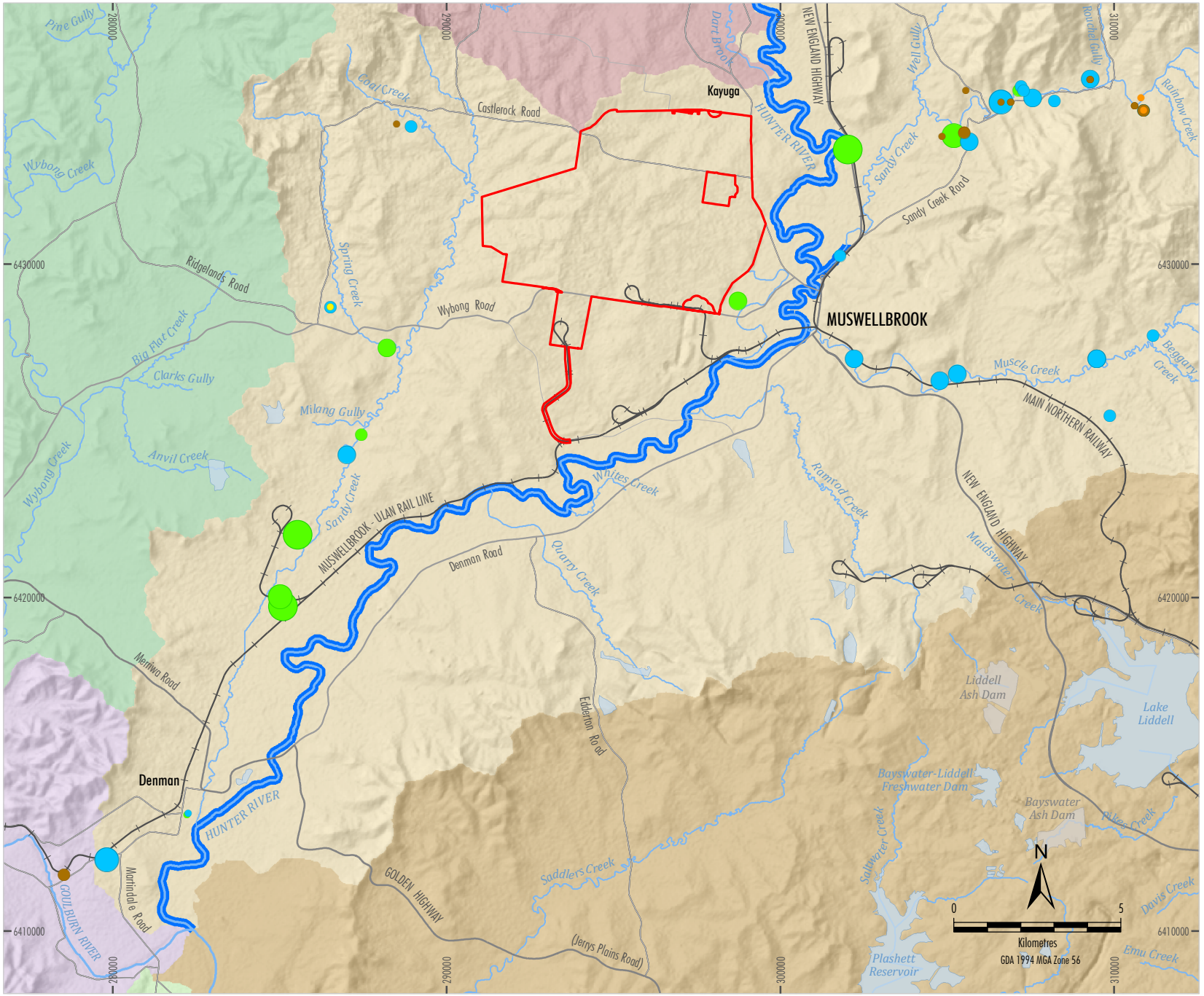
MOUNT PLEASANT OPTIMISATION PROJECT

Agricultural Suitability Assessment

Figure 7



LEGEND

Mining Lease Boundary (Mount Pleasant Operation)

Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009

- Muswellbrook Water Source
- Dart Brook Water Source
- Lower Goulburn River Water Source
- Jerrys Water Source
- Wybong Creek Water Source
- Martindale Creek Water Source

Water Sharing Plan for the Hunter Regulated River Water Source 2016

- Hunter Regulated River Water Source

WATER ACCESS LICENCES

Aquifer

- 1 - 5 shares
- 6 - 20 shares
- 20 - 50 shares
- 50 - 100 shares
- 100+ shares

Unregulated River

- 1 - 5 shares
- 6 - 20 shares
- 20 - 50 shares
- 50 - 100 shares

Domestic and Stock

- 1 - 5 shares
- 6 - 20 shares

Domestic and Stock (Domestic)

- 1 - 5 shares

Domestic and Stock (Stock)

- 1 - 5 shares

Source: NSW Spatial Services (2020); NSW Department of Primary Industries - Water (2020)

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MOUNT PLEASANT OPTIMISATION PROJECT

Relevant Surface Water Sources

Figure 8

MAC-18-02 SSD_EIS_App ARA_205B

Table 4
Hunter Regulated River Water Source – Water Access Licences

Category	Number of WALs	Total Shares
Domestic and stock	165	1,569
Domestic and stock (domestic)	60	144
Domestic and stock (stock)	21	103
Local water utility	5	10,832
Major utility	1	36,000
Regulated river (general security)	827	128,544
Regulated river	156	21,740
Supplementary water	240	48,519

Source: NSW Water Register (2020).

Note: WALs = Water Access Licences.

Muswellbrook Water Source

The Project is located wholly within the Muswellbrook Water Source, which is regulated under the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources, 2009*.

The locations of water access licences in the Muswellbrook Water Source are shown on Figure 8 and summarised in Table 5.

Table 5
Muswellbrook Water Source – Water Access Licences

Category	Number of WALs	Total Shares
Aquifer	14	1169
Domestic and stock	15	81
Domestic and stock [domestic]	2	2
Domestic and stock [stock]	1	5
Unregulated river	24	636

There are two unregulated river licences located downstream of the Project on Sandy Creek:

- WAL 18701 has a total entitlement of 28 units and is located on land owned by Mangoola Coal, approximately 9 km downstream of ML 1645.
- WAL 18700 has a total entitlement of 5 units and is located in Denman, approximately 23 km downstream of ML 1645.

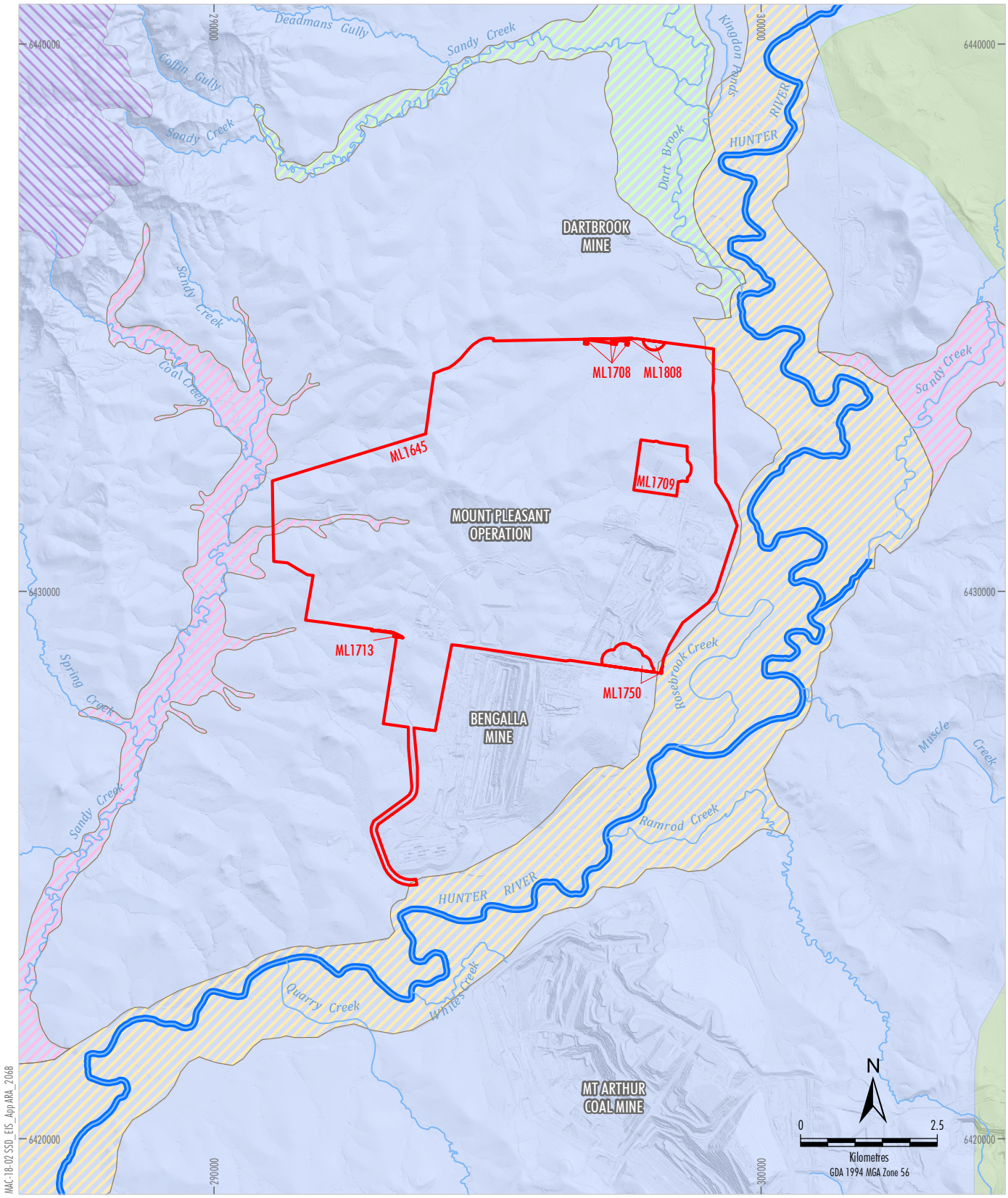
5.6.2 Groundwater Use

Groundwater use in the vicinity of the Project is regulated under the following water sharing plans under the *Water Management Act, 2000* (Figure 9):

- *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016.*
- *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009.*

The Permian hard rock groundwater associated with the Sydney Basin-North Coast Groundwater Source is mapped as ‘less productive’ in accordance with the AIP (DPI – Water, 2012).

All the alluvial groundwater sources in the vicinity of the Project are mapped as ‘highly productive’, although in reality, yields and water quality can vary considerably.



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)

Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016

- Liverpool Ranges Basalt Coast
- New England Fold Belt Coast
- Sydney Basin - North Coast

Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009

- Unnamed Alluvium within Dart Brook Water Source
- Hunter Regulated River Alluvial Water Source
- Unnamed Alluvium within Muswellbrook Water Source

Water Sharing Plan for the Hunter Regulated River Water Source 2016

- Hunter Regulated River Water Source

Source: NSW Spatial Services (2020); NSW Department of Primary Industries - Water (2020)

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MOUNT PLEASANT OPTIMISATION PROJECT

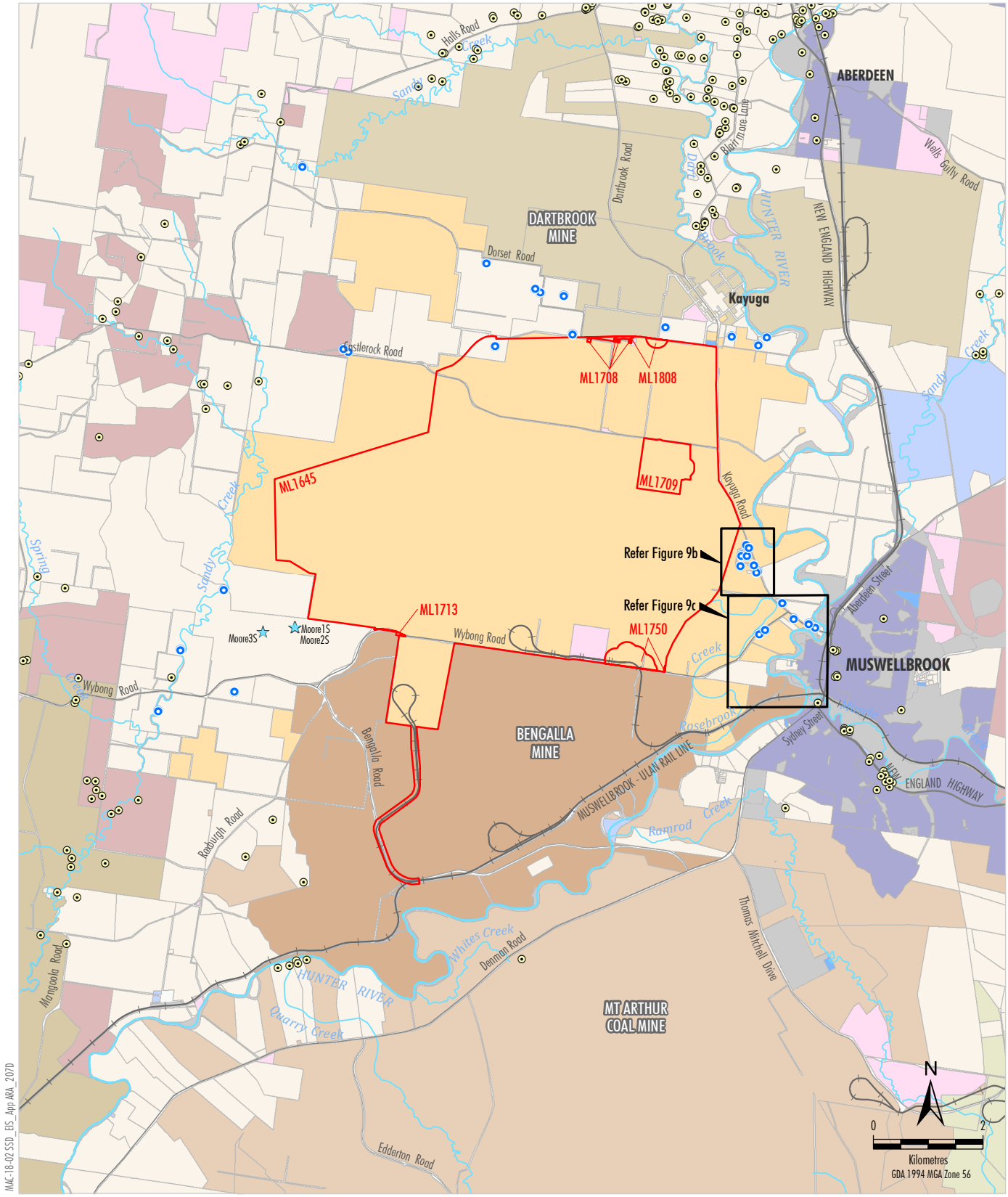
Relevant Groundwater Sources

Figure 9

MACH has conducted a census of privately-owned groundwater bores in the vicinity of the Mount Pleasant Operation (Appendix C of the EIS). The census involved:

- Characterisation of existing groundwater bores through collation and review of the WaterNSW registered bore database and other regional information (e.g. 1:25,000 topographic maps).
- Site visits with local landholders to confirm the location and use of groundwater bores on their property.
- Opportunistic collection of baseline data where practical (e.g. water levels and basic water quality parameters).

Groundwater bores, wells and springs identified on privately-owned land during the census are shown on Figures 10a, 10b and 10c. A number of bores were also visited on mine-owned land during the census (e.g. monitoring bores). WaterNSW records are shown for properties that are more distant from the Mount Pleasant Operation.



MAC-18-02 SSD_EIS_App ARA_207D

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Mount Pleasant-controlled
- Bengalla-controlled
- Dartbrook-controlled
- Mangoola-controlled
- Muswellbrook Coal-controlled
- Mt Arthur-controlled
- Other Mining/Resource-controlled
- Crown
- The State of NSW
- Muswellbrook Shire Council
- Upper Hunter Shire Council
- Privately-owned Land
- Muswellbrook and Upper Hunter LEP Zones B2, B5, R1, R5
- Muswellbrook and Upper Hunter LEP Zones IN1, SP2, RE1, RE2, W1
- Bore/Well on Privately-Owned Land (Bore Census)
- Spring on Privately-owned Land (Bore Census)
- Water NSW Record

Source: MACH (2020); Water NSW (2020); NSW Spatial Services (2020)

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MOUNT PLEASANT OPTIMISATION PROJECT

Groundwater Bores, Wells and Springs Identified during the Bore Census

Figure 10a

MAC-18-02 SSD_EIS_App ARA_211B

LEGEND
- Mining Lease Boundary (Mount Pleasant Operation)
- Mount Pleasant-controlled
- Privately-owned Land
- Muswellbrook and Upper Hunter LEP Zones IN1, SP2, RE1, RE2, W1
- Bore/Well on Privately-Owned Land (Bore Census)

Source: MACH (2020); Water NSW (2020); NSW Spatial Services (2020)

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MOUNT PLEASANT OPTIMISATION PROJECT

Groundwater Bores, Wells and Springs Identified during the Bore Census

Figure 10b

LEGEND
- Mount Pleasant-controlled
- Bengalla-controlled
- Crown
- The State of NSW
- Muswellbrook Shire Council
- Privately-owned Land
- Muswellbrook and Upper Hunter LEP Zones B2, B5, R1, R5
- Muswellbrook and Upper Hunter LEP Zones IN1, SP2, RE1, RE2, W1
- Bore/Well on Privately-Owned Land (Bore Census)
- Water NSW Record

Source: MACH (2020); Water NSW (2020); NSW Spatial Services (2020)

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MOUNT PLEASANT OPTIMISATION PROJECT

Groundwater Bores, Wells and Springs Identified during the Bore Census

Figure 10c

6 POTENTIAL IMPACTS ON AGRICULTURAL RESOURCES

6.1 PROPOSED SURFACE DISTURBANCE

The Project would consolidate the existing/approved open cut mining disturbance of the Mount Pleasant Operation (Figure 2).

The Project open cut extent would remain wholly within the existing Mount Pleasant Operation Mining Leases (Figure 2).

The Project would result in no significant increase in total disturbance area compared to the existing approved Mount Pleasant Operation, due to the relinquishment of an approved disturbance area in the north-west. The infill disturbance areas associated with the Project and relinquishment areas are both mapped as Class 3 (grazing land or land well suited to pasture improvement).

There is no NSW Government-mapped BSAL or CIC land within the Project General Extension Areas (Figure 3).

Part of the relinquishment area intersects a lot classified as equine CIC. The proposed Northern Link Road Option 1 would traverse this same lot. The proposed Northern Link Road Option 1 is not considered to significantly impact the equine CIC given:

- The currently approved Northern Link Road alignment is similar to the proposed Project realignment Option 1.
- The Project would reduce the total area of equine CIC approved to be disturbed by the Mount Pleasant Operation (i.e. due to relinquishment of the North-West Out-of-Pit Emplacement).
- The nature of the road would limit potential impacts on the block of equine CIC (i.e. it would be established as a replacement public road for existing road users that travel on Castlerock Road rather than an access route for the Mount Pleasant Operation).
- The link road would not adversely impact travel times or accessibility to Scone from any equine operations located north west of the Project.

6.2 DISPLACEMENT OF AGRICULTURE OVER THE LIFE OF THE PROJECT

6.2.1 Project Mining Leases

The Project is primarily located on MACH-owned land consisting of previously cleared agricultural areas used for cattle grazing. The most recent disaggregated data published by the ABS (2017) similarly indicates that as of 2015-16, livestock (cattle and calves) accounted for around 60% of gross value (agricultural output valued at market prices) in the Statistical Area Level 2 regions of Muswellbrook and the Muswellbrook Region (Appendix O of the EIS).

AnalytEcon (2021) has assessed the potential impacts agricultural impacts of the Project as they relate to the temporary displacement of agriculture over the Project life. These losses refer to (Appendix O of the EIS):

- the forgone gross value of agricultural production; that is, the forgone revenue from the sale of primary agricultural products due to the disruption of agricultural land use; and
- the forgone net value of agricultural production; that is, the forgone gross revenue less the costs of production due to the disruption of agricultural land use.

The direct agricultural impacts of the Project relate to the forgone net value of agricultural production, and represent an opportunity cost for MACH. That is, while the Project generates significant value added as a result of coal mining activities, that value added has an opportunity cost in the form of the value added from agricultural activities that is forgone (Appendix O of the EIS).

To estimate the forgone net value of agricultural production, an estimate of 4,100 hectares (ha) of land that would be displaced from agricultural production has been adopted for both the Mount Pleasant Operation and the Project (corresponding to the approximate area of the mining leases). This estimate assumes that the entire mining lease areas would be unavailable for agricultural use over the life of the Mount Pleasant Operation and the Project, respectively. This is considered to be a conservative approach; in reality, only discrete portions of the mining lease areas would be unavailable at a time as these areas are progressively developed. These same areas are then progressively restored (primarily to woodland) as this infrastructure is decommissioned and these areas are rehabilitated (Appendix O of the EIS).

The foregone gross margin due to the Mount Pleasant Operation (incorporating the Project) is approximately $22.8 million in net present value (NPV) terms. The total incremental forgone gross margin associated with the Project is around $5.5 million in NPV terms (Appendix O of the EIS).

6.2.2 Biodiversity Offset Areas

The Mount Pleasant Operation has already offset the approved biodiversity impacts of the mine, with the establishment of major biodiversity offsets of some 12,875 ha on a number of regional properties with a combined area of 15,590 ha and managed in accordance with the Offset Management Plan and Re-Establishment Plan (MACH, 2020).

The Project would involve the relinquishment of a significant portion of the approved disturbance area of the Mount Pleasant Operation, to compensate for proposed infill disturbance areas. Accordingly, the additional biodiversity offset requirements for the Project are anticipated to be minimal.

Notwithstanding, any agricultural land associated with the additional Project biodiversity offset areas would be permanently displaced. The forgone value of agricultural production from any biodiversity offset area is not expected to be significant, as the site would be selected for its biodiversity values and is therefore expected to have marginal agricultural value (Appendix O of the EIS).

6.3 POTENTIAL INDIRECT IMPACTS ON PROXIMAL AGRICULTURAL LAND

A range of agricultural enterprises are located on private land in the vicinity of the Mount Pleasant Operation and the proposed Project.

MACH has approached the design of this Project and its relationship with nearby agricultural enterprises with the following aims:

- being open to the feedback of nearby agricultural enterprises on the existing impacts of the Mount Pleasant Operation;
- facilitating ongoing agricultural production on available MACH-owned lands and the productive use of MACH water resources that are not presently required for mining; and
- incorporating staging in the Project design to reduce potential incremental Mount Pleasant Operation impacts on nearby residences, including proximal agricultural enterprises.

Table 6 presents a summary of the key assessment outcomes related to adjacent agricultural enterprises. MACH would continue to facilitate the productive use of agricultural land it owns outside of Project active mining areas through leasing arrangements (e.g. to local farmers) over the life of the Project.

Table 6
Summary of Key Assessment Outcomes for Nearby Agricultural Enterprises

Potential Impact	Summary of Assessment Outcome
Potential impacts to infrastructure used by nearby agricultural enterprises	
Increased traffic levels on surrounding road network.	The Project would continue to use the existing site access to the Mount Pleasant Operation. Heavy vehicle deliveries would be required to continue using Bengalla Road and Wybong Road and would be prohibited from use of the Kayuga Bridge over the Hunter River. Any employee travel on Kayuga Road would be primarily limited to employees residing locally (e.g. in Aberdeen and Scone). The Road Transport Assessment (Appendix J of the EIS) concludes that the existing road network can satisfactorily accommodate the forecast traffic demands resulting from the Project without any specific additional road upgrade requirements.
Changes in the surrounding road network.	The approved Mount Pleasant Operation is already required to construct the Northern Link Road to compensate for the planned closure of Castlerock Road. MACH would not close Wybong Road or construct the currently approved Western Link Road as a component of the Project. The proposed Project realignment of the Northern Link Road would have no material impact on travel time on the surrounding road network, and has been designed to optimise efficiency.
Access to agricultural support services and infrastructure.	The Project would not have any material incremental impact on agricultural support services or infrastructure, as MACH would continue to make its agricultural properties that are not required for mining available for ongoing productive agricultural use by local farmers. MACH further contributes to local demand for agricultural and rural services through Mount Pleasant Operation on-site weed and pest management activities, on-site and off-site fencing, rehabilitation works, maintenance activities and management of its major biodiversity offset properties in the broader region.
Potential impacts to agricultural resources used by nearby agricultural enterprises	
Availability and/or quality of water available to agricultural enterprises.	The Project would not have any material impacts on water resources used by nearby agricultural enterprises (water extraction would continue from the regulated Hunter River and other sources in accordance with applicable water access licences) (Appendices C and D of the EIS).
Increased biosecurity risks (weeds, plants and animals).	MACH would continue to implement weed and pest animal management programs to reduce biosecurity risks to off-site areas. Where vehicles and mechanical equipment have operated off-road, these would be washed down to minimise seed transport off site.
Potential impacts affecting amenity	
Construction noise, operational noise and dust emissions.	Noise and air quality contributions from the Project on adjoining agricultural properties would be broadly consistent with the currently approved Mount Pleasant Operation, with local and temporal changes in emission levels occurring as the open cut activities initially progress north, and then westwards over the life of the Project. Wilkinson Murray (2020) and TAS (2020) concluded that MACH's proposed staging of the expansion of Project ROM coal production would be effective in minimising potential noise and air quality impacts to the majority of receivers in the vicinity of the Mount Pleasant Operation (Appendices A and B of the EIS).
Blasting and blast vibration.	The Project would comply with applicable overpressure and blast vibration criteria at nearby private residences with the application of blast management measures, including minimising blast maximum instantaneous charge (Appendix A of the EIS).
Odour.	Any spontaneous combustion that may occur over the life of the Project would be managed in accordance with the Mount Pleasant Operation Spontaneous Combustion Management Plan (Appendix B of the EIS).
Visual and landscape changes.	The landforms and activities of the existing approved Mount Pleasant Operation are visible from surrounding agricultural properties, from the public road network and west-facing areas of Muswellbrook (Appendix M). The lights of the Mount Pleasant Operation are also visible at night (i.e. a combination of direct and indirect lighting effects). The Project expansion in elevation and scale of the integrated waste rock emplacement landform and associated activities (including lighting) would alter the visual impacts of the approved Mount Pleasant Operation from nearby rural properties. There would be moderate cumulative impacts due to the extension of duration of the mine operations that would be evident in the local and sub-regional area (Appendix M of the EIS). These impacts would be mitigated through progressive rehabilitation.

6.4 POTENTIAL INDIRECT IMPACTS ON REGIONAL EQUINE AND VITICULTURE ENTERPRISES

No equine or viticulture enterprises have been identified in the EIS assessments that would experience material adverse direct impacts as a result of the Project that are not already occurring with the approved Mount Pleasant Operation. The nearest equine enterprise is a horse stud that is located on land that MACH owns and produces stock horses.

Representatives of the Hunter Thoroughbred Breeders Association, Coolmore Australia and Godolphin have recently advised the NSW Independent Planning Commission that existing major open cut mining operations have not noticeably affected the thoroughbred horses or the viability of the Coolmore and Godolphin Woodlands Studs (NSW Independent Planning Commission, 2020). The existing HVO North and Mt Arthur Coal Mine open cuts have operated at distances of approximately 5 to 6 km from the Coolmore and Godolphin Woodlands Studs.

The Project is located a significant distance from the key parts of the equine CIC as follows:

- Scone and the associated concentration of horse studs and support facilities (including the Scone Equine Hospital) is located over 15 km north of the Project.
- The “epicentre” of the thoroughbred breeding industry in the Hunter Valley associated with Coolmore and Godolphin Woodlands Studs is located approximately 20 km south of the Project.

Table 7 summarises potential Project visual impacts from the public road network, dynamic impacts and concerns/fears or perceptions about predicted environmental impacts.

The Muswellbrook Race Club is proximal to the existing Bengalla Mine, Mt Arthur Coal Mine and is located approximately 2.5 km to the south, south-east of the Mount Pleasant Operation. The Race Club is also located in close proximity to the Muswellbrook–Ulan Rail Line and the approved Mount Pleasant Operation Stage 2 rail infrastructure (i.e. rail spur).

The construction of the approved Stage 2 rail infrastructure will occur in 2020/21/22. The Mount Pleasant Operation open cut is also currently at its closest proximity to the Race Club, with mining activities currently centred in the south-east of ML 1645.

The Race Club also has existing views of the more proximal components of the Bengalla Mine and Mt Arthur Coal Mine landforms. Over the life of the Project, the focus of Mount Pleasant Operation mining activities would progressively move north and west, away from the Race Club.

Compliance with all applicable air quality and noise criteria is predicted at the Muswellbrook Race Club (Appendices A and B of the EIS).

There would not be any material additional incompatibility between the Project and the Muswellbrook Race Club, given that Project impacts would be similar to the approved Mount Pleasant Operation. Existing impacts would be ameliorated with progressive rehabilitation and as the Mount Pleasant Operation moves west.

Table 7
Summary of Key Assessment Outcomes for Regional Equine and Viticulture Enterprises

Potential Impact	Summary of Assessment Outcome
Potential indirect, flow-on or perceptual impacts on equine and viticulture enterprises	
Visual and landscape changes.	In the sub-regional and regional context, the expansion in scale and elevation of the integrated waste rock emplacement landform associated with the Project is considered to be consistent with extensive existing mining landscapes within the region (Appendix M of the EIS). The relinquishment of some previously approved disturbance areas would balance the additional disturbance areas required for the Project (Appendix M of the EIS). There are a number of horse studs (i.e. Abbey Thoroughbreds, Balmoral Park Thoroughbred Studs and Edinglassie Stud) that have high visual impacts from the approved Mount Pleasant Operation, in the context of these businesses also having views of other mining operations (e.g. Bengalla Mine and Mt Arthur Coal Mine). The visual impacts of the Project on these horse studs would continue to be high to moderate/low and would reduce in the long term (Appendix M of the EIS). There would be no views of the Project from Monarch, Coolmore and Godolphin Woodlands, Kelvinside, Segenhoe and Yarraman Park Studs and therefore there would be no visual impacts at these more remote locations (Appendix M of the EIS). It is expected that the potential diffuse light effects of the Project would extend further north in comparison to the existing levels, creating more localised lighting visual impacts. However, the nature of the diffuse light effects would be consistent with the approved effects of the approved Mount Pleasant Operation and the existing effects of other developments in the vicinity of the Project (e.g. Bengalla Mine and Mt Arthur Coal Mine) (Appendix M of the EIS).
Dynamic impacts, perception of impacts as a result of preferences, associations and memories.	Personal perceptions would be affected by preferences, associations and memories derived from reading, hearing and/or seeing information on previous, existing and proposed activities and stakeholder interactions. Perceptions vary between individuals and can, therefore, be difficult to assess (Appendix M of the EIS). DP&E (2017) relevantly states: *When considering perceptions of adverse impacts on amenity, an evaluation must be made of the reasonableness of those perceptions. This evaluation involves 'the identification of evidence that can be objectively assessed to ascertain whether it supports a factual finding of an adverse effect on amenity…': Telstra Corporation Ltd v Hornsby Shire Council [2006] NSWLEC 133.* The impact of the Project on the landscape and the extended duration of those impacts over time in the context of existing land use patterns at the regional, subregional and local scales would create a moderate dynamic landscape impact (Appendix M of the EIS). MACH would continue to engage with agricultural industries to identify and manage any concerns (including concerns regarding customer perceptions) over the life of the Project.

7 CONCLUSION

This Agricultural and Land Resources Assessment provides a consolidated summary of the potential impacts of the Project on agricultural resources.

The Project proposes extraction of additional coal reserves within Mount Pleasant Operation Mining Leases and an increase in the rate of coal extraction without significantly increasing the total disturbance footprint. The extraction of additional Project coal reserves would be supported by the use and augmentation of existing and approved infrastructure at the Mount Pleasant Operation (Figure 2).

The Project would result in no significant increase in total disturbance area compared to the existing approved Mount Pleasant Operation, due to the relinquishment of an approved disturbance area in the north-west. The infill disturbance areas associated with the Project and relinquishment areas are both mapped as Class 3 (grazing land or land well suited to pasture improvement).

There is no NSW Government-mapped BSAL or CIC land within the Project General Extension Areas (Figure 3). Part of the relinquishment area intersects a lot classified as equine CIC. The proposed Northern Link Road Option 1 would traverse this same lot (Figure 3). The proposed Northern Link Road Option 1 is not considered to significantly impact the equine CIC.

The foregone gross margin due to the Mount Pleasant Operation (incorporating the Project) is approximately $22.8 million in NPV terms. The total incremental forgone gross margin associated with the Project is approximately $5.5 million in NPV terms (Appendix O of the EIS). The forgone value of agricultural production from any additional Project biodiversity offset areas is not expected to be significant (Appendix O of the EIS).

No equine or viticulture enterprises have been identified in the EIS assessments that would experience material adverse direct impacts as a result of the Project that are not already occurring with the approved Mount Pleasant Operation.

MACH has approached the design of this Project and its relationship with nearby agricultural enterprises with the following aims:

- being open to the feedback of nearby agricultural enterprises on the existing impacts of the Mount Pleasant Operation;
- facilitating ongoing agricultural production on available MACH-owned lands and the productive use of MACH water resources that are not presently required for mining; and
- incorporating staging in the Project design to reduce potential incremental Mount Pleasant Operation impacts on nearby residences, including proximal agricultural enterprises.

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Attachment 1

Soil Resource Assessment

Soil Resource Assessment

Mount Pleasant Optimisation Project
MACH Energy Australia Pty Ltd

Final
12 December 2020

GTenvironmental

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EXECUTIVE SUMMARY

GT Environmental Pty Ltd (GTE) was commissioned by MACH Energy Australia Pty Ltd (MACH Energy) to conduct a soil resource assessment (SRA) for the Mount Pleasant Optimisation Project (the Project).

Extension of the Project site is to the west and south-west in Mining Lease (ML) 1645 with open cut mining to remain contained in the current ML. The Project site covers an area of 3,825 hectares (ha) and includes existing mining areas covering an area of 1,240 ha. Expansion and upgrading of on-site coal handling and processing facilities, administration, electricity supply and general supporting facilities would occur on the Project site.

This SRA was scoped and conducted in accordance with the *Guidelines for Surveying Soils and Land Resources* (McKenzie *et al*. 2008). These Guidelines were developed to provide a consistent approach to soil survey methodology across Australia. Soil characteristics and soil profiles have been described in accordance with the *Australian Soil and Land Survey Handbook* (National Committee on Soil and Terrain, 2009 and Gunn *et al*. 1988).

Collection of soil samples for laboratory analysis was undertaken in line with the Land Suitability Assessment Techniques (LSAT) outlined in the *Technical Guidelines for Environmental Management of Exploration and Mining in Queensland* (Department of Minerals and Energy, 1995). Laboratory analysis was based on the *Agricultural Impact Statement Technical Notes* (NSW Department of Primary Industries [DPI], 2013).

Determination of land capability at the Project site has been conducted based on land and soil capability (LSC) classes in the Project site based on *The Land and Soil Capability Assessment Scheme – Second Approximation* (NSW Office of Environment and Heritage [OEH], 2012).

Assessment of agricultural suitability at the Project site has been conducted based on *Agricultural Land Classification, Agfact AC.25*, (NSW Agriculture, 2002).

Selection of Topdressing Material for Rehabilitation of Disturbed Areas in the Hunter Valley (Elliot and Veness, 1981) was used to assess the soil resources throughout the Project site.

The following conclusions have been made:

- Twelve soil mapping units (SMUs) identified during assessment including one variant[1] and one phase[2], as well as five pre-existing SMUs from existing soils data are present in the Project site,

[1] A soil with one or more attributes outside the usual range for a defined soil profile class, but because of its restricted distribution (or because the varying properties are not considered to have particular management significance), it is not defined as a separate soil profile class.

[2] A subdivision of a soil profile class based on attributes that have particular significance for land use, such as shallow phase, where the soil depth is predominantly shallow and may influence particular land uses.

- The Project site includes areas of flat to gently undulating plains dominated by uniform and gradational dermosol clays to undulating plains of texture contrast dermosols, sodosols and kandosols. Uniform and gradational shallow and moderately deep clays are present on simple and upper slopes with a small area (two hectares) of rudosols observed,
- Land suitability has been assessed against the Land and Soil Capability Assessment (OEH, 2012) and Agricultural Land Classification (NSW Agriculture, 2002), the results of which are outlined in Tables E-1 and E-2,
- Sufficient topsoil is suitable for rehabilitation use. Topsoil suitable for rehabilitation use is suitable in supporting native vegetation, grasses and grazing agricultural activities,
- Eight SMUs (Chr1, Chr2, Vb1, Vb2, Chr4, Chb2, Rr and Db) may provide suitable subsoil for supporting topsoil placement without the need for amelioration. Other subsoils are not suitable for rehabilitation use unless improved with amelioration,
- Recommended topsoil and subsoil stripping depths, with appropriate treatment measures (where required), are provided in Table 7-9, and
- The proposed post-mine final land use for the majority of the Project site will be restored to self-sustaining native woodland ecosystems characteristic of vegetation communities found in the local area.

Table E-1: Land and Soil Capability Assessment Summary

Land and Soil Capability Class	Description	SMU
1	Extremely high capability land: Land has no limitations.	-
2	Very high capability land: Land has slight limitations.	-
3	High capability land: Land has moderate limitations.	Chr2, Kb, Chr4, Db
4	Moderate capability land: Land has moderate to high limitations.	Chr1, Vb1 (VbShp), Sb, Chr3, Vb2, Chb1, Sr, Chr5, GSS/3
5	Moderate–low capability land: Land has high limitations.	Chb2, Rr, GSS/1, GSS/2
6	Low capability land: Land has very high limitations.	GSS/5
7	Very low capability land: Land has severe limitations.	GSS/7
8	Extremely low capability land: Land is incapable of sustaining any land use apart from nature conservation.	-

Table E-2: Agricultural Suitability Assessment Summary

Agricultural Suitability Class	Description	SMU
1	Arable land suitable for intensive cultivation.	-
2	Arable land suitable for regular cultivation.	Db
3	Grazing land.	Vb2, Sr, Chr1, Chr2, Vb1, Sb, Chr3, Kb, Chb1, Chr4, Chr5, Chb2, GSS/1, GSS/2, GSS/3
4	Land suitable for grazing but not for cultivation.	VbShp, Rr, GSS/5, GSS/7
5	Land unsuitable for agriculture or at best suited only to light grazing.	-

1 INTRODUCTION

1.1 Project Details

The Mount Pleasant Operation Development Consent DA 92/97 was granted on 22 December 1999. The Mount Pleasant Operation was also approved under the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) in 2012 (EPBC 2011/5795).

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation from Coal and Allied Operations Pty Ltd on 4 August 2016. MACH Energy commenced construction activities at the Mount Pleasant Operation in November 2016 and commenced mining operations in October 2017, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

MACH Mount Pleasant Operations Pty Ltd manages the Mount Pleasant Operation as agent for and on behalf of the unincorporated Mount Pleasant Joint Venture between MACH Energy (95% owner) and J.C.D. Australia Pty Ltd (5% owner)[3].

The approved Mount Pleasant Operation includes the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure located approximately three kilometres (km) north-west of Muswellbrook in the Upper Hunter Valley of New South Wales (NSW) (Figures 1 and 2).

The mine is approved to produce up to 10.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. Up to approximately nine trains per day of thermal coal products from the Mount Pleasant Operation are transported by rail to the Port of Newcastle for export, or to domestic customers for use in electricity generation.

GT Environmental Pty Ltd (GTE) was commissioned by MACH to conduct a Soil Resource Assessment (SRA) for the Mount Pleasant Optimisation Project (the Project).

Extension of the Project site is to the west and south-west in Mining Lease (ML) 1645 with open cut mining to remain contained in the current ML. The Project site covers an area of 3,825 hectares (ha) and includes existing mining areas covering an area of 1,240 ha. Expansion and upgrading of on-site coal handling and processing facilities, administration, electricity supply and general supporting facilities would occur on the Project site.

1.1.1 Objective of report

The objective of this SRA is to assist in the preparation of a State Significant Development (SSD) Application for the Project by mapping the available soil resources. In addition, this SRA assesses the land suitability, stripping and amelioration of soils, to ensure there is sufficient and suitable soil resources for the rehabilitation for the Project site.

[3] Throughout this report, MACH Mount Pleasant Operations Pty Ltd and the unincorporated Mount Pleasant Joint Venture will be referred to as MACH.

1.1.2 Scope of report

This report provides a baseline assessment of the soil and land suitability for the Project site. The remainder of this report comprises the following sections:

- description of the Project background (Section 2.1),
- description of the Project site setting (Section 2.2),
- description of the methods and guidelines relevant to this report (Section 3),
- summary of the desktop review, including a review of available background material (Section 4.1),
- overview of the field work methodology (Section 4.2),
- identification and description of soil mapping units (SMUs) and their distribution across the Project site (Section 5),
- assessment of land and soil capability (LSC) classes in the Project site based on *The Land and Soil Capability Assessment Scheme – Second Approximation* (NSW Office of Environment and Heritage [OEH], 2012) and agricultural suitability assessment based on *Agricultural Land Classification, Agfact AC.25*, (NSW Agriculture, 2002) (Section 6),
- assessment of the suitability of each SMU for reuse in mine rehabilitation activities, including determination of erosion potential, soil stripping volumes, recommended rehabilitation use, soil amelioration and soil stripping management (Section 7), and
- assessment of the proposed land use and indicative assessment of final land use (Section 8).

2 PROJECT BACKGROUND AND SETTING

2.1 Project Background

In late 2017, MACH commenced mining operations in the south-east of the Mount Pleasant Operation Approved Extent of Surface Development.

MACH currently has approval to mine in the Approved Extent of Surface Development until December 2026 (following a Development Consent Modification to extend operations – Mod 3). A further Modification for the relocation of the current rail spur and loop and the Hunter River water supply pump station and pipeline (Mod 4), was also recently approved by the NSW government.

The Project would include the following development:

- increased open cut coal extraction within Mount Pleasant Operation MLs by mining of additional coal reserves, including lower coal seams in North Pit,
- staged increase in extraction, handling and processing of ROM coal up to 21 Mtpa (i.e. progressive increase in ROM coal mining rate from 10.5 Mtpa over the Project life),
- staged upgrades to the existing Coal Handling and Preparation Plant (CHPP) and coal handling infrastructure to facilitate the handling and processing of additional coal,
- rail transport of up to approximately 17 Mtpa of product coal to domestic and export customers,
- upgrades to workshops, electricity distribution and other ancillary infrastructure,
- existing infrastructure relocations to facilitate mining extensions (e.g. local roads, powerlines and water pipelines),
- construction and operation of new water management and water storage infrastructure in support of the mine,
- additional reject dewatering facilities to allow co disposal of fine rejects with waste rock as part of ROM waste rock operations,
- development of an integrated waste rock emplacement landform that incorporates geomorphic drainage design principles for hydrological stability, and varying topographic relief to be more natural in exterior appearance,
- construction and operation of new ancillary infrastructure in support of mining,
- extension to the time limit on mining operations to 22 December 2048,
- an average operational workforce of approximately 600 people, with a peak of approximately 830 people,
- ongoing exploration activities, and
- other associated infrastructure, plant, equipment and activities.

2.2 Local Setting

The Project site is located approximately three km north-west of the township of Muswellbrook, refer Figure 1. The Project extends to the west with the Project extensions located to the west and north-west of the existing mine, refer Figure 2.

2.2.1 Land use

The Project site is situated in and adjacent to existing open cut mining disturbance of the Mount Pleasant Operation with cattle and sheep grazing occupying undisturbed areas to the north. To the south and south-west, agricultural activities primarily comprise cropping, plantations, horse and cattle studs and minor cultivation with some rural residential areas. The Bengalla Mine is located to the immediate south of the Project.

2.2.2 Native vegetation

The land in and surrounding the Project consists of a mosaic of cleared land and derived native grassland with patches of woodland and scattered paddock trees. Most woodland/forest patches are fragmented and show evidence of historic and ongoing disturbance from grazing. Common vegetation tree species include White Box (*Eucalyptus albens*), Narrow-leaved Ironbark (*Eucalyptus crebra*), Grey Box (*Eucalyptus moluccana*), Spotted Gum (*Corymbia maculata*) and Forest Red Gum (*Eucalyptus tereticornis*).

2.2.3 Topography and hydrology

The landscape of the Project site includes predominantly gently undulating plains to rolling hills with minor level flood plains located to the south. Elevations range from approximately 140 to 360 metres (m) Australian Height Datum (AHD) (NSW Globe, 2020).

The local drainage network is generally characterised by steep gullies which drain from the surrounding hills into the flat alluvial plains adjacent the Hunter River.

The main drainage feature in the vicinity of the Mount Pleasant Operation is the Hunter River, which flows in a southerly direction approximately 1 km to the east of the Mount Pleasant Operation.

There are several ephemeral drainage lines which traverse the Mount Pleasant Operation area and drain into the Hunter River. The eastern portion of the mining area drains via Rosebrook Creek, as well as other unnamed drainages. Areas in the south and west of the mining area drain via an unnamed drainage line (sometimes referred to as Dry Creek) and Sandy Creek respectively, both of which are tributaries of the Hunter River.

2.2.4 Regional geology

The Mount Pleasant Operation is located within the Hunter Coalfield, in the northern section of the Sydney Basin. The Mount Pleasant Operation coal resource is in the Permian Wittingham Coal Measures, within the Denman Formation and Jerrys Plains Subgroup and the Archerfield Sandstone and Vane Subgroup.

Lithologies comprise mostly sandstones, siltstones and coal measures with minor conglomerates and tuffs. Coal seams amenable to open cut mining occur in eight correlated seams and include the Upper Piercefield (Warkworth) Seam to the lowermost Edderton Seam.

Sediments were deposited in environments ranging from marine to freshwater deltaic and condition of the bedrock varies from moderately to strongly weathered.

3 PROJECT METHODS AND GUIDELINES

This soils and land suitability survey was scoped and conducted in accordance with the *Guidelines for Surveying Soils and Land Resources* (McKenzie *et al*. 2008). These guidelines were developed to provide a consistent approach to soil survey methodology across Australia. Soil characteristics and soil profiles have been described in accordance with the *Australian Soil and Land Survey: Field Handbook* (National Committee on Soil and Terrain, 2009 and Gunn *et al*. 1988).

Soils have been grouped according to their parent material and position in the landscape and classified in accordance with the *Australian Soil Classification; Second Edition* (Isbell, 2016).

Collection of soil samples for laboratory analysis was undertaken in line with the Land Suitability Assessment Techniques (LSAT) outlined in the *Technical Guidelines for Environmental Management of Exploration and Mining in Queensland* (Department of Minerals and Energy [DME], 1995). Laboratory analysis was based on the *Agricultural Impact Statement Technical Notes* (NSW Department of Primary Industries [DPI], 2013).

Land and soil capability at the Project site has been determined based on LSC classes in accordance with *The Land and Soil Capability Assessment Scheme – Second Approximation* (OEH, 2012).

Agricultural suitability at the Project site has been assessed based on the *Agricultural Land Classification, Agfact AC.25* (NSW Agriculture, 2002). The Agricultural Suitability system is used to classify land in terms of its suitability for general agricultural use. Agricultural land is classified by evaluating biophysical, social and economic factors that may constrain the use of land for agriculture.

Selection of Topdressing Material for Rehabilitation of Disturbed Areas in the Hunter Valley (Elliot and Veness, 1981) was used to assess the soil resources throughout the Project site.

4 METHODOLOGY

The methodology for the baseline soil assessment, which involved a desktop review and field surveys, is described below.

4.1 Desktop Review

GTE reviewed the available soils and land resources information for the Project site to develop preliminary SMUs, determine their likely distribution and to inform the development of the field survey program.

4.1.1 Regional soils reports and available information

The following references were reviewed as part of the desktop study:

- *Soil and Land Capability Impact Assessment, Continuation of Bengalla Mine* (GSS Environmental 2013)

  The soil and land capability impact assessment provides comprehensive soil data as part of the Environmental Impact Statement (EIS) undertaken for the Continuation of Bengalla Mine Project. The total area reviewed covers 1,370 ha. It was reported that seven soil types including one variant was identified, including chromosols, vertosols, sodosols, kurosols and rudosols.

  Soils distribution was mapped based on soil profiles from 10 test pits, landscape, topography and vegetation. Rural land capability, agricultural suitability, Biophysical Strategic Agricultural Land (BSAL), erosion, resource stripping and topdressing management were reviewed for the seven soil types.

  This soil and land suitability assessment was utilised to assess the south-west portion of the Project site and is referenced where applicable.

- *Mount Pleasant Mine, Environmental Impact Statement for Coal & Allied Operations Pty Ltd* (Mitchell McCotter 1997)

  An EIS was undertaken for the Mount Pleasant Mine by Mitchell McCotter in 1997. The EIS included a land use assessment involving soil investigations and assessment. Five SMUs were reported and reviewed on their landscape position which included flood plains (medium clays profiles), drainage lines (brown solonised and brown/yellow solodic soils), hillslope (dominate the study area, including cracking clays, solonised brown soils, red-brown earths, red-yellow solodic soils), sandy hillslopes (red massive earths, sandy red and yellow solodic or solonetzic soils, yellow solods and yellow podzolic soils) and volcanic hillslopes (structured clay soils with gradational brown soils and red duplex soils).

Land capability was reviewed based on the published maps of NSW Agriculture of the Hunter Valley with most of the site considered Class 5 and 4, occasional to limited cultivation. Stripping depths, soil handling strategies and final land capability were also assessed.

- *eSPADE* (NSW Department of Planning, Industry and Environment 2020)

  eSPADE is an internet-based information system that allows map-based access to soil and land information from across NSW. Available existing soil profiles and soil and land resources were reviewed in and adjacent the Project site.

  Four land resource reports were available. These reports included information about landscape, landform, soils, geology, vegetation, land degradation and existing erosion.

  Twelve soil profiles including brown chromosols, red chromosols, brown dermosols and rudosols were reported in or adjacent the Project site.

4.1.2 Satellite imagery

Satellite Imagery from Google Earth™, NSW globe and eSPADE (2020) was reviewed as part of the desktop assessment. Initial and final SMUs and boundaries were identified using this satellite imagery.

Pre-disturbance satellite imagery and contour lines indicating the topography of the Project site from NSW Globe (2020) were used to further define SMU boundaries.

4.2 Field Work

4.2.1 Survey timing

Detailed field survey of the Project site was undertaken from 3 to 4 April 2018 and 25 to 29 November 2019.

4.2.2 Survey team

The fieldwork was led by associate environmental consultant Reece McCann and assisted by technical officers Greg Tuck (2018) and Brett Larkin (2019).

4.2.3 Survey techniques

Survey techniques were based on pre-determined sampling locations derived from the desktop review of background information, existing available soils information and an examination of satellite imagery terrain patterns.

The specific locations of the survey sites were further refined using free survey techniques (McKenzie *et al*. 2008 and Gunn *et al*. 1988) to verify proposed SMUs and assign boundaries to each. Free survey is a commonly used method in broader scale land assessment as it enables flexibility in site selection (over grid mapping techniques), to achieve a more accurate and time effective result. The soil assessment program considered the use of existing access and drilling tracks to ensure greater efficiency in the field. Where existing access and tracks were unavailable, transects across existing observations sites and landforms were used to extrapolate across these areas.

Two types of observation sites (detailed sites and check sites) are described below.

Detailed sites

Detailed site locations were selected initially based on the desktop review of existing soils data, topography and geology information. Once fieldworks commenced, detailed sites were adjusted based on observations in the field of landform, vegetation, rockiness, topsoil colours and textures.

Detailed sites were undertaken at 30 locations for the Project. Additional detailed sites were undertaken for GSS Environmental (2013) and eSPADE (2020).

Soil profiles were sampled using a 50 millimetres (mm) diameter hand auger in accordance with the *Guidelines for Surveying Soil and Land Resources* (McKenzie *et al*. 2008). A backhoe was used for test pit sites B1 to B9, located in the north east of the Project.

Soil samples were collected from 12 of the detailed sites for laboratory analysis. Representative sites were selected from these 12 sites, reviewed against the other detailed sites in the SMU and selected as representing the dominant soil attributes which make up the SMU.

Soil sampling of profiles was conducted as per McKenzie *et al*. (2008), with samples taken with reference to standard depths incorporating the surface and every horizon change in the soil profile (typically at depths of 0.0-0.10 m, 0.20-0.30 m, 0.50-0.60 m, 0.80-0.90 m and 0.90-1.00 m). Depths were modified at sites where field observations identified soil horizons intersecting at the nominated depths, to ensure samples were collected in each separate horizon, and not across multiple horizons or in sub-horizon boundaries.

The major information recorded for detailed sites included:

- location (GDA94) and type of soil observation (e.g. erosion exposed cutting or hand auger),
- major vegetation types and density,
- landform type, position of the site and slope gradient,
- surface condition (e.g. presence of cracks, surface crust, rocks, stones and cobbles, erosion status, microrelief),
- types and vertical extent of soil horizons,
- colour (Munsell, 2009) and mottling of each horizon,

- observations of field texture, pH, presence and abundance of segregations, coarse fragments, structure, consistence, pedality and moisture content for each horizon,
- presence of organic matter, roots and prevalence of biological activity,
- presence of gleyed horizons, iron staining, and field pH, and
- photographs of the soil profile, surface and surrounding landscape.

Detailed site descriptions for the Project are presented in Appendix A and the locations are presented on Figure 3.

Check sites

Check sites were undertaken at 93 sites and were used to confirm SMU type and refine mapped soil boundaries.

Check sites documented attributes such that an SMU could be determined. Attributes recorded included, but were not necessarily limited to, surface conditions including rock, slope percentage, landform type and position, major vegetation, land condition and boundary. These attributes indicate useable topsoil stripping depth.

Check site descriptions for the Project are presented in Appendix B and the locations are presented on Figure 3.

4.2.4 Laboratory analysis

Soil samples were collected from sites considered to be most representative of SMUs found in the Project site and submitted to Environmental Analysis Laboratory for analysis. The laboratory holds National Association of Testing Authority (NATA) accreditation and is certified by the Australasian Soil and Plant Analysis Council (ASPAC).

Laboratory analysis was undertaken to assist in determining the overall characterisation of the soils and to establish their physical and chemical limitations. Laboratory testing was also used to identify soils that may require specific management measures. For each SMU, the topsoil and subsoil horizons were sampled and analysed for the following parameters;

- pH (0.01 M CaCl2),
- Electrical Conductivity (EC [1:5]),
- chloride,
- Bicarbonate extractable Phosphorus (Bicarb Extr. P), buffering index,
- Exchangeable Cations (Calcium [Ca], Magnesium [Mg], Sodium [Na], Potassium [K]),
- Cation Exchange Capacity (CEC),
- Calcium/Magnesium (Ca/Mg) Ratio,
- Exchangeable Sodium Percentage (ESP),
- nitrates,
- organic matter content/carbon,

- Particle Size Analysis (PSA) – Hydrometer Method (Coarse Sand [CS], Fine Sand [FS], Silt, Clay),
- Emerson Aggregate Test (EAT),
- Dispersion ratio (R1),
- sulfate,
- metals – total (Manganese [Mn], Boron [B], Copper [Cu], Iron [Fe], Zinc [Zn]), and
- carbonate fizz test.

The laboratory analytical results were used in conjunction with the field assessment results to determine the depth of soil material suitable for stripping and reuse during rehabilitation. The analytical program, number of samples and justification is provided in Table 4-1.

The laboratory results are summarised in Section 5 and detailed in Appendix C.

Table 4-1: Analytical Program and Number of Samples

Major Analysis	Number of Samples Tested	Application	Justification
In situ measurements:	Field pH – 77	Indication of possible limitations from pH.	Used for 'on the spot' estimates of possible pH limitations and to confirm the effective soil depth.
pH	55	Nutrient availability, nutrient fixation, toxicities (Al, Mn), liming, sodicity and correlation with other physical, chemical and biological properties.	Measurement of pH is a useful indicator of various soil properties (e.g. values >8.5 usually indicate high exchangeable sodium levels and the presence of carbonates and nutrient availability limitations). Values <6.5 may indicate issues with reduced potential of vegetation growth and potentially increase other forms of land degradation.
EC	55	Appraisal of salinity hazard in soil substrates or groundwater and total soluble salts.	The measure of EC is used as a means of appraising soil salinity. The electrical conductance increases with soluble salt content and thus allows simple interpretation of salinity.
Chloride Content	55	The concentration of chloride is usually an indicator of the severity of potential salinity.	The chloride anion is usually present in soil associated with sodium. It is highly mobile making it a valuable indicator of salt and water movement. It provides additional confirmation of salinity risk.
Bicarb Extr P. (Colwell)	55	Measurement of the total phosphorus in the soil.	Bicarb. Extr. P has been used to assess P fertility. The Bicarb. Extr. P test provides reliable and consistent data across a wide range of pH values from strongly acid to strongly alkaline.
CEC, Exchangeable Cations, Ca/MG ratio, ESP	55	Fertile soils have moderate to high CEC. Infertile soils have low CEC. Nutrient status, calculation of ESP, assessment of other physical and chemical properties, dispersity, shrink – swell, water movement and aeration.	The amounts and relative proportions of the exchangeable cations in soil have important effects on both physical and chemical properties. High levels of exchangeable sodium cause dispersion and increased swelling, reducing water movement and affecting near surface aeration whereas exchangeable calcium flocculates colloids and will reduce swelling tendencies. Excessively high or low concentrations of one or the other of the cations may impact buffering capacity and as a result, soil nutrient availability.
Available Nitrates	55	Presence of nitrogen in an available form for plant uptake.	Testing provides an indication of the general fertility of soils and thus their suitability as a topdressing agent.

Major Analysis	Number of Samples Tested	Application	Justification
Organic Matter / Carbon	55	Soil organic matter comprises an accumulation of partially disintegrated and decomposed plant and animal residues and other organic compounds synthesized by the soil microbes as the decay occurs. Soil organic matter forms a substantial reserve of potentially mineralizable nitrogen, sulfur and other nutrients. Organic Carbon is a part of the natural carbon cycle and the amount indicates soil health and fertility.	Testing for soil organic / carbon matter provides an indication of the general fertility of soils and thus suitability as a topdressing agent. It also provides information on stored potential nutrients which may not yet be accessible to plants but may become available in the future.
PSA (<2 mm)	55	Nutrient retention, exchange properties, erodibility, doughtiness, workability, permeability, sealing, drainage, interpretation of most other physical and chemical properties and soil attributes	Particle size distribution data provides an assessment of the composition of a soil (based on the dominant grain size in a soil). This assists with confirmation of field observations as well as providing better grounds for identification of SMU and water holding capacity.
R1 Dispersion	55	Measurement of the amount of silt and clay that disperses during testing as a percent.	The measure of R1 dispersion is useful when used in conjunction with ESP and the Ca/Mg ratio for predicting soil physical behaviour.
Emerson Aggregate Test	55	Measurement of the behavior of soil aggregates, when immersed, on their coherence in water.	The measure of Emerson Aggregate Test (EAT) is useful when determining soil physical behaviour.
Selected Metals	55	Detection of heavy metals.	The analysis of copper, zinc, manganese and iron will assess potential natural concentrations of these select heavy metals in the soil as well as any phytotoxicity issues that may exist.
Sulfur	55	Measurement of total sulfur in soil.	Total levels of sulfur help identify whether organic matter or gypsum are present in a profile.
Carbonate Fizz Test	55	The measurement of carbonate and gypsum in the soil profile	Testing assesses if carbonate and gypsum is present in the soil profile. Although visual assessment is the primary indicator, this test confirms at a chemical level. Carbonate and gypsum present, it assists in assessing soil structure and dispersive behaviour of soil.

4.3 General Soil Assessment

Major soil characteristics and chemistry in Section 5 were determined against criteria outlined in the tables below.

4.3.1 Soil pH (0.01 m HCL)

Table 4-2 presents the pH ratings used to interpret pH data (Bruce and Rayment, 1982).

Table 4-2: pH 1:5 Soil/Water Ratings

Rating	pH
strongly acid	< 5.5
acid	5.6–6.5
neutral	6.6–7.5
alkaline	7.6–8.5
strongly alkaline	>8.5

4.3.2 Electrical conductivity (1:5 soil/water)

Table 4-3 presents the EC 1:5 salinity ratings used to assess the significance of laboratory measured EC 1:5 data where clay content was known (Shaw, 1988).

Table 4-3: Electrical Conductivity Ratings

Rating	EC 1:5 deciSiemens per metre (dS/m)			
	10–20 per cent (%) clay	20–40% clay	40–60% clay	60–80% clay
Very low	<0.05	<0.08	<0.12	<0.18
Low	0.05–0.10	0.08–0.17	0.12–0.25	0.18–0.37
Moderate	0.10–0.25	0.17–0.40	0.25–0.58	0.37–0.85
High	0.25–0.45	0.40–0.67	0.58–1.00	0.85–1.5
Very high	0.45–0.70	0.67–1.05	1.00–1.58	1.5–2.4
Extreme	>0.70	>1.05	>1.58	>2.4

4.3.3 Cation exchange capacity

Table 4-4 presents the ratings used to assess CEC levels in the surface soil as a guide to overall fertility status (Landon, 1991).

Table 4-4: Cation Exchange Capacity Ratings

Rating	CEC/ECEC (milliequivalent [meq]/100 grams [g] of soil)
Very low	<5
Low	5–15
Moderate	15–25
High	25–40
Very high	>40

4.3.4 Cation dominance – exchangeable sodium percentage

Table 4-5 presents the ratings used to interpret sodicity levels (Baker and Eldershaw, 1993).

Table 4-5: Exchangeable Sodium Percentage Ratings

Rating	ESP (%)
Non-sodic (low)	<6
Sodic (moderate)	6–15
Strongly sodic (high)	15–20
Extremely sodic (very high)	>20

4.3.5 Calcium/magnesium ratio

Table 4-6 presents the ratings used to interpret Ca/Mg ratios (Baker and Eldershaw, 1993). Soils that disperse readily but have low ESP levels often have high levels of Mg relative to the other cations. The ratio of Ca to Mg provides a guide to the relative abundance of the two major cations and is useful when used in conjunction with ESP and R1 ratio for predicting soil physical behaviour.

Table 4-6: Ca:Mg Ratio Ratings

Rating	Ca/Mg Ratio	Comments
Very low	<0.10	Mg is >10 times more dominant than Ca
Low	0.10–0.50	Mg is 5–10 times more dominant than Ca
Moderate	0.51–1.0	Ca and Mg becoming co-dominant
High	1.1–2	Ca more dominant than Mg
Very high	>2	Ca >2 times more dominant than Mg

4.3.6 Emerson aggregate test

EAT classifies the behaviour of soil aggregates, when immersed, on their coherence in water. Testing is done only on soils with suitable aggregates. Sands and gravels are usually unsuitable for the test; however, all samples were subject to analysis. Interpretation of EAT laboratory results are presented in Table 4-7.

Table 4-7: Emerson Aggregate Test

Emerson Class Number	Dispersion
1	Complete / Strong
2	Moderate
3	Slight
4	Very slight
Equal to or above 5	Nil

4.3.7 Dispersion ratio

Table 4-8 presents the ratings that were used to interpret the R1 ratios (Baker and Eldershaw, 1993). The R1 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 the Ca/Mg ratio for predicting soil physical behaviour.

Table 4-8: Dispersion Ratio

Rating	R1 Ratio
Low	<0.6
Moderate	0.6–0.8
High	0.8–0.95
Very high	>0.95

4.3.8 Available phosphorus

Table 4-9 presents bicarbonate extractable Phosphorus (P) categories presented by Ahern *et al*. (1994) that were used to assess available P levels.

Table 4-9 Available Phosphorus

Rating	Bicarbonate extractable Phosphorus
Very low	<5
Low	6-9
Moderate	10-15
High	16-40
Very high	>40

4.3.9 Organic carbon

Table 4-10 presents organic carbon levels adapted by Emerson (1991). The level of available organic carbon was used to assess soil condition.

Table 4-10 Organic Carbon and Soil Condition

Level of Organic Matter (%[g/100g])	Rating	Interpretation
<0.40	Extremely low	Subsoils or severely eroded, degraded surface soils
0.40-0.60	Very low	Very poor structural condition, very low structural stability
0.60-1.00	Low	Poor to moderate structural condition, low to moderate structural stability
1.00-1.80	Moderate	Average structural condition, average structural stability
1.80-3.00	High	Good structural condition, high structural stability
>3.00	Very high	Good structural condition, high structural stability and soils probably water repellent

4.3.10 Soil erodibility

Soil erodibility factor (k factor) of topsoil was reviewed using the suggested k factor (Rosewell, 1993) in Table 4-11 and interpreted by ratings for K of the Universal Soil Loss Equation (Rosewell and Loch, 2002) in Table 4-12, as outlined in Hazelton and Murphy (2007).

Table 4-11 Estimating USLE K Factors from Soil Texture

Soil	Symbol	Suggest K factor
Sand	S	0.015
Clayey sand	CLS	0.025
Loamy sand	LS	0.020
Sandy loam	SL	0.030
Fine sandy loam	FSL	0.035
Sandy clay loam	SCL	0.025
Loam	L	0.040
Loam, fine sandy	Lfs	0.050
Silt loam	SIL	0.055
Clay loam	CL	0.030
Silty clay loam	SiCL	0.040
Fine sandy clay loam	FSCL	0.025
Sandy clay	SC	0.017
Silty clay	SiC	0.025

Soil	Symbol	Suggest K factor
Light clay	LC	0.025
Light medium clay	LMC	0.018
Medium clay	MC	0.015
Heavy clay	HC	0.012

Table 4-12 Soil Erodibility Classes based on Universal Soil Loss Equation

Rating	K of the Universal Soil Loss Equation tonne/ha/year of rainfall erosivity
Very low	0.00-0.01
Low	0.01-0.02
Moderate	0.02-0.04
High	0.04-0.06
Very high	>0.06

4.3.11 Additional References

Additional references in assessing field and laboratory analysis included;

- Department of Primary Industries, NSW. (2020) *Soil Testing: Result Interpretation*, and
- Hazelton P.A and Murphy B.W. (2007) *Interpreting Soil Test Results*. CSIRO Publishing, Australia.

5 RESULTS

5.1 Soil Mapping Units

Desktop review and fieldwork reported 138 observation sites in or adjacent to the Project Site. Twelve SMUs, including one variant[4] and one phase[5], were identified during GTE fieldworks, in addition to five pre-existing SMUs from existing soils data. These SMUs are presented on Figure 3.

The SMUs have been grouped according to basic soil morphology, position in the landscape, and parent material. Individual SMUs have been classified in accordance with the *Australian Soil Classification* (Isbell, 2002). Comparable land systems, as described by soils and land resources eSPADE (2020), are also provided in Table 5-1.

Table 5-1: Summary of Identified SMUs

SMU and Variants[1]	Concept Summary	Land Systems and Facet (eSPADE. 2020)	Affinity with GSS, 2013 SMUs	Detailed sites
Chb1	Haplic, Brown Chromosol; Medium, Clayey, Deep on upper to mid-slopes	Cressfield Road, cfz(5)	GSS/1	10, 12[2], 17, 19, B2, B4, B5, B6, B7, B8, B9
Chb2	Medium brown. Chromosol variant on gently undulating plains	Cressfield Road, cfz(5)	-	B1[2]
Chr1	Haplic Eutrophic Red Chromosol; Thick, Clayey on mid to lower slopes	Cressfield Road, cfz(2)	-	1[2], 6, B1
Chr2	Eutrophic Red Chromosol; Medium, Silty on upper slopes	Cressfield Road, cfz(2)	-	2[2], 21, B3
Chr3	Red Chromosol; Shallow Thick, Silty, Moderate on upper/simple slope	Cressfield Road, cfz(1)	-	8[2]
Chr4	Eutrophic Brown Chromosol; Thick Clayey Deep on simple hill slopes	Cressfield Road, cfz(2) Cressfield Road Variant, cfza(2)	-	13[2]
Chr5 / GSS/2	Haplic, Eutrophic, Red Chromosol; Thin, Clayey, Moderate on simple slope	Cressfield Road, cfz(2)	GSS/2	5[2]
Kb	Haplic Mellic Brown Kandosol; Thick, Clay loamy, Deep on upper slopes	-	-	7, 9[2], 15
Sb	Eutrophic Brown Sodosol; Medium, Slightly gravelly, Clayey, Deep on simple slopes	Cressfield Road, cfz(2)	-	4[2]
Sr	Subnatric, Red Sodosol; Thin Clayey, Moderate on mid-slopes	Cressfield Road, cfz(2)	-	20[2]
Vb1	Epipedal Brown Vertosol; Very fine, Deep on mid to upper slopes.	Cressfield Road, cfz(5) Cressfield Road Variant,	-	3[2], 14, 16*, 18

[4] A soil with one or more attributes outside the usual range for a defined soil profile class, but because of its restricted distribution (or because the varying properties are not considered to have particular management significance), it is not defined as a separate soil profile class.

[5] A subdivision of a soil profile class based on attributes that have particular significance for land use, such as shallow phase, where the soil depth is predominantly shallow and may influence particular land uses.

SMU and Variants[1]	Concept Summary	Land Systems and Facet (eSPADE. 2020)	Affinity with GSS, 2013 SMUs	Detailed sites
	Shallow phase (VbShp) present, site 18.	cfza(3)		
Vb2	Haplic Brown Vertosol; Deep on simple slopes	Cressfield Road, cfz(5) Cressfield Road Variant, cfza(3)	-	11[2]
SMUs identified in eSPADE public soil profiles				
Db	Brown Dermosol	Singleton sgw(2)	-	82
Rr	Leptic Red Rudosol	Cressfield Road Variant, cfza(1)	-	85
SMU and Variants identified in GSS (2013)				
GSS/3	Brown Chromosol	Cressfield Road, cfz(1,2) Cressfield Road Variant, cfza(1,2))	-	Sample pit 10
GSS/5	Brown Kurosol	Cressfield Road, cfz(2) Donalds Gully dnz(1)	-	Sample pit 4
GSS/7	Rudosol	Cressfield Road, cfz(1)	-	-

1 – Proposed SMU order is based on relevance and alphabetic order.
2 – Indicates laboratory site.

5.1.1 SMU Chb1 – Medium brown chromosol on upper to mid-slopes

Overview

The SMU Chb1 is a Haplic, Brown Chromosol associated with upper to mid slopes on undulating plains and hills. A moderately capable land with moderate to high limitations for high-impact land uses such as cropping, high-intensity grazing and horticulture. This land has low to moderate erosion potential. Vegetation includes grass fields and semi to extensively cleared tall eucalyptus woodlands.

Topsoil is suitable for post-mine rehabilitation without treatment. Subsoil is unsuitable for post-mine rehabilitation without treatment. Amelioration of subsoils with gypsum may increase the quality to support topsoil placement on level plains.

SMU GSS/1 (GSS, 2013) was reviewed as like SMU Chb1 in terms of Australian Soil Classification, textures, colours, landform positions, soil, land and agricultural land assessment.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- weak texture contrast from loam to clay,
- pH (laboratory analysis) is acidic in topsoils increasing to alkaline subsoils,
- low EC in topsoils, increases to moderate with subsoil depth,
- CEC is low to moderate throughout,
- ESP is non-sodic throughout,
- Ca:Mg ratio is high decreasing to low subsoils,
- R1 dispersion report low levels in topsoil increasing slightly to moderate in subsoils, and
- the level of extractable phosphorus (Colwell) present is moderate in topsoil and decreases to low in subsoils.

Representative site

Site 12 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.2 SMU Chb2 – Medium brown chromosol variant on gently undulating plains

Overview

The SMU Chb2 is a Haplic Eutrophic Brown Chromosol on gently undulating rises and alluvial plains. This SMU is located to the north eastern area of the Project site. A moderate to low capability land that has high limitations for high-impact land uses with low to moderate erosion potential. Vegetation includes grass fields and semi to extensively cleared tall eucalyptus woodlands. Subsoils are suitable for post-mine rehabilitation.

Topsoil is unsuitable for post-mine rehabilitation without amelioration. This may include the input of organic matter to soften soils peds. Subsoil is suitable for post-mine rehabilitation in supporting topsoil placement on level plains to 0.70 metres below ground level (mbgl).

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- texture contrast from silty clay loam to clay,
- pH (laboratory analysis) is acidic in topsoil, increasing to neutral between 0.15 mbgl and neutral at 0.30 mbgl and neutral subsoil horizons below 0.70 mbgl;
- extreme EC in topsoil, decreasing to moderate and high with subsoil depth,
- CEC is moderate in topsoils increasing to high in subsoils,
- ESP is non-sodic throughout, and
- Ca:Mg ratios are very high.

Representative site

Site B1 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.3 SMU Chr1 – Thick red clayey chromosol on mid to lower slopes

Overview

The SMU Chr1 is a Haplic Eutrophic Red Chromosol associated with mid to lower slopes on undulating plains and hills. Vegetation includes sparse tall woodlands including narrow leaf ironbark. A moderately capable land with moderate to high limitations for high-impact land uses such as cropping, high-intensity grazing and horticulture. This SMU has low to moderate erosion potential.

Topsoil is suitable for post-mine rehabilitation but may benefit from the input of agricultural lime to increase pH levels. Subsoils above 0.7 mbgl are suitable for post-mine rehabilitation, without treatment. Subsoils below 0.7 mbgl are a finer texture and suitable for capping waste rock.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- strong texture contrast from loam to clay textures,
- pH (laboratory analysis) is acidic throughout to neutral subsoil horizons below 0.70 mbgl,
- very low EC in topsoil increasing slightly to low in subsoils,
- CEC is low in topsoils and moderate to low throughout in subsoils,
- ESP is non-sodic throughout the profile,
- Ca:Mg ratios are very high in topsoil, decreasing to high in subsoils,
- r1 dispersion report low levels in topsoil increasing slightly from 0.70 mbgl to moderate in subsoils, and
- the level of extractable phosphorus (Colwell) present is high decreasing to low in subsoils.

Representative site

Site 1 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.4 SMU Chr2 – Medium red chromosol on upper slopes

Overview

The SMU Chr2 is a Eutrophic Red Chromosol; Medium, Silty associated with mid to lower slopes on undulating plains and hills. Vegetation includes sparse tall woodlands. A moderately capable land with moderate to high limitations for high-impact land uses such as cropping, high-intensity grazing and horticulture. This SMU has low to moderate erosion potential.

Topsoil and subsoils above 0.7 mbgl are suitable for post-mine rehabilitation, without treatment. Topsoil may benefit further with input of agricultural lime to increase pH levels. Subsoils below 0.7 mbgl are a finer texture with alkaline pH and are suitable for capping waste rock.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- texture contrast from loams to clay textures,
- pH (laboratory analysis) is strongly acidic in topsoils increasing to neutral and alkaline in subsoil horizons;
- moderate EC in the topsoil and moderate to very high in subsoils,
- CEC is moderate in topsoils to low and moderate in subsoils,
- ESP is non-sodic throughout,
- Ca:Mg ratios are very high in topsoil, decreasing to high in subsoils,
- r1 dispersion report low levels throughout, and
- the level of extractable phosphorus (Colwell) present is very high in topsoil decreasing to moderate levels in subsoils.

Representative site

Site 2 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.5 SMU Chr3 – Thick silty red chromosol on upper/simple slope

Overview

The SMU Chr3 is a Red Chromosol associated with upper slopes on undulating plains and hills. A moderately capable land with moderate to high limitations for high-impact land uses such as cropping, high-intensity grazing and horticulture. This SMU has low to moderate erosion potential. Vegetation includes grasses and semi cleared tall eucalyptus woodlands.

Topsoil and subsoils are not suitable for post-mine rehabilitation without amelioration. Amelioration treatment such as input of organic matter and mixing with other suitable topsoil and subsoils may improve soil structure for supporting topsoil placement.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- weak texture contrast from loam topsoils to clay loam, clayey subsoils,
- pH (laboratory analysis) is strongly acidic throughout,
- low EC in topsoil which varies between low and very low throughout the profile,
- CEC is low throughout,
- ESP is non-sodic throughout,
- Ca:Mg ratios are very high throughout,
- r1 dispersion report very low levels in topsoil increasing slightly to low in subsoils, and
- the level of extractable phosphorus (Colwell) present is very high in topsoil and varies between moderate and low in subsoils.

Representative site

Site 8 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.6 SMU Chr4 – Thick red clayey chromosol on simple hill slopes

Overview

The SMU Chr4 is a Eutrophic Brown Chromosol associated with simple slopes on undulating plains and hills. A highly capable land with low to moderate erosion potential, it is suitable for sustaining high impact land uses. Vegetation includes grass fields and semi to extensively cleared tall eucalyptus woodlands.

Topsoil is unsuitable for post-mine rehabilitation without amelioration. This may include the input of organic matter to improve soil structure.

Subsoil is complicated where review of the horizons identified presents a suitable supporting subsoil at depth 0.60 to 0.80 mbgl. Soils of 0.00-0.50 mbgl and below 0.90 mbgl presents undesirable attributes and is suitable for capping waste rock. The amelioration of subsoil may include the input of organic matter to improve soil structure.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- texture contrast from sandy loam to clay,
- pH (laboratory analysis) is strongly acidic in A horizons increasing to acidic in subsoil, B horizons,
- very low EC throughout,
- CEC is low in topsoil and varies between low and very low in subsoils,
- ESP is non-sodic throughout,
- Ca:Mg ratios are very high throughout,
- r1 dispersion report low levels in topsoil increasing to moderate in subsoils, and
- the level of extractable phosphorus (Colwell) present is moderate in topsoil and decreases to low in subsoils.

Representative site

Site 13 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.7 SMU Chr5 – Massive silty red chromosol on simple slopes

Overview

The SMU Chr5 is a Haplic, Eutrophic, Red Chromosol associated with lower slopes and depressions on undulating plains and hills. A moderately capable land with moderate to high limitations for high-impact land uses such as cropping, high-intensity grazing and horticulture. This land has low to moderate erosion potential. Vegetation includes grass fields and semi to extensively cleared tall eucalyptus woodlands.

Topsoil is suitable for post-mine rehabilitation. Subsoil is not suitable for post-mine rehabilitation without amelioration. Organic matter amelioration of subsoils may improve the soil structure and potential reuse for supporting topsoil placement.

SMU GSS/2 (GSS, 2013) was reviewed as like SMU Chr5 in terms of Australian Soil Classification, textures, colours, landform positions, soil, land and agricultural land assessments.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- texture contrast from silty clay loam to clay textures,
- pH (laboratory analysis) is acidic to 0.80 mbgl where it increases to neutral,
- moderate EC in topsoil, varies with depth from low to high in subsoils,
- CEC is moderate in topsoil and varies from low to moderate in subsoils,
- ESP is non-sodic throughout,
- Ca:Mg ratios are very high throughout and decrease slightly to high at 0.8 mbgl,
- r1 dispersion report low levels in topsoil increasing slightly to moderate in subsoils between 0.10 to 0.093 mbgl, and
- the level of extractable phosphorus present (Colwell) is very high in topsoils and decreases to high in B21 horizon and continues to decrease with subsoil depth to moderate levels.

Representative site

Site 5 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.8 SMU Kb – Brown kandosol on upper slopes

Overview

The SMU Kb is a Haplic Mellic Brown Kandosol associated with upper slopes on undulating plains and hills. This SMU is predominantly found in south eastern areas of the Project site. A highly capable land suitable for sustaining high impact land uses with low to moderate erosion potential. Vegetation includes grasses and semi cleared tall eucalyptus woodlands. Topsoil is suitable for post-mine rehabilitation.

Topsoil is suitable for post-mine rehabilitation and may benefit with organic matter input. Subsoil is not suitable for post-mine rehabilitation without amelioration. Organic matter amelioration of subsoils may improve the soil structure and potential reuse for supporting topsoil placement.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- very weak texture contrast clayey sands to clay loam throughout,
- pH (laboratory analysis) is strongly acidic in topsoil and increases to alkaline in subsoil,
- high EC in the surface, decreasing to low and moderate levels in subsoils,
- CEC is low throughout,
- ESP is non-sodic throughout,
- Ca:Mg ratios are very high throughout,
- r1 dispersion report low levels in topsoil increasing to moderate levels in subsoils, and
- the level of extractable phosphorus (Colwell) present is high in topsoil and varies between moderate and low in subsoils.

Representative site

Site 9 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.9 SMU Sb – Brown sodosol on simple slopes

Overview

The SMU Sb is a Eutrophic Brown Sodosol associated with lower slopes and depressions on undulating plains and hills. A moderately capable land with moderate to high limitations for high-impact land uses which restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. This land has low to moderate erosion potential. Vegetation includes grasses and tall eucalyptus woodlands.

Topsoil is suitable for post-mine rehabilitation and may benefit from organic matter input. Subsoil is not suitable for post-mine rehabilitation without amelioration. Gypsum amelioration of subsoils may improve the soil structure and reduce dispersive attributes for supporting topsoil placement on level plains.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- texture contrast from loam to clay textures,
- pH (laboratory analysis) is acidic to 0.30 mbgl and increases to alkaline in subsoils,
- very low EC in topsoil increasing to low in subsoil and high from 0.70 mbgl,
- CEC is moderate to 0.30 mbgl and decreases to low in subsoils,
- ESP is non-sodic to 0.60 mbgl increasing to moderately sodic in subsoils,
- Ca:Mg ratios are high in topsoil, decreasing to low in subsoils,
- r1 dispersion report low levels in topsoil increasing slightly to moderate in subsoils, and
- the level of extractable phosphorus (Colwell) present is moderate in topsoil and varies between moderate and low in subsoils.

Representative site

Site 4 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.10 SMU Sr – Red Sodosol on mid-slopes

Overview

The SMU Sr is a Subnatric, Red Sodosol associated with simple slopes on undulating plains and hills. A moderately capable land with moderate to high limitations for high-impact land uses such as cropping, high-intensity grazing and horticulture with moderate erosion potential. Vegetation includes grass fields and semi to extensively cleared tall eucalyptus woodlands.

Topsoil and subsoils are not suitable for post-mine rehabilitation without amelioration. Gypsum amelioration may be applied to topsoil and subsoils to improve the soil structure and reduce dispersive attributes.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- texture contrast from clay loam to clay,
- pH (laboratory analysis) is acidic in topsoils and increases to alkaline subsoil horizons,
- low EC throughout,
- CEC is moderate throughout,
- ESP is moderately sodic in topsoils decreasing to marginally non sodic from 0.50 mbgl,
- Ca:Mg ratios are very high throughout,
- r1 dispersion report low levels in topsoil increasing slightly to moderate at 0.20 mbgl and decreasing to low at 0.50 mbgl, and
- the level of extractable phosphorus (Colwell) present is moderate in topsoil and varies from low to moderate in subsoils.

Representative site

Site 20 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.11 SMU Vb1 – Sodic brown vertosol on mid to upper slopes

Overview

The SMU Vb1 is an Epipedal Brown Vertosol associated with upper slopes on undulating plains and hills. The SMU includes a shallow phase, Vb1 Shallow Phase located in the northern portion of the Project site.

Vegetation includes grasses and extensively cleared woodlands. A moderately capable land with moderate to high limitations for high-impact land uses such as cropping, high-intensity grazing and horticulture with low to moderate erosion potential.

Topsoil and subsoils, 0.10 to 0.50 mbgl, are suitable for post-mine rehabilitation. Gypsum amelioration may be applied to subsoils below 0.50 mbgl to improve the soil structure and reduce dispersive attributes.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- clay textures,
- pH (laboratory analysis) is acidic in the top 0.30 mbgl and increases to alkaline in subsoils,
- very low EC increasing to moderate levels from 0.50 mbgl,
- CEC is high in topsoil and decreases to very low in subsoils at 0.60 mbgl. CEC then increases to moderate to 0.85 mbgl,
- ESP is non-sodic to 0.30 mbgl and increases to moderate sodic subsoils,
- Ca:Mg ratios are moderate in topsoil, decreasing to low in subsoils,
- r1 dispersion report low levels in topsoil increasing slightly to moderate in subsoils, and
- the level of extractable phosphorus (Colwell) present is moderate in topsoil varying from moderate to low levels in subsoils.

Representative site

Site 3 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.12 SMU Vb2 – Shallow brown vertosol on simple slopes

Overview

The SMU Vb2 is a Haplic Brown Vertosol associated with upper slopes on undulating plains and hills. A moderately capable land with moderate to high limitations for high-impact land uses such as cropping, high-intensity grazing and horticulture with low to moderate erosion potential. Vegetation includes grass fields and semi to completely cleared tall eucalyptus woodlands.

Topsoil and subsoils, 0.10 to 0.50 mbgl, are suitable for post-mine rehabilitation. Organic matter may be applied to improve the topsoil horizon. Gypsum amelioration may be applied to subsoils below 0.50 mbgl to improve the soil structure and reduce dispersive attributes.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- shallow uniform clays on loam and clay loam subsoil horizons,
- pH (laboratory analysis) is acidic in topsoils and increases to neutral at 0.3 mbgl and alkaline in subsoil horizons,
- low EC in the topsoils and varies from low to moderate in subsoils,
- CEC is moderate in topsoil and decreases to varying levels of moderate and low in subsoils,
- ESP is non-sodic until subsoils at 0.9 mbgl and increases to moderately sodic in deep subsoils,
- Ca:Mg ratios are very high in topsoils, decreasing to high and moderate with subsoil depth,
- r1 dispersion report low levels throughout, and
- the level of extractable phosphorus (Colwell) present is high in topsoil and decreases to low and moderate levels in subsoils.

Representative site

Site 11 was selected as a representative site of this SMU for chemical analysis. A site description and soil profile morphology summary are presented in Appendix A.

5.1.13 SMU Db – Brown Dermosol

Overview

The SMU Db is a pre-existing SMU identified during the desktop review and has not been laboratory tested. It is a Eutrophic Brown Dermosol on level to gently undulating plains. Land use includes occasional cultivation and cleared lands. A highly capable land suitable for sustaining high impact land uses with low to moderate erosion potential.

The SMU Db is located on the Hunter River floodplain and is not relevant to Project-related mining activities.

Soil characteristics and chemistry

The major characteristics indicate that this SMU has:

- texture contrast silty clay loam to clay textures; and
- field pH is acidic.

Representative site

Site 82 (eSPADE, 2020) was selected as a representative site of this SMU.

A limited site description and soil profile morphology summary are presented in Appendix A. No soil chemistry results were available for this SMU. Further information is presented in Appendix D.

5.1.14 SMU Rr – Rudosol on hillcrest

Overview

The SMU Rr is a pre-existing SMU identified during the desktop review. It is an Acidic Paralithic Leptic Rudosol on hill crests and rises. This SMU is in one polygon unit located approximately in the centre of the Project site, south-west of the main disturbance area.

A moderate to low capability land with high limitations for high-impact land uses with low erosion potential. Vegetation includes grass fields and limited clearing of native vegetation.

Topsoil and minor subsoils are suitable for post-mine rehabilitation; however further laboratory analysis would assist in assessing specific soil depths.

Soil characteristics and chemistry

The major characteristics from the laboratory data indicate that this SMU has:

- uniform textures of sandy clay loam; and
- field pH is acidic.

Representative site

Site 85 (eSPADE, 2020) was selected as a representative site of this SMU.

A limited site description and soil profile morphology summary are presented in Appendix A. No soil chemistry results were available for this SMU. Further information is presented in Appendix D.

5.2 SMUs – GSS, 2013

Soil types and mapping data were already reviewed in areas to the west and south-west of the Project as part of the *Soils and Land Capability Impact Assessment, Continuation of Bengalla Mine* (GSS, 2013). Accordingly, further survey of these areas was not warranted.

Seven soil locations and five soil types located in and adjacent to the Project site were reviewed and included as part of this assessment. The five soil types are summarised in Table 5-2, together with the equivalent SMUs from this assessment where applicable. The combined SMUs are presented in Figure 3.

Table 5-2: Soil Types. GSS, 2013

Soil Type and ASC	Description	Area (ha)	GTE SMU in this Assessment
GSS/1, Brown Chromosol	Brown Chromosol, moderate. Very gently to gently undulating plains. Cattle grazing, isolated ironbark, grasses. Neutral to acid to alkaline pH, non-saline, High CEC, non-sodic to sodic B22 horizon. Slight to high moderate EAT. SMU GSS/1 and area are presented as part of Chb1, south of Wybong Road	252	Chb1
GSS/2, Red Chromosol	Red Chromosol. Upper slope, gently and moderately inclined. Grazing with red ironbark and native grasses. Neutral to alkaline pH. Non-saline, moderate to high CEC, non-sodic to sodic B22 horizon. Slight to negligible EAT. SMU GSS/2 and area are presented as part of Chr5, south of Wybong Road	208	Chr5
GSS/3, Brown Vertosol	Brown Vertosol. Flat areas on mid to lower slopes. Grazing with isolated white box. Neutral to alkaline pH. Non-saline, high CEC, non-sodic to moderately sodic B2 horizon. Negligible to slight back to negligible EAT	240	-
GSS/5, Brown Kurosol	Brown Kurosol. Lower slope to level and gently inclined. Grazing with native grasses. Moderately acidic to strongly acidic pH, non-saline, Low to moderate CEC, non-sodic to moderately sodic A2 horizons, strongly sodic B2 horizon. Negligible to high/moderate at depth EAT	12	-
GSS/7, Rudosol	Rudosol. Upper slopes and crests. Light grazing with native trees and grasses	135	-

6 LAND SUITABILITY ASSESSMENT

6.1 Land and Soil Capability Assessment Methodology

The Land and Soil Capability Assessment Scheme – Second Approximation (OEH, 2012) aims to provide a reliable assessment of the potential of the land to support a range of sustainable land uses and land management practices.

The scheme defines LSC classes based on the biophysical features of the land. These features determine the limitations and hazards and include:

- water erosion, including sheet, rill and gully erosion,
- wind erosion,
- soil structure decline,
- soil acidification,
- salinity,
- waterlogging,
- shallow soils and rockiness, and
- mass movement.

The LSC class is determined for each limitation or hazard. The final LSC class of the land is based on the most limiting hazard or limitation. The LSC classes and their general definition are summarised in Table 6-1.

Table 6-1: Land and Soil Capability Classes – General Definitions (OEH, 2012)

LSC Class	General Definition
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	**High capability land**: Land has moderate limitations and can sustain high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate–low capability land**: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
6	**Low capability land**: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations are required to prevent severe land and environmental degradation
Land generally incapable of agricultural land use (selective forestry and nature conservation)	

LSC Class	General Definition
7	**Very low capability land**: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land**: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

Two existing soil profiles (eSPADE, 2020) indicate a dominant soil type in two areas of the Project site. The Project site to the south-east is based on an existing soil profile, soil profile 82. The site was identified during the Hunter Soil and Land Resources Survey (2016). It is identified as a Eutrophic Brown Dermosol located on the Hunter River floodplain (SMU Db).

A smaller polygon area to the centre west is based on an existing soil profile, soil profile 85. The site was identified during the Hunter Soil and Land Resources Survey (2016). It is identified as a Leptic Rudosol located on a hillcrest (SMU Rr). These sites have not been laboratory tested; however, review of the available technical information will be included to provide an LSC class.

All remaining existing soil profiles in the Project site are reviewed as either part of the dominant or subdominant mapped GTE SMUs in the following sections. The overall LSC assessment is presented in Tables 6-10 and 6-11.

6.1.1 Water erosion

Water erosion class was determined by slope (%) class figures using the Eastern and Central division presented in Table 4 as per OEH (2012) scheme criterion. LSC assessment is presented in Table 6-2.

Table 6-2: Water Erosion Assessment

SMU	Slope % (Field Assessment)[1]	LSC Class
GTE SMUs		
Chb1	10	4
Chb2	3	3
Chr1	13	4
Chr2	9	3
Chr3	10	4
Chr4	9	3
Chr5	14	4
Kb	8	3
Sb	14	4
Sr	6	3
Vb1	17	4
Vb2	10	4
Existing Soil Profiles – eSPADE, 2020		
Db	3	3
Rr	3	3

1 – Hand clinometer used to obtain the maximum slope percent of the representative site.

6.1.2 Wind erosion

Factors used to assess wind erosion include surface soil texture, site exposure to prevailing winds, wind erosive power and average annual rainfall across the test site (OEH, 2012).

The long term mean annual rainfall at the nearby meteorological station of Scone SCS is 636.0 mm (Bureau of Meteorology [BOM], 2020). The assessment is presented in Table 6-3. Wind erosive power was reviewed as moderate based on Figure 6 in OEH (2012).

Table 6-3: Wind Erosion Assessment

SMU	Wind Erodibility Class of Surface Soil[1]	Site Exposure[2]	Wind Erosive power	LSC Class
GTE SMUs				
Chb1	Low – Clay loam	High – Hilltop	Moderate	3
Chb2	Low – Silty clay loam	Moderate – Intermediate situations	Moderate	2
Chr1	Low – Loam	Moderate – Intermediate situations	Moderate	1
Chr2	Low – Clay loam	Moderate – Intermediate situations	Moderate	2
Chr3	Low – Loam	Moderate – Intermediate situations	Moderate	2
Chr4	Low – Loam	Moderate – Intermediate situations	Moderate	2
Chr5	Low – Silty clay loam	Moderate – Intermediate situations	Moderate	2
Kb	Low – Loam	High – Hilltop	Moderate	3
Sb	Low – Clay loam	Low – Sheltered locations	Moderate	1
Sr	Low – Clay loam	Moderate – Intermediate situations	Moderate	2
Vb1	Low – Heavy clay	High – Hilltop	Moderate	3
Vb2	Low – Light clay	Moderate – Intermediate situations	Moderate	2
Existing Soil Profiles – eSPADE, 2020				
Db	Low – Silty clay loam	Moderate – Intermediate situations	Moderate	2
Rr	Moderate – Sandy clay loam	Moderate – Intermediate situations[3]	Moderate	3

1 – Laboratory surface soil texture
2 – General position of SMU based on representative site
3 – Soil technical report indicates landform element of 'hillcrest', however review of contour / landform as mapped, GTE reviewed 'intermediate situations' is more appropriate.

6.1.3 Soil structure decline

Poor soil structure limits plant growth through poor germination and root growth, low infiltration and impeding mechanical processes. The LSC classification assesses the nature of the surface soil using surface texture, degree of sodicity and degree of self-mulching (OEH, 2012).

The assessment of soil structure decline has been undertaken in accordance with Table 7 of OEH (2012) and assesses the field texture against a modifier (such as sodicity). The assessment is presented in Table 6-4.

Table 6-4: Soil Structure Decline Assessment

SMU	Field Texture Surface Soil[1]	Modifier	Outcome	LSC Class
GTE SMUs				
Chb1	Clay loam	Normal	Fragile medium textured soil	3
Chb2	Silty clay loam[2]	Normal	Fragile medium textured soil	3
Chr1	Loam	Normal	Fragile medium textured soil	3
Chr2	Clay loam	Friable	Friable clay loam surface soil	1
Chr3	Loam	Normal	Fragile medium textured soil	3
Chr4	Loam	Normal	Fragile medium textured soil	3
Chr5	Silty clay loam	Normal	Fragile medium textured soil	3
Kb	Loam	Normal	Fragile medium textured soil	3
Sb	Clay loam	Friable	Friable clay loam surface soil	1
Sr	Clay loam	Normal	Fragile medium textured soil	3
Vb1	Heavy clay	Strongly self-mulching	Strongly self-mulching surface soil	1
Vb2	Light clay	Strongly self-mulching	Strongly self-mulching surface soil	1
Existing Soil Profiles – eSPADE, 2020				
Db	Silty clay loam	Friable	Fragile medium textured soil – includes dark, friable loam soils	1
Rr	Sandy clay loam	High levels of silt and very fine sand	Fragile light textured soil – very hard setting	4

1 – Laboratory surface soil texture
2 – Field surface soil texture

6.1.4 Soil acidification hazard

Soil acidification hazard was reviewed by determining the estimated buffering capacity and pH of the surface soils and mean annual rainfall. Tables 10 and 12 of *The Land and Soil Capability Assessment Scheme – Second Approximation* (OEH, 2012) were used to assess these attributes against the mean annual rainfall of 636 mm (BOM, 2020). Results are summarised in Table 6-5.

Table 6-5: Soil Texture and Buffering Capacity

SMU	Surface Soil Texture[1]	Buffering capacity	pH ($CaCl_2$)	LSC Class
GTE SMUs				
Chb1	Clay loam	M	6.0-7.5	2
Chb2	Silty clay loam[2]	M	4.7-5.5 (water)	4
Chr1	Loam	M	4.7-6.0	3
Chr2	Clay loam	M	4.7-6.0	3
Chr3	Loam	M	4.7-6.0	3
Chr4	Loam	M	6.0-7.5	2
Chr5	Silty clay loam	M	6.0-7.5	2
Kb	Loam	M	4.7-6.0	3
Sb	Clay loam	M	6.0-7.5	2
Sr	Clay loam	M	6.0-7.5	2
Vb1	Heavy clay	H	6.0-7.5	2
Vb2	Light clay	H	6.0-7.5	2
Existing Soil Profiles – eSPADE, 2020				
Db	Silty clay loam	M	5.5-6.7 (water) – (5.5)[4]	3
Rr	Sandy clay loam	L	4.7-5.5 (water) – (5.0)[3]	5

1 – Laboratory surface soil texture, no calcium carbonate observed in surface soils or reported in laboratory analysis
2 – Field surface soil texture, no calcium carbonate observed in surface soils
3 – pH Assessment based on Raupach, laboratory analysis is unavailable
4 – pH Assessment based on Raupach; laboratory analysis is unavailable. Result on border, result reviewed in acid-neutral range

6.1.5 Salinity hazard

Assessment of salinity hazard in OEH (2012) is a simple initial evaluation. The methodology is based on *Native Vegetation Regulation 2005: Environmental Outcomes Assessment Methodology* (Department of Environment, Climate Change and Water, 2011) and requires three inputs; recharge potential, discharge potential and salt stores.

Given detailed salinity information is available from soil test work, a more robust methodology has been applied that allows direct assessment of each soil type and the actual soil salinity. The following Table 6-6 indicates thresholds for salt-sensitive crops and pastures to be included in place of the regional approach to salinity assessment presented in OEH (2012).

Table 6-6: Nominated Soil Salinity Hazard

LSC Class	Ece dS/m
1	<1
2	1-2
3	2.1-4
4	4.1-8
5	8.1-12
6	12.1-16
7	16.1-30
8	>30

Assessment of the salinity hazard based on the nominated values in Table 6-6 is presented in Table 6-7.

Table 6-7: Soil Salinity Hazard Assessment

SMU	Ece dS/m[1]	LSC
GTE SMUs		
Chb1	1.253	2
Chb2	10.1	5
Chr1	0.399	1
Chr2	1.714	2
Chr3	0.484	1
Chr4	0.33	1
Chr5	1.479	2
Kb	3.970	3
Sb	0.527	1
Sr	0.886	1
Vb1	0.403	1
Vb2	0.889	1
Existing Soil Profiles – eSPADE, 2020		
Db	n/a	-
Rr	n/a	-

1 – Approximate conversion factor from $EC_{1:5}$ to Ece, BSAL Interim Protocol, 2013

6.1.6 Waterlogging

Waterlogging was reviewed by reviewing the typical soil drainage as outlined in Table 14 of the OEH (2012). The assessment is outlined in Table 6-8.

Table 6-8: Waterlogging Hazard Assessment

SMU	Soil Drainage[1]	LSC
GTE SMUs		
Chb1	Moderately well drained	2
Chb2	Moderately well drained	2
Chr1	Moderately well drained	2
Chr2	Moderately well drained	2
Chr3	Moderately well drained	2

SMU	Soil Drainage[1]	LSC
Chr4	Moderately well drained	2
Chr5	Moderately well drained	2
Kb	Rapidly drained and well drained	1
Sb	Moderately well drained	2
Sr	Moderately well drained	2
Vb1	Moderately well drained	2
Vb2	Moderately well drained	2
Existing Soil Profiles – eSPADE, 2020		
Db	Moderately well drained	2
Rr	Moderately well drained	2

1 – Approximate conversion factor from $EC_{1:5}$ to Ece, BSAL Interim Protocol, 2013

6.1.7 Shallow soils and rockiness

Shallow soils and rockiness was reviewed against Table 15 of OEH (2012). The assessment is present in Table 6-9.

Table 6-9: Shallow Soils and Rockiness Hazard Assessment

SMU	Rocky outcrop / Soil Depth (cm)	LSC
GTE SMUs		
Chb1	Nil / 75 - <100	2
Chb2	Nil / >100	1
Chr1	Nil / 75 - <100	2
Chr2	Nil / 75 - <100	2
Chr3	<30 (localised[1]) 50-<75	4
Chr4	Nil / >100	1
Chr5	Nil / >100	1
Kb	Nil / >100	1
Sb	Nil / >100	1
Sr	Nil / 50 - <75	4
Vb1	Nil / 75 - <100	2
Vb1 Shallow Phase (VbShp)[1]	Nil / 50 - <75	4
Vb2	Nil / >100	1
Existing Soil Profiles – eSPADE, 2020		
Rr	<30 (localised[2]) / 75<100	3
Db	Nil / 75<100	3

1 –SMU Vb1 Shallow phase (VbShp) separated and reviewed for this attribute
2 – Localised as shallow soils were not observed in surrounding areas

6.1.8 Mass movement

No existing evidence of mass movement was observed at the Project site. The assessment of LSC of 1 is given across all SMUs.

6.2 Land and Soil Capability Assessment Summary

Reviewing the methodology outlined in Section 6.1, each SMU was reviewed to determine the final LSC. Table 6-10 summarises this assessment.

Table 6-10: LSC Assessment Matrix

SMU	Hazards and LSC Score								
	Water Erosion	Wind Erosion	Structural Decline Class	Soil Acidification	Salinity	Water Logging	Shallow Soil	Mass Movement	LSC Class
GTE SMUs									
Chb1	4	3	3	2	2	2	2	1	**4**
Chb2	3	2	3	4	5	2	1	1	**5**
Chr1	4	1	3	3	1	2	2	1	**4**
Chr2	3	2	1	3	2	2	2	1	**3**
Chr3	4	2	3	3	1	2	4	1	**4**
Chr4	3	2	3	2	1	2	1	1	**3**
Chr5	4	2	3	2	2	2	1	1	**4**
Kb	3	3	3	3	3	1	1	1	**3**
Sb	4	1	1	2	1	2	1	1	**4**
Sr	3	2	3	2	1	2	4	1	**4**
Vb1	4	3	1	2	1	2	2	1	**4**
VbShp	4	3	1	2	1	2	4	1	**4**
Vb2	4	2	1	2	1	2	1	1	**4**
Existing Soil Profiles – eSPADE, 2020									
Db	3	2	1	3	-	2	3	1	**3**
Rr	3	3	4	5	-	2	3	1	**5**

Note – Orange highlighted cells indicate most limiting hazard

6.2.1 Land and Soil Capability Assessment Summary – GSS (2013)

The Project site to the south-west has been reviewed and reported by GSS (2013). A summary of the assessment is presented in Table 6-11 (SMUs are presented on Figure 3).

Table 6-11: Land and Soil Capability Assessment Summary – GSS (2013)

LSC Class	SMU GSS, (GTE)
1	-
2	-
3	-
4	GSS/3
5	GSS/1 (Chb1), GSS/2 (Chr5)
6	GSS/5
7	GSS/7
8	-

The GSS (2013) SMUs GSS/1 and GSS/2 were reported as LSC Class 5. These SMUs were identified to have similarities with SMUs Chb1 and Chr5, both LSC Class 4. SMU GSS/3 was assessed as both LSC Class 2 and 4 in the previous land capability study (GSS, 2013). Review of the SMU GSS/3 in the Project site indicates LSC Class 4 based on available GSS (2013) information and assessment.

Review of the assessment of the SMUs indicates they all support a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation). Limitations across all four SMUs may be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology, such as contour ripping and banks.

The separate LSC classes have been presented on Figure 4.

6.3 Agricultural Suitability Assessment Methodology

The Agricultural Suitability system is used to classify land in terms of its suitability for general agricultural use. Agricultural land is classified by evaluating biophysical, social and economic factors that may constrain the use of land for agriculture.

The system is based on *Agricultural Land Classification, Agfact AC.25*, (NSW Agriculture, 2002) and contains five classes of agricultural suitability as presented in Table 6-12.

Table 6-12: Agricultural Suitability Classes and Descriptions

Class	Description
1	Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.
2	Arable land suitable for regular cultivation for crops but not suited to continuous cultivation. It has a moderate to high suitability for agriculture, but edaphic (soil factors) or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures.
3	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture. The overall production level is moderate because of edaphic factors or environmental constraints. Erosion hazard, soil structural breakdown or other factors including climate may limit the capacity for cultivation, and soil conservation or drainage works may be required.
4	Land suitable for grazing but not for cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be seasonally high, but the overall production level is low because of major environmental constraints
5	Land unsuitable for agriculture or at best suited only to light grazing. Agricultural production is very low or zero because of severe constraints, including economic factors which preclude land improvement.

Agricultural Suitability Classes have been determined using the field survey and remote sensing undertaken for the soil resource assessment. This does not include specific information on current agricultural productivity levels, social factors, economic factors, local or regional infrastructure or flooding. The agricultural suitability criteria used in this assessment are summarised in Table 6-13.

Table 6-13: Agricultural Suitability Selected Criteria

Agricultural Suitability Class	Slope	Soil Depth	Capable of Sustaining Cultivation	Drainage	Erosion Hazard	Flooding
1	Level to very gently undulating	Deep	Capable of sustaining regular cultivation	Well to moderately well drained	Low	Very low
2	Level to gently undulating	Deep to moderately deep	Capable, tillage practices may be required	Moderately, well drained or rapidly drained	Low to moderate	Low
3	Level to moderately	Moderately deep to shallow	Limited suitability for cultivation	Well drained to imperfectly drained	Low to high	Moderate
4	Level to steeply inclined	Mostly shallow	Unsuitable for cultivation, however minimum tillage may establish perennial pastures	Well drained to poorly drained	Low to very high	High
5	Extreme	Mostly shallow	Unsuitable for cultivation	Very poor	Extreme	High

6.4 Agricultural Suitability Assessment Summary

The identified SMUs in the Project site have been reviewed against the selected criteria in Table 6-13, as presented in Table 6-14 and on Figure 5.

Table 6-14: Agricultural Suitability Assessment

SMU	Slope[1]	Soil Depth	Capable of Sustaining Cultivation	Drainage	Erosion Hazard	Flooding	Agricultural Land Suitability
Chb1	Level to moderately	Deep	Limited suitability for cultivation	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Chb2	Level to very gently undulating	Deep	Limited suitability for cultivation	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Chr1	Level to moderately	Deep to moderately deep	Limited suitability for cultivation	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Chr2	Level to moderately	Deep to moderately deep	Capable, tillage practices may be required	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Chr3	Level to moderately	Deep	Limited suitability for cultivation	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Chr4	Level to moderately	Deep to moderately deep	Limited suitability for cultivation	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Chr5	Level to moderately	Moderately deep to shallow	Limited suitability for cultivation	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Kb	Level to moderately	Moderately deep to shallow	Limited suitability for cultivation	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Sb	Level to moderately	Moderately deep to shallow	Limited suitability for cultivation	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Sr	Level to moderately	Deep	Capable, tillage practices may be required	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Vb1	Level to moderately	Deep to moderately deep	Limited suitability for cultivation	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
VbShp	Level to moderately	Deep to moderately deep	Moderately deep to shallow	Moderately, well drained or rapidly drained	Low to moderate	Very low	**4**
Vb2	Level to moderately	Deep	Capable, tillage practices may be required	Moderately, well drained or rapidly drained	Low to moderate	Very low	**3**
Db	Level to very gently undulating	Deep to moderately deep	Capable, tillage practices may be required	Moderately, well drained or rapidly drained	Low to moderate	Low	**2**
Rr	Level to very gently undulating	Deep to moderately deep	Unsuitable for cultivation, potential to establish perennial pastures	Moderately, well drained or rapidly drained	Low to moderate	Very low	**4**

Note – Orange highlighted cells indicate most limiting hazard
1 – Slope reviewed against National Committee on Soil and Terrain (2009),

6.4.1 Agricultural Suitability Assessment Summary – GSS (2013)

The Project site to the south-west has been reviewed for agricultural suitability and reported by GSS (2013). A summary of the assessment is presented in Table 6-15.

Table 6-15: Agricultural Suitability Assessment Summary – GSS (2013)

Agricultural Suitability Class	Soil Type GSS. (GTE)
1	-
2	
3	GSS/1 (Chb1), GSS/2 (Chr5), GSS/3
4	GSS/5, GSS/7
5	-

The GSS (2013) SMUs GSS/1, GSS/2 and GSS/3 and GTE SMUs Chb1 and Chr5 reported agricultural suitability assessment classes of 3. The five SMUs indicated they consist of grazing land or land well suited to pasture improvement which may be cultivated or cropped in rotation with sown pasture. Limitations included the slope of the land, capability to sustain cultivation with low to moderate erosion risk. It was observed that GSS/3 was assessed as agricultural suitability class 2 and 3 in the previous land capability study (GSS, 2013). Review of the SMU GSS/3 in the Project site indicates agricultural suitability class 3 based on available GSS (2013) information and assessment.

6.5 Soil Erosion

Soil erosion is a potential significant issue which although a natural process, can be accelerated by practices such as land clearing in preparation for construction and operational activities.

Soil erosion is the removal of soil by water, wind or human activities from the land surface, movement and deposition. Erosion can occur across all landscapes and the rate is determined by various attributes including ground cover, slope, soil texture, soil surface erodibility, soil chemistry, wind speed and rainfall rates. Erosion may lead to several types of erosion including sheet, rill, gully, tunnel or mass movement.

The assessment methodology includes soil texture, erodibility and chemistry related to dispersion of topsoil and subsoils of each SMU.

6.5.1 Soil Erosion Potential Assessment

The soil erosion assessment for the Project site SMUs is provided below in Table 7-1.

Table 7-1: Soil Erosion Assessment

SMU	Horizon	Landform	Texture	K Factor[1]	Sodicity / ESP	Emerson Ag Test	Erosion Potential[2]
Chb1 / GSS/1	Topsoil	Moderately inclined	Clay loam	0.03 – Mod	Non-sodic	Nil	Low to moderate
	Subsoil		Silty clay	0.025 – Mod	Non-sodic	Slight	Low to moderate
Chb2	Topsoil	Gently inclined	Silty clay loam	0.04 – Mod/High	Non-sodic	n/a	Low to moderate
	Subsoil		Medium clay	0.015 – Low	Non-sodic	n/a	Low
Chr1	Topsoil	Moderately inclined	Loam	0.04 – Mod/High	Non-sodic	Nil	Low to moderate
	Subsoil		Medium	0.015 – Low	Marginal	Nil	Low to

SMU	Horizon	Landform	Texture	K Factor[1]	Sodicity / ESP	Emerson Ag Test	Erosion Potential[2]
			clay		sodic		moderate
Chr2	Topsoil	Moderately inclined	Clay loam	0.03 – Mod	Non-sodic	Nil	Low to moderate
	Subsoil		Medium heavy clay	0.015 – Low	Non-sodic	Nil	Low
Chr3	Topsoil	Moderately inclined	Sandy loam	0.03 – Mod	Non-sodic	Nil	Low to moderate
	Subsoil		Clay loam	0.03 – Mod	Non-sodic	Nil	Low to moderate
Chr4	Topsoil	Moderately inclined	Loam	0.04 – Mod/High	Non-sodic	Nil	Low to moderate
	Subsoil		Light clay	0.025 – Mod	Non-sodic	Nil	Low to moderate
Chr5 / GSS/2	Topsoil	Moderately inclined	Silty loam	0.055 – High	Non-sodic	Nil	Low to moderate
	Subsoil		Silty clay loam	0.04 – Mod/High	Non-sodic	Nil	Low to moderate
Kb	Topsoil	Moderately inclined	Loam	0.04 – Mod/High	Non-sodic	Nil	Low to moderate
	Subsoil		Loam	0.04 – Mod/High	Non-sodic	Nil	Low to moderate
Sb	Topsoil	Moderately inclined	Clay loam	0.03 – Mod	Non-sodic	Slight	Low to moderate
	Subsoil		Medium clay	0.015 – Low	Sodic to non-sodic	Moderate	Moderate
Sr	Topsoil	Moderately inclined	Clay loam	0.03 – Mod	Sodic	Nil	Moderate
	Subsoil		Heavy clay	0.012 – Low	Sodic	Nil	Moderate
Vb1	Topsoil	Moderately inclined	Heavy clay	0.012 – Low	Non-sodic	Nil	Low
	Subsoil		Medium clay	0.015 – Low	Sodic to non-sodic	Slight to complete	Moderate
Vb2	Topsoil	Moderately inclined	Light clay	0.025 – Mod	Non-sodic	Nil	Low to moderate
	Subsoil		Medium clay	0.015 – Low	Non-sodic	Slight	Low to moderate
Db	Topsoil	Gently inclined	Silty clay loam	0.04 – Mod/High	n/a	n/a	Low to moderate
	Subsoil		Light clay	0.025 – Mod	n/a	n/a	Low
Rr	Topsoil	Gently inclined	Sandy clay loam	0.025 – Mod	n/a	n/a	Low
	Subsoil		Sandy clay loam	0.025 – Mod	n/a	n/a	Low

1 – K Factor is reviewed by Rosewell (1993) and Rosewell and Loch (2002), outlined in in Hazelton and Murphy (2007)
2 – GTE Assessment based on available assessment criteria

Separate soil types identified in GSS, 2013 are summarised below in Table 7-2.

Table 7-2: Soil Erosion Assessment GSS (2013)

SMU / Soil type	Dominant Slope	K Factor[1]	Erosion Hazard
GSS/3 / Brown Vertosol	Level to gently inclined	0.025	Moderate
GSS/5 / Brown Kurosol	Level to gently inclined	0.04	Moderate
GSS/7 / Rudosol	Moderately to steeply inclined	n/a	High

1 – K Factor is reviewed in Hazelton and Murphy (2007)

The assessment indicates the erosion potential of the Project site SMUs ranges from low to moderate, except for the SMU GSS/7, which has a high erosion hazard. Erosion and sediment controls should be implemented to ensure that erosion of soil resources during stripping, stockpiling and rehabilitation placement is minimised.

SMUs assessed with low erosion potential may only require on-site observation. SMUs assessed with low to moderate and moderate erosion potential may require management in the stripping and placement of soils. It is recommended that SMU GSS/7, with erosion potential of high, be separated from other soils and managed appropriately.

Further assessment of the SMUs, including erosive and dispersive qualities, is included in Section 7, with specific management recommendations in Sections 7.1.4 to 7.1.6.

7 MANAGEMENT MEASURES

The following management measures are related to construction and operational activities at the Project site. These include stripping depths of soils for rehabilitation use and amelioration management.

7.1 Topsoil and Subsoil Stripping

Areas to be disturbed as a result of mining activities and infrastructure corridors will require stripping of the topsoil and possibly subsoil for reuse in the rehabilitation of these areas. All SMUs in the Project site have been reviewed to determine their suitability for stripping and reuse for rehabilitation purposes.

Soil stripping, stockpiling and placement would follow the procedures within the Mount Pleasant Operation Mining Operations Plan and Rehabilitation Management Plan (MOP) approved for the Project. The MOP would include details of areas to be disturbed, the volumes of soils required for rehabilitation, soil stripping depth and the management of stockpiled soils, soil replacement depths and soil treatment measures.

7.1.1 Soil stripping criteria

Soil resources on the Project site for mine rehabilitation reuse have been reviewed against stripping suitability criteria, Elliot and Veness (1981). This methodology includes assessing topsoil, and subsoil with the nominated attributes. These are summarised in Table 7-3.

Table 7-3: Soil Stripping Criteria

Attribute	Criteria
Structure grade	>30% peds
Coherence	Coherent (wet and dry)
Mottling	Absent
Macrostructure	>10 cm
Force to disrupt peds	=<3 force
Texture	Finer than a fine sandy loam
Gravel and Sand Content	<60%
pH	4.5 to 8.4
Salt Content	<1.5 dS/m

7.1.2 SMU topsoil stripping recommendations

The SMU suitability and stripping depths have been reviewed based on the criteria outlined in Table 7-3. Topsoil stripping assessment is presented as highly suitable (no limitations), suitable (orange highlight, marginal limitation) or unsuitable criteria (red highlight, unsuitable limitation).

Table 7-4 and 7-5 (GSS, 2013) summarises the topsoil stripping assessment and recommended depths, in the absence of amelioration.

Table 7-4: Topsoil Stripping Assessment, Elliot and Veness (1981)

SMU	Criteria									Suitability, Stripping Depth (mbgl)*
	Structure grade	Coherence	Mottling	Macro-structure	Force to disrupt peds[2]	Texture	Gravel and Sand Content	pH	Salt Content	
Chb1	>30% peds	Coherent	Absent	<10cm	=<3 force	<FSL	<60	4.5-8.4	<1.5 dS/m	Highly suitable 0.00-0.10
Chb2	>30% peds	Coherent	Absent	<10cm	Not suitable	-	-	-	-	Not suitable
Chr1	Marginal	Coherent	Absent	<10cm	=<3 force	Marginal	<60	4.5-8.4	<1.5 dS/m	Suitable 0.0-0.20
Chr2	>30% peds	Coherent	Absent	<10cm	=<3 force	<FSL	<60	4.5-8.4	<1.5 dS/m	Highly suitable 0.00-0.15
Chr3	Not suitable	-	-	-	-	-	-	-	-	Not suitable
Chr4	Not suitable	-	-	-	-	-	-	-	-	Not suitable
Chr5	>30% peds	Coherent	Absent	<10cm	=<3 force	<FSL	<60	4.5-8.4	<1.5 dS/m	Highly suitable 0.00-0.15
Kb	Marginal	Coherent	Absent	<10cm	=<3 force	Marginal	<60	4.5-8.4	<1.5 dS/m	Suitable 0.0-0.10
Sb[1]	Marginal	Coherent	Absent	<10cm	=<3 force	<FSL	<60	4.5-8.4	<1.5 dS/m	Suitable 0.0-0.15
Sr	>30% peds	Coherent	Absent	<10cm	=<3 force	<FSL	<60	4.5-8.4	<1.5 dS/m	Not suitable due to sodic limitations
Vb1	>30% peds	Not required	Absent	<10cm	=<3 force	<FSL	<60	4.5-8.4	<1.5 dS/m	Highly suitable 0.00-0.10
Vb2	Marginal	Coherent	Absent	<10cm	=<3 force	<FSL	<60	4.5-8.4	<1.5 dS/m	Suitable 0.0-0.10
Db	>30% peds	n/a	Absent	n/a	=<3 force	<FSL	<60	4.5-8.4[3]	n/a[4]	Suitable 0.00-0.15
Rr	>30% peds	n/a	Absent	n/a	=<3 force	<FSL	<60	4.5-8.4[3]	n/a[4]	Suitable 0.00-0.45[5]

* In the absence of soil amelioration.

1 – Minor mottles observed in site 4, however this appears to be a very minor sub-dominant attribute.

2 – Force to disrupt peds based on Butler, 1955, as referenced A.Young, *Tropical Soils and Soil Survey (1980)*. Key is 1 is nil, 2 is very small, 3 is small moderate, 4 is strong, 5 is very strong.

3 – pH field result (Raupach) assessed. GTE recommends pH laboratory analysis be conducted prior to stripping.

4 – Based on similar and surrounding SMUs, this analysis is assumed to be below 1.5 dS/m. GTE recommends EC laboratory analysis be conducted prior to stripping.

5 – Soil Profile 85 A horizon is reported at 0.0-0.90 mbgl, a conservative stripping depth until additional laboratory analysis is undertaken is 0.0-0.45 mbgl.

Table 7-5: Topsoil Stripping Assessment GSS (2013)

Soil Type		Recommended Stripping Depth	Main Limitation(s)	Capability
No.	ASC Name	Mbgl	Description	
3	Brown Vertosol	0.00-0.20	Texture, chemical properties of subsoil	Highly Suitable
5	Brown Kurosol	0.00-0.10	Texture, chemical properties of subsoil	Suitable
7	Rudosol	-	Slope, variable depth to bedrock, texture	Unsuitable

SMUs 1 and 2 are reviewed against their similar SMUs, Chb1 and Chr5, and are therefore not presented separately in Table 7-5. The assessment indicates they have the same recommended stripping depths of 0.1 mbgl for SMUs 1 and Chb1 and 0.15 mbgl for SMUs 2 and Chr5.

7.1.3 SMU subsoil stripping recommendations

SMU subsoil horizons may provide potential rehabilitation use. Review of the soil chemistry may indicate if a subsoil may:

- support regrowth of native vegetation and grasses for rehabilitation of areas that are relatively flat and sloped areas;
- support subsoils for topsoil placement; or
- be suitable for capping waste rock due to major limitations.

Table 7-3 has been used to assess the suitability of subsoils, as presented in Table 7-6.

Table 7-6 Subsoil Stripping Assessment

SMU	Subsoil Stripping Recommendation and Limitation Assessment	Subsoil Depth (mbgl)
Chb1	Subsoils may be marginal for use as supporting subsoils on level plains however structure indicates silty, massive, slightly dispersive soils which may be undesirable without further treatment. Subsoils below 0.10 to 1.00 mbgl, suitable for capping waste rock.	-
Chr1	Suitable for support subsoils for topsoil placement, level plains. Subsoils below 0.70 mbgl are a finer texture which is undesirable limitation.	0.20-0.70
Chr2	Suitable for support subsoils for topsoil placement, slopes or level plains. Subsoils below 0.70 mbgl are a finer texture / alkaline pH, suitable for capping waste rock.	0.15-0.70
Chr3	Subsoils may be marginal for use as supporting subsoils on level plains however structure indicates silty, massive soils which may be undesirable without further treatment. Soils from 0.00 to 0.50 mbgl, suitable for capping waste rock.	-
Chr4	Soil profile is complicated where review of the horizons identified presents a suitable supporting subsoil at depth 0.60 to 0.80 mbgl. Soils of 0.00-0.50 mbgl and below 0.90 mbgl presents undesirable.	0.60-0.80
Chr5	Subsoils may be marginal for use as supporting subsoils on level plains however structure indicates clayey, massive soils which may be undesirable without further treatment.	-
Kb	Subsoils may be marginal for use as supporting subsoils on level plains however structure indicates silty, massive soils which may be undesirable without further treatment. Subsoils below 0.10 to 1.00 mbgl, suitable for capping waste rock.	-
Sb	Subsoils below 0.15 mbgl present dispersive attributes, suitable for capping waste rock.	-

SMU	Subsoil Stripping Recommendation and Limitation Assessment	Subsoil Depth (mbgl)
Sr	Soils from 0.00 to 0.60 mbgl, suitable for capping waste rock. Amelioration of dispersive attributes in subsoils 0.10 mbgl may consider buried subsoils on level plains.	-
Vb1	Suitable for support subsoils for topsoil placement, level plains. Subsoils below 0.50 mbgl present dispersive attributes, suitable for capping waste rock.	0.10-0.50
Vb2	Suitable for support subsoils for topsoil placement, level plains. Subsoils below 0.50 mbgl present dispersive attributes and undesirable structure, suitable for capping waste rock.	0.10-0.50
Chb2	Suitable for support subsoils for topsoil placement, level plains.	0.10-0.70
Db[1,2]	Suitable for support subsoils for topsoil placement, level plains.	0.15-0.40[4]
Rr[1,2]	Suitable for support subsoils for topsoil placement, level plains.	0.45- 0.90[3]

1 – pH field result (Raupach) assessed. GTE recommends pH laboratory analysis be conducted prior to stripping.
2 – Based on similar and surrounding SMUs, this analysis is assumed to be below 1.5 dS/m. GTE recommends EC laboratory analysis be conducted prior to stripping.
3 – Soil Profile 85 A horizon is reported at 0.0-0.90 mbgl, a conservative subsoil stripping depth until additional laboratory analysis is undertaken is 0.45-0.90 mbgl.
4 – Soil Profile 82 subsoil is reviewed on a conservative approach with available data. Further laboratory analysis including EAT, ESP, pH and EC is recommended.

GSS (2013) reported that all subsoils within the south-west portion of the Project site were reviewed as undesirable because of severe physical and/or chemical limitations.

Table 7-7 presents the recommended stripping depths for each SMU and total estimated suitable topsoil and subsoil reserves for the mining disturbance area within the Project site. Topsoil stripping depths is presented on Figure 6.

Table 7-7: Recommended Rehabilitation Stripping Depths and Approximate Volumes Suitable

	Recommended Topsoil Stripping Depth in soil profile (mbgl)	Recommended Subsoil Stripping Depth in soil profile (mbgl)	Area of SMU within the Mining Disturbance Area (ha)	Approximate Topsoil Volume within the Mining Disturbance Area (cubic metres [m^3])	Approximate Subsoil Volume within the Mining Disturbance Area (m^3)
Chb1	0.00-0.10	-	385	385,000	0
Chr1	0.00-0.20	0.20-0.70	85	170,000	425,000
Chr2	0.00-0.15	0.15-0.70	135	202,500	742,500
Chr3	-	-	35	0	0
Chr4	-	0.60-0.80	148	0	296,000
Chr5	0.00-0.15	-	0	0	0
Kb	0.00-0.10	-	45	45,000	0
Sb	0.00-0.15	-	35	52,500	0
Sr	-	-	89	0	0
Vb1	0.00-0.10	0.10-0.50	147	147,000	588,000
Vb2	0.00-0.10	0.10-0.50	52	52,000	208,000
VbShp	0.00-0.10	0.10-0.50	26	26,000	104,000
Chb2	-	0.10-0.70	16	0	96,000

	Recommended Topsoil Stripping Depth in soil profile (mbgl)	Recommended Subsoil Stripping Depth in soil profile (mbgl)	Area of SMU within the Mining Disturbance Area (ha)	Approximate Topsoil Volume within the Mining Disturbance Area (cubic metres [m^3])	Approximate Subsoil Volume within the Mining Disturbance Area (m^3)
Db	0.00-0.15	0.15-0.40[3]	0	0	0
Rr	0.00-0.45[1]	0.45-0.90[2]	2	9,000	9,000
1	0.00-0.10	-	10	10,000	0
2	0.00-0.15	-	0	0	0
3	0.00-0.20	-	2	4,000	0
5	0.00-0.10	-	28	28,000	0
7	-	-	0	0	0
TOTAL FOR PROJECT SITE			**1,240**	**1,131,000**	**2,468,500**

1 – Soil Profile 85 A horizon is reported at 0.0-0.90 mbgl, a conservative stripping depth until additional laboratory analysis is undertaken is 0.0-0.45 mbgl.
2 – Soil Profile 85 A horizon is reported at 0.0-0.90 mbgl, a conservative subsoil stripping depth until additional laboratory analysis is undertaken is 0.45-0.90 mbgl.
3 – Soil Profile 82 subsoil is reviewed on a conservative approach with available data. Further laboratory analysis including EAT, ESP, pH and EC is recommended.

7.1.4 Soil amelioration recommendations and management

The rehabilitation reuse of the SMUs may be assisted with the following treatments and amelioration recommendations for topsoil and subsoils.

- SMUs Chr1, Chr2 and Kb reported very strongly acidic pH levels below 5.0 pH which may reduce the potential for vegetation growth and potentially increase other forms of land degradation. Agricultural lime application is recommended to raise pH levels which would assist in improving the suitability of these soils for rehabilitation.

  The remaining SMUs presented moderately acidic pH levels and may not require further management as the general post-mining rehabilitation is to restore self-sustaining native woodland ecosystems, which is consistent with what was observed during the soil survey. If visual observations of rehabilitation decline or chemical modifications are reported in the soils, then a further assessment into reducing or increasing pH may be considered.

  If the pH of soils starts to increase and become more alkaline, methods such as adding composted organic matter or mulching will naturally lower pH. Significant measures may include using powdered sulfur to assist.

- Gypsum ameliorants may be used to reduce any dispersive attributes for subsoils. It is recommended that this be reviewed further during the stripping and stockpiling of subsoil materials.

  Subsoils for SMUs Sb, Sr, Vb1 and Vb2 would benefit from gypsum ameliorants if additional subsoil resources were required.

- Organic matter applied to all soil resources in general will increase water holding capacity, reduce erosion, reduce nutrient leaching and improve the structure of the soil. SMUs Vb1 reported the lowest organic carbon levels and is recommended that this soil have organic matter applied from sources such as off-site composting, manure or sewage treatment waste.

  Topsoil of SMUs Chb2, Chr1, Chr3, Chr4, Sb and Vb2, would benefit from the input of organic matter in improving the structure and force to disrupt peds.

  SMU Kb presents slightly increased EC and salt content in the topsoil horizon. To assist in reducing the salt content, applied organic matter and good stripping management will encourage water infiltration and good structure. This will assist in reducing the salt content present in the top horizon.

  Subsoils for Chb1, Chr3, Chr4, Chr5 and Kb, would benefit from organic matter input if additional subsoil resources were required.

- For all SMUs, except for SMU Chr5, phosphorus levels (Olsen) are low when reviewed against agricultural activities such as irrigated and dryland pastures. The phosphorus buffering index (PBI) indicates that SMUs are generally prone to leaching (<50 PBI ratio). It is recommended that phosphorous fertilizers, such as single super (SSP) and double super (Di-ammonium phosphate [DAP]), be considered to increase phosphorus levels.

  SMUs Chr1, Vb1 Sb report lower levels of nitrate and may benefit from nitrogen-based fertilizers to increase levels. These may include low percentage fertilizers such as calcium nitrate, sodium nitrate to moderate percentage fertilizers such as ammonium nitrate and calcium ammonia nitrate. These SMUs may benefit from nitrogen and phosphorus fertilizers such as mono-ammonium phosphate (MAP) or DAP. Nitrogen and phosphorus levels should be monitored during and after application.

Table 7-8 summarises recommended topsoil and subsoil suitability, stripping depth and treatments listed above. A summary of recommended stripping depths for each SMU (incorporating treatment measures where required) is provided in Table 7-9.

Table 7-8: Soil Resource, Depth and Amelioration Recommendations Summary

Soil Resource and Amelioration (as required)	Depth (m)[1]	SMU
Topsoil		
Topsoil recommended without amelioration	0.00-0.20	Chb1, Chr5, Db, Rr
Topsoil may be improved with agricultural lime amelioration	0.00-0.20	Chr2
Topsoil may be improved with gypsum amelioration	0.00-0.20	Sr
Topsoil may be improved with organic matter amelioration	0.00-0.20	Chb2, Chr1, Chr3, Chr4, Sb, Kb, Vb1, Vb2
Subsoil		
Subsoil usable without amelioration	0.10-0.50	Db, Vb1, Vb2
	0.15-0.80	Chr1, Chr2, Chr4, Chb2, Rr
Subsoil may be improved with gypsum amelioration	0.10-0.80	Sb, Sr, Vb1, Vb2

Soil Resource and Amelioration (as required)	Depth (m)[1]	SMU
Subsoil may be improved with organic matter amelioration	0.10-0.80	Chb1, Chr3, Chr4, Chr5, Kb,

1 – Nominated range of depths allow SMUs to be grouped together. Refer to Tables 7-4 and 7-5 for specific SMU soil stripping depths.

Table 7-9: Summary of Recommended Soil Stripping Depths including Amelioration Where Required

SMU	Topsoil Stripping Depth		Subsoil Stripping Depth		Area of SMU within the Mining Disturbance Area (ha)
	(Without Treatment) (mbgl)	With Treatment) (mbgl)	(Without Treatment) (mbgl)	(With Treatment) (mbgl)	
Chb1	0.00-0.10	-	-	0.10-0.80	385
Chr1	0.00-0.20	-	0.20-0.70	-	85
Chr2	0.00-0.15	0.15-0.20	0.2-0.70	-	135
Chr3	-	0.00-0.20	-	0.20-0.80	35
Chr4	-	0.00-0.20	0.60-0.80	0.20-0.80	148
Chr5	0.00-0.15	-	-	0.15-0.80	0
Kb	0.00-0.10	0.10-0.20	-	0.20-0.80	45
Sb	0.00-0.15	0.15-0.20	-	0.20-0.80	35
Sr	-	0.00-0.20	-	0.20-0.80	89
Vb1	0.00-0.10	0.10-0.20	0.20-0.50	0.50-0.80	147
Vb2	0.00-0.10	0.10-0.20	0.20-0.50	0.50-0.80	52
VbShp	0.00-0.10	-	0.10-0.50	-	26
Chb2	-	0.00-0.20	0.20-0.70	-	16
Db	0.00-0.15	-	0.15-0.40[3]	-	0
Rr	0.00-0.45[1]	-	0.45-0.90[2]	-	2
1	0.00-0.10	-	-	-	10
2	0.00-0.15	-	-	-	0
3	0.00-0.20	-	-	-	2
5	0.00-0.10	-	-	-	28
7	-	-	-	-	0

1 – Soil Profile 85 A horizon is reported at 0.0-0.90 mbgl, a conservative stripping depth until additional laboratory analysis is undertaken is 0.0-0.45 mbgl.

2 – Soil Profile 85 A horizon is reported at 0.0-0.90 mbgl, a conservative subsoil stripping depth until additional laboratory analysis is undertaken is 0.45-0.90 mbgl.

3 – Soil Profile 82 subsoil is reviewed on a conservative approach with available data. Further laboratory analysis including EAT, ESP, pH and EC is recommended.

7.1.5 Soil stripping management

The following soil stripping management recommendations may assist in minimizing soil loss and quality during soil resource stripping:

- A data management system should be in place prior to the stripping and stockpiling of soil resources on the Project site. This will record and map the areas stripped, the volumes removed and stockpile areas. It will also assist in minimising cross-stockpile contamination of topsoils and subsoils,
- Supervisors and competent operators should be familiar with the areas to be stripped based on existing soils mapping and recommended topsoil and subsoil reuse and depth,
- Soil stripping should be undertaken progressively,
- Vegetation removal should occur prior to stripping which will reduce loss of stripped topsoil and mixing with unsuitable soils. Vegetation removed may be stockpiled and reused as whole limbs, or as mulch, if appropriate,
- Inspections of the stripped areas should be undertaken to observe any unexpected changes in soils. Erosion and sediment control measures should be established in areas prone to erosion,
- Stripping should not occur during excessively wet weather events to prevent cross horizon contamination, soil structure decline and soil loss,
- Contour ripping of soils during the rehabilitation process will reduce erosion potential and hard setting of surfaces prior to vegetation establishment.

7.1.6 Soil stockpile management and design

Stockpile design should consider the following management recommendations:

- Topsoil and subsoils should be kept separate to prevent mixing of soils,
- Topsoil and subsoil stockpiles should be retained at a height of no more than 3 m[6] and 5 m, respectively, with slopes no greater than 1:2 (vertical to horizontal) and a slightly roughened surface to minimise erosion,
- The surface of the stockpile should be flat,
- Adequate erosion and sediment control should be implemented, including sediment fencing on the downslope area of stockpiles,

[6] Unless authorised by the Mount Pleasant Operation MOP to be greater than 3 m in height.

- All topsoil and subsoil stockpiles should be seeded with a non-persistent cover crop to reduce erosion potential as soon as practicable after completion of stockpiling. Where seasonal conditions preclude adequate development of a cover crop, stockpiles should be treated (e.g. with a straw/vegetative mulch/cleared vegetation/geomesh) to improve stability,
- There should be no vehicle access on soil stockpiles, except when soil quality monitoring is required,
- If unacceptable weed generation is observed on soil stockpiles, a weed eradication program should be implemented,
- If a stockpile is scheduled to remain in place for more than 24 months, additional management measures may be considered where required such as,
    - Catch drains or runoff areas may be excavated along the surface edge, ideally lined with geotextile or geomembrane material for runoff of sloped areas to minimise erosion of the batter edges,
    - Revegetation of the stockpiles with cover crops, native or suitable grasses and/or trees will minimise erosion and soil loss, minimise the establishment of weeds, assist in maintaining organic matter, nutrients and microbial activity and rejuvenate native vegetation through existing seedbank,
- Inspection of the stockpiles (once completed) with scheduled ongoing maintenance either as required or recommended every three months. Where possible, stockpile locations should be placed against existing vegetated areas and away from current or proposed drainage lines, and
- Locations should be placed in areas where it may assist future rehabilitation reuse, i.e. reduce movement of materials where possible.

7.1.7 Recommended topsoil application depths for rehabilitation

It is recommended that the minimum placement depth of topsoil be 0.10 m.

The placement of suitable subsoils of up to 0.30 m beneath the 0.10 m cap of topsoil may also improve rehabilitation outcomes and could be trialled to verify if results warrant the additional materials handling requirements. If subsoils are suitable for rehabilitation stripping, they may be mixed with suitable topsoils to create slightly reduced, but suitable topsoil.

Rehabilitation of the Fines Emplacement Area would involve a topsoil cover placed over a layer of inert waste rock. It is understood that the rehabilitation concepts for the Fines Emplacement Area would be refined over the life of the Project, subject to the outcomes of proposed rehabilitation studies.

Sufficient soil sources are available for rehabilitation of mine disturbance areas, including the Fines Emplacement Area, based on a minimum topsoil depth of 0.10 m (Section 7.1.8).

7.1.8 Soil resource volumes balance

Topsoil volumes have been calculated based on the recommended stripping depths in Table 7-7. These volumes include all disturbed areas in the Project site.

The volumes based on the disturbed area excluding the final void is presented in Table 7-10.

Table 7-10: Topsoil Resource Volume Balance

Topsoil Resource	Volume (m^3)
Topsoil volume suitable for stripping	1,131,000
Total volume required for disturbed areas excluding final void	1,094,330
Topsoil volume difference / remaining	36,670

The approximate subsoil volume available within the mining disturbance area is presented in Table 7-7.

8 LAND USE IMPACTS AND FINAL LAND USE

Areas which are disturbed by mining, related infrastructure and corridors will undergo rehabilitation. Mining disturbance would include a proposed final void, with surface rehabilitation forming a significant portion of the Project site. Current mine planning indicates that approximately 1,240 ha of the Project site would be disturbed, which will result in changes to the pre-mining land use and suitability. The remainder of the Project site (2,585 ha) will either not be disturbed or will have minor altered local topography from local impacts such as access roads or other minor infrastructure.

Post-mine land use suitability is influenced by various factors including physical, biological and chemical changes of soil, depth of soil and slope gradient and length in the final landform design. Open cut mining activities in general are expected to change the nature of the final landform and suitability for land use activities. It is expected that all areas of the Project site affected by mining activities would meet the following rehabilitation objectives:

- safe, stable and non-polluting; and
- fit for the intended post-mining land use.

The proposed post-mine final land use for the majority of the Project site would be restored to self-sustaining native woodland ecosystems characteristic of vegetation communities found in the local area.

Sufficient topsoil and subsoil resources are available to achieve the desired rehabilitation outcomes (Section 7.1.8).

9 CONCLUSION

The following conclusions have been made for the soils and land suitability assessment for the Project site;

- Twelve SMUs identified during assessment including one variant and one phase, as well as five pre-existing SMUs from existing soils data are present in the Project site,
- The Project site includes areas of flat to gently undulating plains dominated by uniform and gradational dermosol clays to undulating plains of texture contrast dermosols, sodosols and kandosols. Uniform and gradational shallow and moderately deep clays are present on simple and upper slopes with a small area (two hectares) of rudosols observed,
- Land suitability assessment has been undertaken against the LSC (OEH, 2012) and Agricultural Land Classification (NSW Agriculture, 2002) the results of which are outlined in Tables 9-1 and 9-2,
- Sufficient topsoil is suitable for rehabilitation use. Topsoil suitable for rehabilitation use is suitable in supporting native vegetation, grasses and where required supporting grazing agricultural activities,
- Eight SMUs (Chr1, Chr2, Vb1, Vb2, Chr4, Chb2, Rr and Db) may provide suitable subsoil for supporting topsoil placement. Other subsoils are not suitable for rehabilitation use due to inherent limitations (e.g. some are dispersive soils),
- Recommended topsoil and subsoil stripping depths, with appropriate treatment measures (where required), are provided in Table 7-9, and
- The proposed post-mine final land use for the majority of the Project site would be restored to self-sustaining native woodland ecosystems characteristic of vegetation communities found in the local area.

Table 9-1: Land and Soil Capability Assessment Summary

Land and Soil Capability Class	Description	SMU
1	Extremely high capability land: Land has no limitations.	-
2	Very high capability land: Land has slight limitations.	-
3	High capability land: Land has moderate limitations.	Chr2, Kb, Chr4, Db
4	Moderate capability land: Land has moderate to high limitations.	Chr1, Vb1 (VbShp), Sb, Chr3, Vb2, Chb1, Sr, Chr5, GSS/3
5	Moderate–low capability land: Land has high limitations.	Chb2, Rr, GSS/1, GSS/2
6	Low capability land: Land has very high limitations.	GSS/5
7	Very low capability land: Land has severe limitations.	GSS/7
8	Extremely low capability land: Land is incapable of sustaining any land use apart from nature conservation.	-

Table 9-2: Agricultural Suitability Assessment Summary

Agricultural Suitability Class	Description	SMU
1	Arable land suitable for intensive cultivation.	-
2	Arable land suitable for regular cultivation.	Db
3	Grazing land.	Vb2, Sr, Chr1, Chr2, Vb1, Sb, Chr3, Kb, Chb1, Chr4, Chr5, Chb2, GSS/1, GSS/2, GSS/3
4	Land suitable for grazing but not for cultivation.	VbShp, Rr, GSS/5, GSS/7
5	Land unsuitable for agriculture or at best suited only to light grazing.	-

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11 GLOSSARY OF TERMS

The following descriptions are of terms used in the text of this report.

ASC. Australian soil class

ASPAC. Australasian Soil and Plant Analysis Council.

Calcium and Magnesium Ratio (Ca:Mg). A calculation of the Exchangeable Calcium to Exchangeable Magnesium ratio. Ca:Mg provides a guide to a soil's structure, which influences soil drainage, root development and plant growth. Well-structured soils have a Ca:Mg greater than 2:1. A ratio of greater than 10:1 indicates potential Mg deficiencies in cattle.

Cation Exchange Capacity (CEC). The maximum positive charge required to balance the negative charge on colloids (clays and other charged particles). The units are milli-equivalents per 100 grams of material or centimoles of charge per kilogram of exchanger. CEC is often used as a measure of soil fertility and nutrient retention capacity.

Chromosol. Soils with a clear or abrupt textural B horizon and in which the major part1 of the upper 0.2 m of the B2 horizon (or the major part of the entire B2 horizon if it is less than 0.2 m thick) is not strongly acid.

Clay. A soil material composed of particles finer than 0.002 mm. When used as a soil texture group such soils contain at least 35% clay.

Colwell P. A measure of the phosphorus that is available for plant uptake. In the Colwell P method, soil is shaken for 16 hours in a bicarbonate solution before the soluble extract is analysed for P. The Colwell P result is generally higher than Olsen P and the values depend on the soil's PBI.

Dermosol. Soils with structured B2 horizons and lacking strong texture contrast between A and B horizons.

Dispersion. A process by which species in solution mix with a second solution, thus reducing in concentration. In the case of sodic soils it will predispose the soil material to lose structure and disseminate into the solution.

Dispersion Ratio (R1). The measurement of soil dispersion when used in conjunction with ESP and the Ca/Mg ratio for predicting soil physical behaviour

Effective Soil Depth (ERD). The depths of which vegetation roots may readily penetrate the soil profile, have access to water and nutrients and not be restricted by physical (e.g. hard pans) or chemical barriers (e.g. elevated chloride ≥800 mg/kg)

EIS. Environmental Impact Statement

Electrical Conductivity (EC). The EC of water is a measure of its ability to conduct an electric current. The EC of soils will vary depending on the texture and amount of moisture held by

the soil particles. Electrical conductance increases with soluble salt content and thus allows simple interpretation of salinity.

Emerson Aggregate Test (EAT). Measurement of the behaviour of soil aggregates, when immersed, on their coherence in water.

Erosion. The displacement of soil, rock or dissolved material by wind or water flow from one location on the earth to another location.

Exchangeable Sodium Percentage (ESP). The amount of sodium as a proportion of all cations in a soil is termed the Exchangeable Sodium Percentage. It is calculated by dividing the exchangeable sodium by the cation exchange capacity (CEC), multiplied by 100. ESP values greater than 6% are considered sodic, with values greater than 15% considered very sodic. ESP = (Exchangeable sodium (meq/100g)/Cation exchange capacity (meq/100g)) x 100

Field pH (Raupach pH). The measurement of the pH in the field by utilising Manutec Pty Ltd, Soil pH Test Kit. This kit consists of pH dye indicator, Barium Sulphate and reference colour chart.

Gradational. The lower boundary between soil layers (horizons) has a gradual transition to the next layer. The solum (soil horizon) becomes gradually more clayey with depth.

Gradient. The rate of inclination of a slope. The degree of deviation from the horizontal.

Horizon. An individual soil layer, based on texture and colour, which differs from those above and below.

Kandosol. Soils which lack strong texture contrast, have massive or only weakly structured B horizons, and are not calcareous throughout.

Kurosol. Soils that have strong texture contrast between the surface (A) horizons and the clay subsoil (B) horizons. The subsoil is strongly acid, i.e. pH is 5.4 or less in water, and non-sodic (at least in the upper horizons).

Layer. See Horizon

Loam. A medium textured soil of approximate composition 10-25% clay, 25-50% silt and >50% sand.

Massive. Refers to the condition of the soil layer in which the layer appears to be as a coherent or solid mass which is largely devoid of peds.

Meter pH. The measurement of the pH in the field by utilising a TPS Aqua-CP/A meter.

Mottle. Areas of contrasting colour in the overall soil colour which are caused by anerobic conditions as a result of poor aeration. Usually an indicator of poor drainage and retention of water.

NATA. National Association of Testing Authority.

Olsen P. A measure of the phosphorus that is available for plant uptake. In the Olsen P laboratory method, soil is shaken for 30 minutes in a bicarbonate solution before the soluble extract is analysed for P.

Ped. An individual natural soil aggregate. In an undisturbed state peds will group together to form larger aggregates.

Pedality. Describes a soil in which some or all of the soil material occurs in the form of peds in the moist state.

pH. A logarithmic index for the concentration of hydrogen ions in an aqueous solution, which is used as a measure of acidity.

pH CaCl2. A measure of the acidity or alkalinity of the soil. In this method, soil is shaken in a calcium chloride solution, which resembles the natural 'saltiness' of soil water. Neutral = pH 7 but values are lower in acidic soils compared with the pH H20 method.

pH H2O. A measure of the acidity / alkalinity of the soil. In this method, soil is shaken in water. Neutral = pH 7.

Phase (Soil). a subdivision of a soil profile class based on attributes that have particular significance for land use, such as shallow phase, where the soil depth is predominantly shallow and may influence particular land uses.

Phosphorus Buffering Index (PBI). A measure of the soil's ability to bind and release phosphorus for plant uptake.

Profile. The solum. This includes the soil A and B horizons and is basically the depth of soil to weathered rock.

Representative Site. A location deemed very representative of the soil mapping unit for which detailed characterisation is to be done.

Rudosol. Soil with negligible (rudimentary) pedologic organisation apart from (a) minimal development of an Al horizon or (b) the presence of less than 10% of B horizon material (including pedogenic carbonate) in fissures in the parent rock or saprolite.

Soil Mapping Unit (SMU). Soils grouped into a single management unit on the basis of similar morphology, position on the landscape, substrate and chemistry.

Sodic. Also commonly referred to as a non-saline alkali soil. It is a soil that contains sufficient exchangeable sodium and does not contain appreciable quantities of soluble salts. A term given to soil with a level of exchangeable sodium cations greater than 10-15% of the soils cation exchange capacity (CEC), or soluble sodium cations greater than 10-15 times the square root of soluble calcium and magnesium cations.

Sodosols. Soils which display a strong texture contrast between surface (A) horizons and subsoil (B) horizons which are sodic.

Subsoil. Subsurface material comprising the B and C horizons of soils with distinct profiles. They often have brighter colours and higher clay content than topsoils.

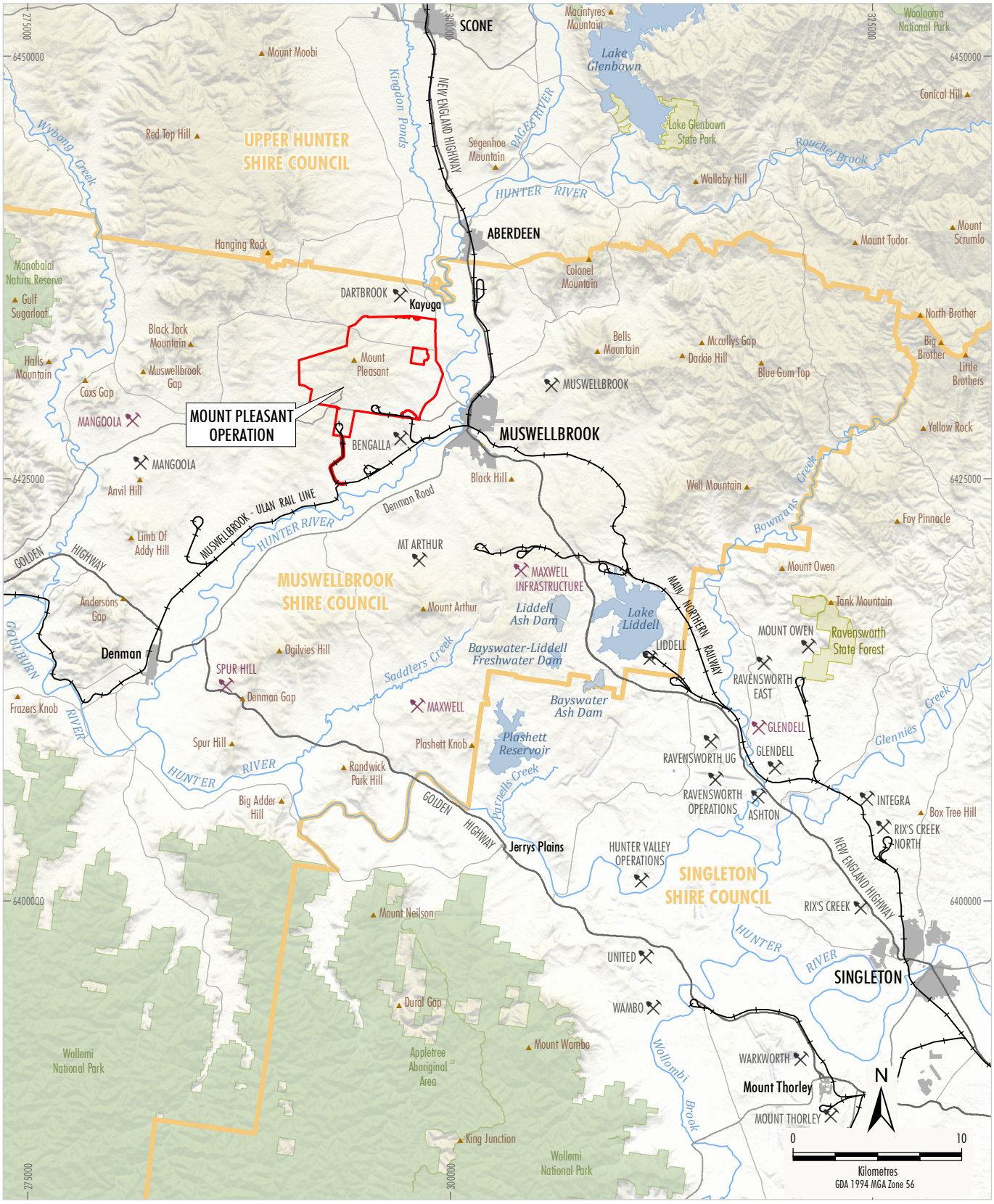
Texture. The size of particles in the soil. Texture is divided into six groups, depending on the amount of coarse sand, fine sand, silt and clay in the soil.

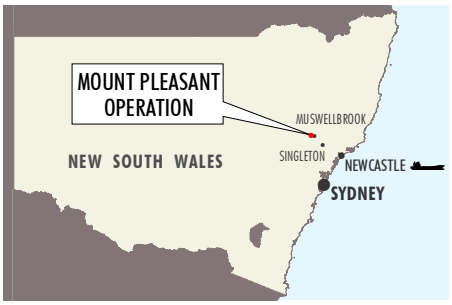
Topsoil. Part of the soil profile, typically the A1 horizon, containing material which is usually darker, more fertile and better structured than the underlying layers.

Variant (Soil). a soil with one or more attributes outside the usual range for a defined soil profile class, but because of its restricted distribution (or because the varying properties are not considered to have particular management significance), it is not defined as a separate soil profile class.

Vertosol. Soils that have a clay field texture of 35% or more clay throughout the solum except for thin, surface crusty horizons 0.03 m or less thick, have open cracks at some time in most years that are at least 5 mm wide and extend upward to the surface or to the base of any plough layer, self-mulching horizon, or thin, surface crusty horizon and at some depth in the solum have slicken sides and/or lenticular peds.

12 FIGURES





LEGEND

- Mining Operation
- Proposed Mining Operations (Application Lodged)
- Railway
- Local Government Boundary
- State Forest/Reserve
- National Parks and Wildlife Estate
- Mining Lease Boundary (Mount Pleasant Operation)

Source: NSW Spatial Services (2020)

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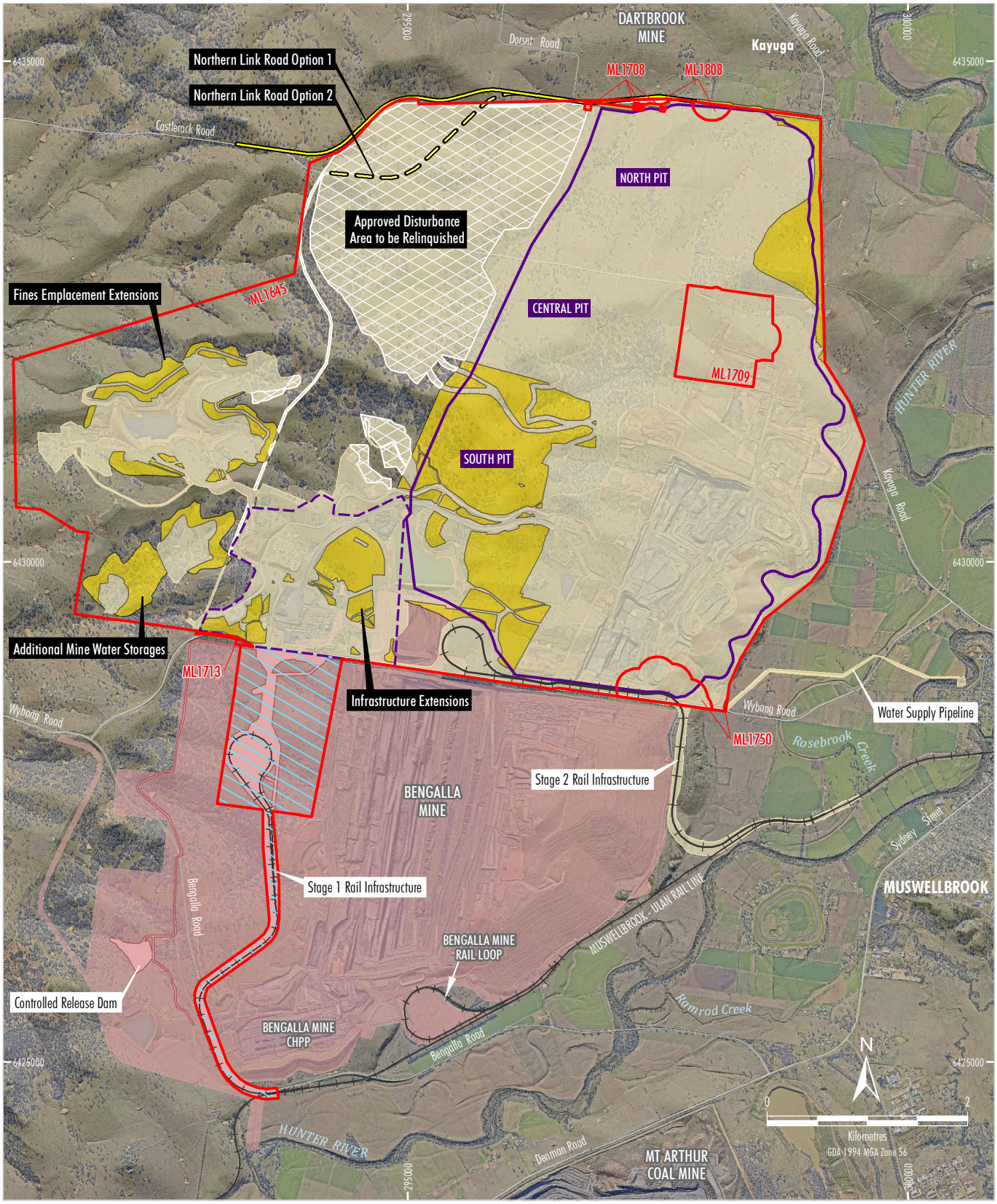
MOUNT PLEASANT OPTIMISATION PROJECT

Project Location

Figure 1

MAC-18-02 SSD_EIS_App Figure 1_Rev E



MAC-18-02 SSD_EIS_App Figure 2_Rev J

LEGEND

Existing Mine Elements

- Mining Lease Boundary (Mount Pleasant Operation)
- Approximate Extent of Existing/Approved Surface Development (DA92/97) [1]
- Infrastructure to be removed under the Terms of Condition 37, Schedule 3 (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170) [1]

Additional/Revised Project Elements

- Approved Disturbance Area to be Relinquished [2]
- Approximate Additional Disturbance of Project Extensions [1]
- Northern Link Road Option 1 Centreline [3]
- Northern Link Road Option 2 Centreline
- Approximate Extent of Project Open Cut and Waste Rock Emplacement Landforms
- Revised Infrastructure Area Envelope

NOTES

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.
2. Subject to detailed design of Northern Link Road alignment.
3. Preferred alignment subject to landholder access.

Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Project General Arrangement

Figure 2

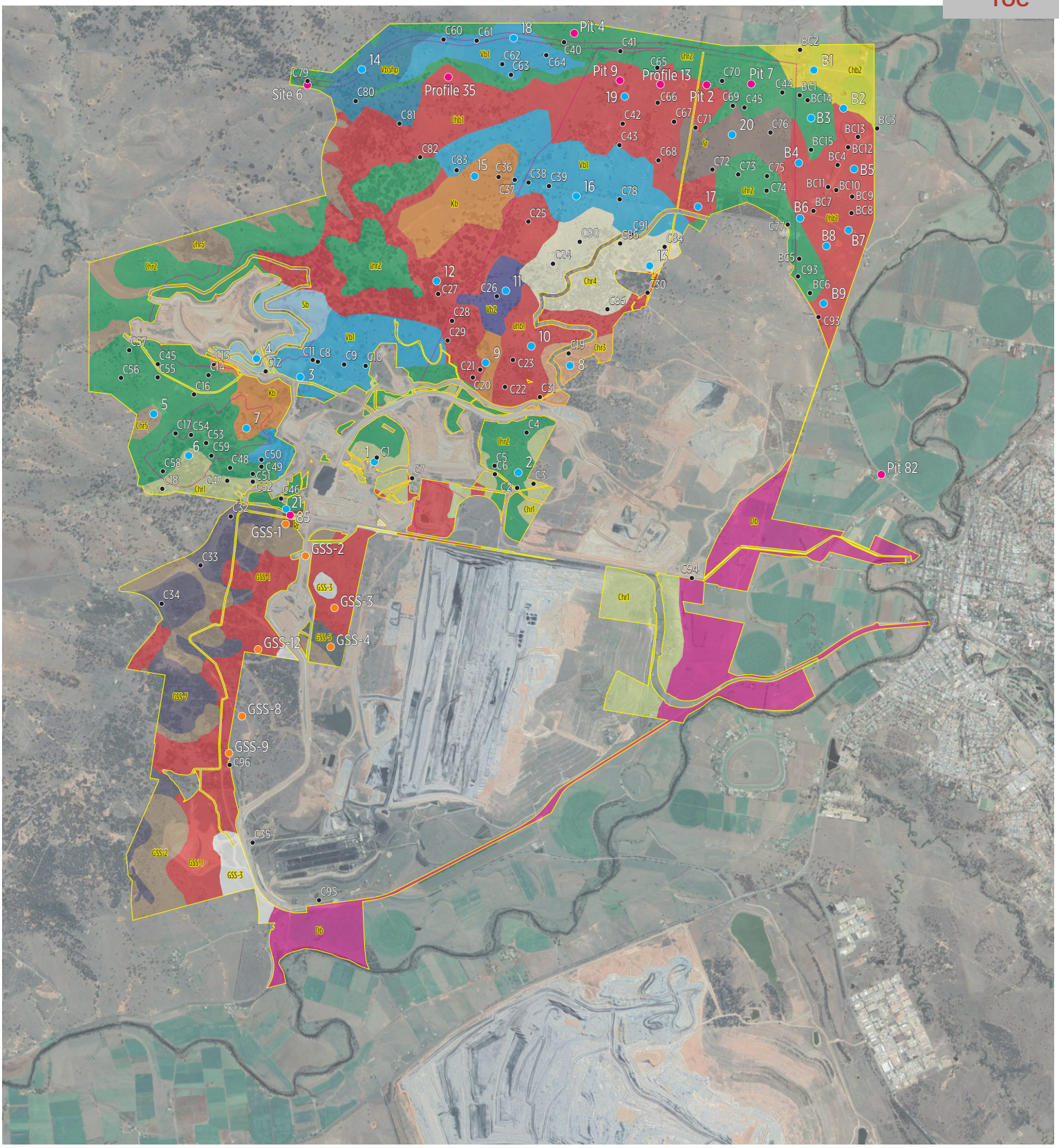


Figure 3: Soil Mapping Units

Version 3 25/06/2020

Soil Resource Assessment
MOUNT PLEASANT OPERATIONS EXTENSION PROJECT

0 2000
Metres

Legend

- Project site
- Proposed disturbance area
- Detailed site
- Check site
- Detailed site (eSPADE)
- Detailed site (Global Soil Systems, 2013)
- Soil mapping unit name
- Chb1 / GSS/1 - Medium brown chromosol on upper to mid-slopes
- Chb2 - Medium brown chromosol variant on gently undulating plains
- Chr1 - Thick red clayey chromosol on mid to lower slopes
- Chr2 - Medium red chromosol on upper slopes
- Chr3 - Thick silty red chromosol on upper/simple slope
- Chr4 - Thick red clayey chromosol on simple hill slopes
- Chr5 / GSS/2 - Massive silty red chromosol on simple slope
- Db - Brown Dermosol
- Kb - Brown kandosol on upper slopes
- Rr - Leptic Red Rudosol
- Sb - Brown sodosol on simple slopes
- Sr - Red Sodosol on mid-slopes
- Vb1 - Sodic brown vertosol on mid to upper slopes
- Vb2 - Shallow brown vertosol on simple slopes
- VbShp - Shallow phase of Vb1
- GSS/3 - Brown Vertosol
- GSS/5 - Brown Kurosol
- GSS/7 - Rudosol

GTenvironmental

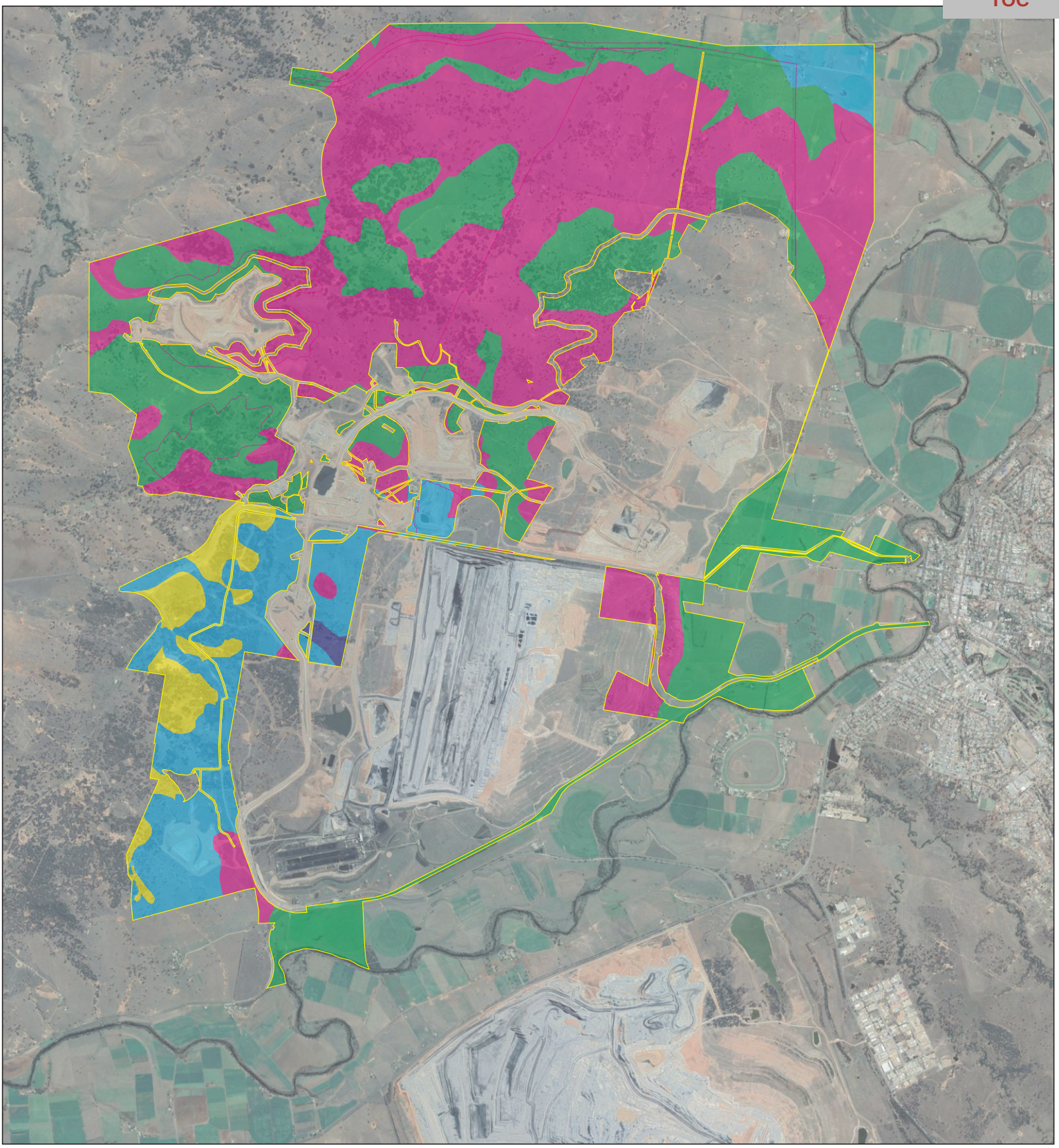


Figure 4: Land and Soil Capability

Version 2 22/10/2020

Soil Resource Assessment
MOUNT PLEASANT OPERATIONS EXTENSION PROJECT

GTenvironmental

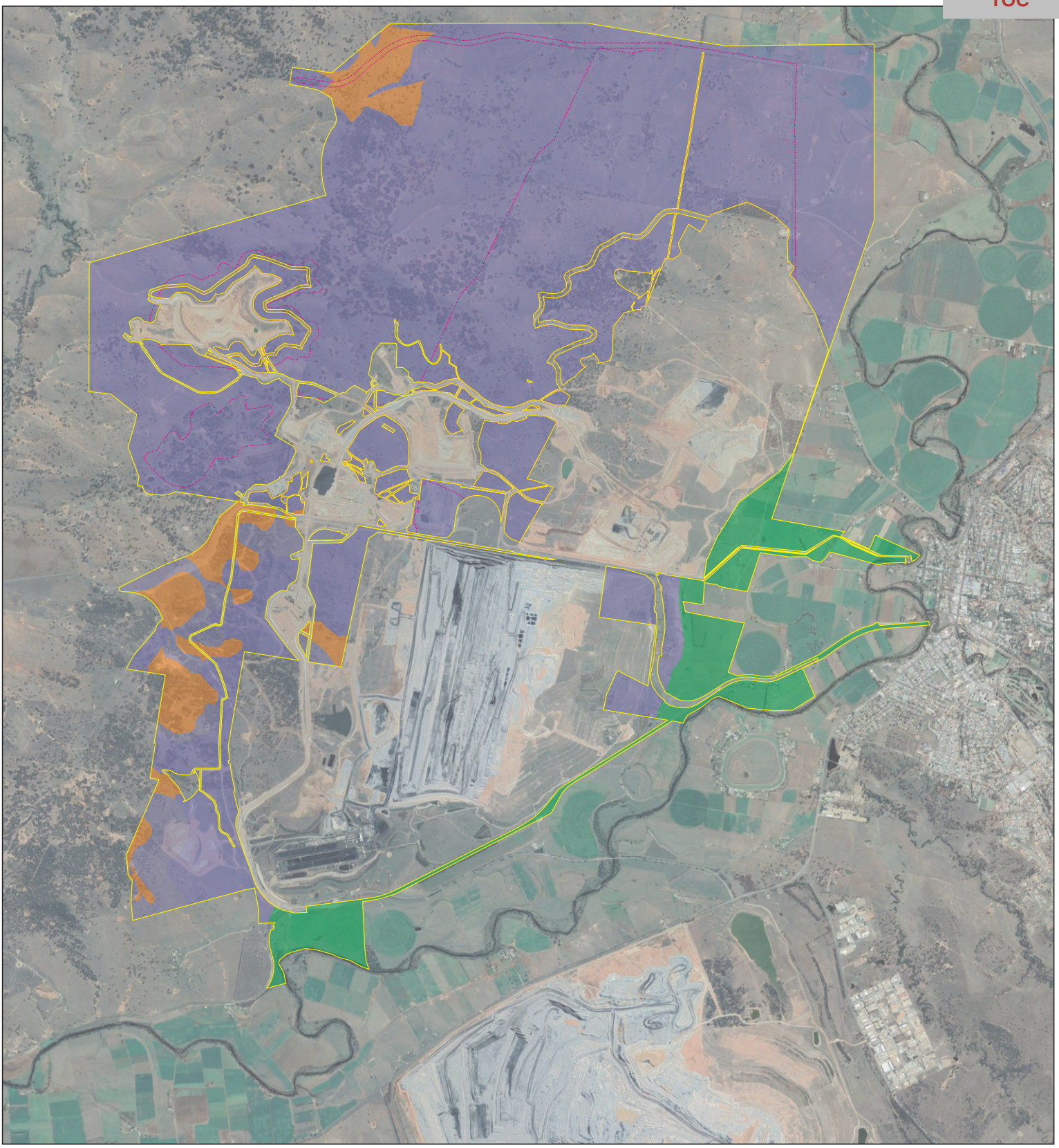


Figure 5: Agricultural Suitability Assessment

Version 2 22/10/2020

Soil Resource Assessment
MOUNT PLEASANT OPERATIONS EXTENSION PROJECT

Legend

- Project site
- Proposed disturbance area
- Class 2
- Class 3
- Class 4

0 2000
Metres

GTenvironmental

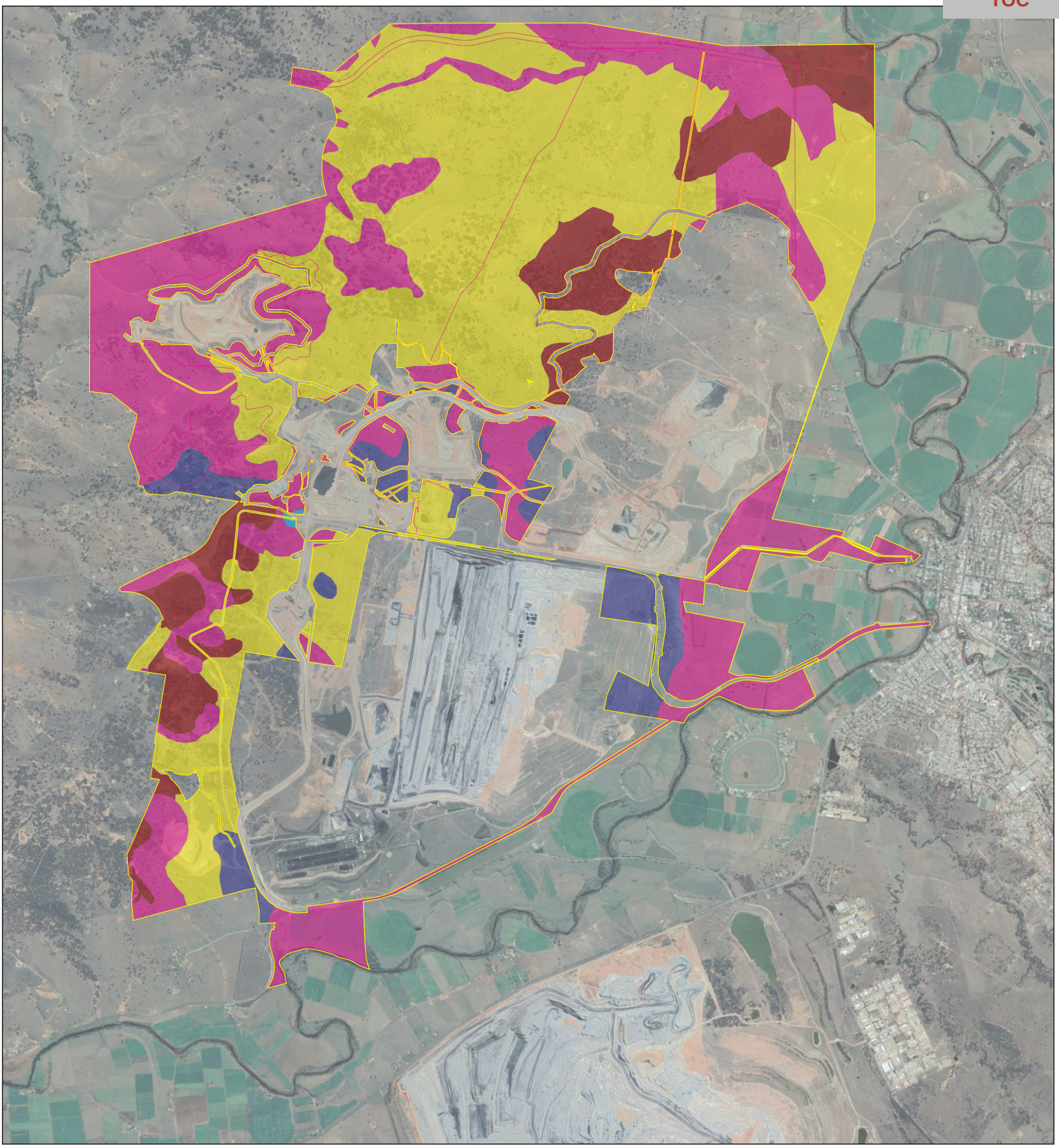


Figure 6: Topsoil Stripping Depths

Version 2 11/04/2020

Soil Resource Assessment
MOUNT PLEASANT OPERATIONS EXTENSION PROJECT

0 2000
Metres

Legend

- Project site
- Proposed disturbance area
- Not suitable for stripping
- 0.10 metres
- 0.15 metres
- 0.20 metres
- 0.45 metres

GTenvironmental

13 APPENDICES

Appendix A	**Site descriptions and soil profile summaries**
Appendix B	**Detailed site descriptions**
Appendix C	**Check site descriptions**
Appendix D	**eSPADE soil profiles**
Appendix E	**Laboratory certificates**

Appendix A – Site descriptions and soil profile summaries

Table A-1: Land Summary SMU Chb1

Item	Description
Representative Site	12
Representative Site photograph	
Location GDA94 ZONE 56H	295053 6431885
Current Use	Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Tall eucalyptus woodlands
Disturbance	Semi to extensively disturbed
Landform element /pattern	Undulating plain, upper to mid slope
Micro relief	Nil
Drainage	Well to moderate
Erosion Observed	Nil
Slope (%)	8/10
Surface coarse fragments	Nil coarse fragments
Surface condition	Firm
Australian Soil Class (ASC) Order (s)	Haplic, Brown Chromosol; Medium, Clayey, Deep
Land suitability summary	Land and Soil Capability: 4 Agricultural Suitability: 3
Erosion potential	Topsoil: Low to moderate Subsoil: Low to moderate
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00-0.10 mbgl Recommended topsoil use: Highly suitable support regrowth of native vegetation and grasses. Topsoil may benefit from Recommended subsoil strip depth: 0.00 mbgl Recommended subsoil use: Subsoils may be marginal for use as supporting subsoils on level plains. Amelioration of subsoils with gypsum may increase the quality to support topsoil placement on level

Item	Description
	plains. Subsoils below 0.10 to 1.00 mbgl, suitable for capping waste rock without amelioration.
Total area (ha)	830
Soil Profile Morphology Summary	

Horizon Depth (m), Boundary (Bdy)	Field Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A11 0.00-0.15 Abrupt	Silty loam	Moderate, firm, <20mm sub-angular	Nil	10YR3/3 Dark brown Nil mottles/bleach	Dry, well	Common, fine	5.5	Nil
B21 0.15-0.80 Clear	Light clay	Massive, loose	<2% coarse fragments <5mm	10YR4/4 Dark yellowish brown Nil mottles/bleach	Dry, well to moderate	Few, fine	8.5	
B22 0.80-1.00 EOBH[1]	Light clay	Massive, loose	<1% coarse fragments <5mm	10YR4/6 Dark yellowish brown Nil mottles/bleach	Dry, moderate	Nil	8.5	

1 – End of bore hole (EOBH).

Table A-2: Soil Chemistry Results for SMU Chb1, Representative Site 12

Analysis (Unit)	12-0.00-0.10	12-0.20-0.30	12-0.50-0.60	12-0.70-0.80	12-0.90-1.00
Soil pH (1:5 soil water [H20])	6.79	8.88	9.08	9.15	9.24
Soil pH (Hydrochloric acid [0.01M])	6.3	8.1	8.3	8.4	8.4
Soil EC (deciSiemens per metre [dS/m])	0.146	0.154	0.220	0.310	0.357
Soil Cl (milligrams per kilogram [mg/kg])	58	62	176	317	404
Exch.Ca (milli-equivalent per 100 grams of soil [meq/100g])	9.3	9.8	6.3	4.4	5.3
Exch. Mg (meq/100g)	5.4	9.5	9.5	8.5	13.5
Exch. K (meq/100g)	0.7	0.5	0.4	0.4	0.4
Exch. Na (meq/100g)	0.11	0.38	0.36	0.50	0.95
CEC (meq/100g)	15	20.19	16.48	13.76	20.24

Analysis (Unit)	12-0.00-0.10	12-0.20-0.30	12-0.50-0.60	12-0.70-0.80	12-0.90-1.00
ESP (%Na/CEC)	0.7	1.9	2.2	3.6	4.7
Ca/Mg (ratio)	1.7	1.0	0.7	0.5	0.4
Zinc (mg/kg)	1.3	<0.5	<0.5	<0.5	<0.5
Manganese (mg/kg)	45	7.4	3.7	2.1	2.0
Iron (mg/kg)	29	4.8	4.4	4.3	4.4
Copper (mg/kg)	0.84	0.67	0.63	0.39	0.40
Boron (mg/kg)	0.37	<0.1	0.18	0.47	0.51
Silicon (mg/kg)	53	24	5.6	7.9	8.4
Total Organic Carbon (percent [%])	2.6	0.8	0.6	0.6	1.2
P (Colwell) (mg/kg)	14	8.5	7.9	7.9	7.5
P (Olsen) (mg/kg)	4.6	2.0	2.0	2.2	2.0
PBI Ratio	30	86	85	73	73
Total S (%)	235	83	73	64	78
Sulfate-S (mg/kg)	17	7.8	15	23	20
Fizz Hcl (Y/N)	N	Y	Y	Y	Y
Emerson Ag Test (Number [No.])	5	3	3	3	3
Total Nitrogen (%)	0.20	0.09	0.07	0.07	0.06
Nitrate (mg/kg)	31	1.7	1.2	1.6	1.6
Sulfate (%)	17	7.8	15	23	20
Moisture Content	3	9	10	10	9
Disp Ratio (R1)	0.54	0.59	0.66	0.63	0.69
Gravel >2 mm (%)	20	22	29	43	43
CS >50 micrometre (µm) (%)	59	20	13	9	13
CS>20µm (%)	65	23	16	17	23
2-50µm-Silt (%)	14	32	35	42	46
2-20µm-Silt (%)	8	28	32	34	36
Clay <2µm (%)	28	48	52	48	41

Table A-3: Land Summary SMU Chb2

Item	Description
Representative Site	B1
Representative Site photograph	
Location GDA94 ZONE 56H	299322 6434365
Current Use	Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Grasses, sparse tall eucalyptus woodlands
Disturbance	Extensive disturbance
Landform element /pattern	Undulating plain, simple slope
Micro relief	Nil
Drainage	Well to moderate
Erosion Observed	Nil
Slope (%)	2/3
Surface coarse fragments	Nil coarse fragments
Surface condition	Soft to firm, minor cracking
ASC Order (s)	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep
Land suitability summary	Land and Soil Capability: 5 Agricultural Suitability: 3
Erosion potential	Topsoil: Low to moderate Subsoil: Low
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00 mbgl Recommended topsoil use: No rehabilitation stripping recommendations for topsoils. Organic matter amelioration may improve topsoil for supporting suitable topsoil placement. Recommended subsoil strip depth: 0.10-0.70 mbgl Recommended subsoil use: Suitable for support subsoils for topsoil placement, level plains. Potential reuse as capping for waste rock due to limitations 0.70-1.00 mbgl.
Total area (ha)	68

Soil Profile Morphology Summary								
								
Horizon Depth (m), Boundary (Bdy)	**Field Texture**	**Structure Strength**	**Inclusions Segregations**	**Colour, Mottle, Bleaching**	**Moisture Drainage**	**Roots**	**Field pH per horizon**	**Notes**
A11 0.00 – 0.14 Abrupt	Silty clay loam	Moderate, subangular peds <20mm, strong	Nil	7.5YR3/2 Dark brown No mottles / bleaching	Dry Moderately to Well drained	Common, medium	6.5	Nil
A12 0.14 – 0.38 Abrupt	Silty clay loam	Moderate, subangular peds <20mm, strong	Nil	7.5YR3/1 Very dark grey No mottles / bleaching	Dry Moderately to Well drained	Few, fine	7.5	
B21 0.38 – 0.76 Abrupt	Medium clay	Moderate, subangular peds <20mm, strong	Nil	7.5YR3/1 Very dark grey No mottles / bleaching	Dry Moderately to imperfect drained	Few, fine	7.5	
B22 0.76-1.10 EOBH	Medium clay	Moderate, subangular peds <20mm, strong	Nil	7.5YR3/2 Dark brown No mottles	Dry Moderately to imperfect drained	Very few, very fine	0.9/8.0	

Table A-4: Soil Chemistry Results for SMU Chb2, Representative Site B1

Analysis (Unit)	B1-0.00-0.05	B1-0.05-0.14	B1-0.15-0.30	B1-0.40-0.75	B1-0.80-1.00
Soil pH (H20)	5.33	6.36	7.42	7.95	8.12
Soil EC (dS/m)	1.174	0.196	0.155	0.103	0.544
Exch.Ca (meq/100g)	14.00	12.23	15.72	20.70	14.15
Exch. Mg (meq/100g)	3.97	6.48	8.74	12.03	7.67
Exch. Na (meq/100g)	0.05	0.10	0.45	0.92	0.65
Exch. K (meq/100g)	1.82	2.35	1.72	1.22	0.36
CEC (meq/100g)	19.84	21.16	26.63	34.87	22.83
Ca/Mg (ratio)	3.5	1.9	1.8	1.7	1.8
ESP (%Na/CEC)	0.3	0.5	1.7	2.6	2.9
Ca/Mg (ratio)	5.33	6.36	7.42	7.95	8.12
Zinc (mg/kg)	1.174	0.196	0.155	0.103	0.544

Table A-5: Land Summary SMU Chr1

Item	Description
Representative Site	1
Representative Site photograph	
Location GDA94 ZONE 56H	294380 6429809
Current Use	Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Sparse Eucalyptus Species
Disturbance	Semi-disturbed
Landform element /pattern	Undulating plain, mid-slope to lower slope
Micro relief	Nil
Drainage	Well to moderate
Erosion Observed	Nil
Slope (%)	13
Surface coarse fragments	Nil coarse fragments
Surface condition	Firm
ASC Order (s)	Haplic Eutrophic Red Chromosol; Thick, Clayey
Land suitability summary	Land and Soil Capability: 4 Agricultural Suitability: 3
Erosion potential	Topsoil: Low to moderate Subsoil: Low to moderate
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00-0.20 mbgl Recommended topsoil use: Suitable support regrowth of native vegetation and grasses. Recommended subsoil strip depth: 0.20-0.70 mbgl Recommended subsoil use: Suitable for support subsoils for topsoil placement, level plains. Subsoils below 0.70 mbgl are a finer texture which is undesirable limitation, suitable for capping waste rock. Organic matter amelioration may improve the subsoils from 0.70 mbgl for supporting subsoils.
Total area (ha)	59

Soil Profile Morphology Summary

Horizon Depth (m), Boundar-y (Bdy)	Field Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A1 0.00-0.08 Abrupt	Sandy loam	Massive to weak, Loose	Nil	10YR3/3 Dark brown Nil mottles/ bleach	Dry, Well	Common, fine	6	
A2 0.08-0.40 Abrupt	Sandy clay loam	Massive to weak, soft, sub-angular	Nil	7.5YR3/2 Dark brown Nil mottles /bleach	Dry, well to moderate	Few, very fine	6	
B2 0.40-0.70 Abrupt	Medium heavy clay	Moderate, firm, sub-angular <30mm	<1% <2mm gravels	2.5YR4/8 Red Nil mottles /bleach	Dry, moderate	Few, very fine	6	
B3 0.70-0.85 EOBH	Loamy sand	Massive, loose	<2% weathered rock	10YR5/4 Yellowish brown Nil mottles /bleach	Dry, rapid	Nil	8.5	

Table A-6: Soil Chemistry Results for SMU Chr1, Representative Site 1

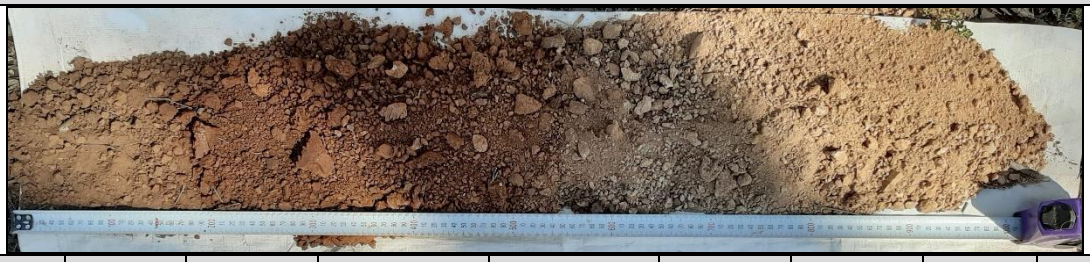
Analysis (Unit)	1-0.00-0.80	1-0.20-0.30	1-0.50-0.60	1-0.70-0.80
Soil pH (H20)	5.79	5.58	5.74	7.91
Soil pH (0.01M)	4.9	4.7	4.7	7.2
Soil EC (dS/m)	0.042	0.052	0.078	0.164
Soil Cl (milligrams per kilogram [mg/kg])	23	42	33	37
Exch.Ca (meq/100g)	4.0	2.3	8.5	5.2
Exch. Mg (meq/100g)	1.5	1.2	5.4	2.1
Exch. K (meq/100g)	0.5	0.3	0.3	0.3
Exch. Na (meq/100g)	0.08	0.17	0.82	0.43
CEC (meq/100g)	6.2	4.1	16	7.97
ESP (%Na/CEC)	1.3	4.0	5.3	5.4
Ca/Mg (ratio)	2.8	1.9	1.6	2.5
Zinc (mg/kg)	2.7	0.54	<0.5	<0.5
Manganese (mg/kg)	40	18	2.2	12
Iron (mg/kg)	179	62	355	287
Copper (mg/kg)	0.39	0.24	0.36	0.16

Analysis (Unit)	1-0.00-0.80	1-0.20-0.30	1-0.50-0.60	1-0.70-0.80
Boron (mg/kg)	0.32	0.18	0.42	0.17
Silicon (mg/kg)	48	28	61	9.8
Total Organic Carbon (%)	3.2	0.92	0.45	0.28
P (Colwell) (mg/kg)	16	9.8	8.2	9.2
P (Olsen) (mg/kg)	4.7	2.6	1.8	2.4
PBI Ratio	30	29	152	68
Total S (%)	193	75	110	<50
Sulfate-S (mg/kg)	6.8	12	36	16
Fizz Hcl (Y/N)	N	N	N	N
Emerson Ag Test (No.)	5	5	5	5
Total Nitrogen %	0.20	0.07	0.04	0.04
Nitrate (mg/kg)	3.0	4.2	0.57	0.61
Sulfate (%)	6.8	12	36	16
Moisture Content	2	3	14	7
Disp Ratio (R1)	0.38	0.54	0.56	0.65
Gravel >2mm (%)	0	1	12	1
CS >50µm (%)	60	59	33	62
CS>20µm (%)	71	68	38	66
2-50µm-Silt (%)	23	21	9	9
2-20µm-Silt (%)	11	13	4	5
Clay <2µm (%)	17	19	58	29

Table A-7: Land Summary SMU Chr2

Item	Description
Representative Site	2
Representative Site photograph	
Location GDA94 ZONE 56H	296026 6429715
Current Use	Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Sparse Eucalyptus Species
Disturbance	Semi-disturbed
Landform element /pattern	Undulating plain, mid-slope
Micro relief	Nil
Drainage	Well to moderate
Erosion Observed	Nil
Slope (%)	8/9
Surface coarse fragments	Nil coarse fragments
Surface condition	Firm, very minor cracking
ASC Order (s)	Eutrophic Red Chromosol; Medium, Silty
Land suitability summary	Land and Soil Capability: 3 Agricultural Suitability: 3
Erosion potential	Topsoil: Low to moderate Subsoil: Low
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00-0.15 mbgl Recommended topsoil use: Highly suitable support regrowth of native vegetation and grasses. Recommended subsoil strip depth: 0.15-0.70 mbgl Recommended subsoil use: No rehabilitation stripping recommendations for subsoils. Subsoils below 0.70 mbgl are a finer texture / alkaline pH, suitable for capping waste rock.
Total area (ha)	770

Soil Profile Morphology Summary



Horizon Depth (m), Boundary (Bdy)	Field Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A1 0.00-0.15 Abrupt	Loam	Weak, firm, sub-angular <10mm	Nil	7.5YR3/3 Dark brown Nil mottles/bleach	Dry, well	Common, fine	5.5	Nil
B21 0.15-0.54 Abrupt	Light clay	Weak, firm, sub-angular <10mm	<1 coarse fragment	5YR3/4 Dark reddish brown Nil mottles/bleach	Dry, moderate	Common, fine	6	
B22 0.54-0.81 Abrupt	Light clay	Weak, soft, sub-angular <10mm	<1 coarse fragment	10YR5/4 Yellowish brown Nil mottles /bleach	Dry, moderate	Nil	8.5	
B23 0.81-1.00 EOBH	Sandy clay loam	Weak, soft, sub-angular <10mm	1% calcium carbonate	10YR5/5 Yellowish brown Nil mottles /bleach	Dry, moderate	Nil	8.5	

Table A-8: Soil Chemistry Results for SMU Chr2, Representative Site 2

Analysis (Unit)	2-0.00-0.10	2-0.20-0.30	2-0.54-0.60	2-0.70-0.80	2-0.90-1.00
Soil pH (H20)	5.47	7.67	8.50	8.60	8.68
Soil pH (0.01M)	4.9	7.2	7.9	8.0	8.1
Soil EC (dS/m)	0.199	0.326	0.411	0.637	0.646
Soil Cl (mg/kg)	87	165	472	843	1,014
Exch.Ca (meq/100g)	10.9	7.7	9.9	8.7	8.1
Exch. Mg (meq/100g)	3.3	4.2	6.3	7.1	7.2
Exch. K (meq/100g)	1.4	1.4	0.9	0.4	0.4
Exch. Na (meq/100g)	0.26	0.27	0.40	0.75	0.60
CEC (meq/100g)	16	13.64	17.46	16.96	16.35
ESP (%Na/CEC)	1.6	2.0	2.3	4.4	3.6
Ca/Mg (ratio)	3.4	1.8	1.6	1.2	1.1
Zinc (mg/kg)	11	0.76	1.5	<0.5	<0.5
Manganese (mg/kg)	62	8.1	5.8	2.5	2.1
Iron (mg/kg)	309	31	19	8.2	8.1
Copper (mg/kg)	1.1	0.83	0.47	0.40	0.49
Boron (mg/kg)	0.70	0.42	0.48	0.48	0.39

Analysis (Unit)	2-0.00-0.10	2-0.20-0.30	2-0.54-0.60	2-0.70-0.80	2-0.90-1.00
Silicon (mg/kg)	90	17	11	9.4	9.7
Total Organic Carbon (%)	6.4	1.5	1.4	0.7	0.9
P (Colwell) (mg/kg)	31	11	12	9.2	9.5
P (Olsen) (mg/kg)	9.6	3.7	4.5	2.9	2.6
PBI Ratio	45	89	76	69	69
Total S (%)	583	210	235	202	131
Sulfate-S (mg/kg)	30	36	68	90	48
Fizz Hcl (Y/N)	N	N	Y	Y	Y
Emerson Ag Test (No.)	5	5	5	5	5
Total Nitrogen %	0.50	0.13	0.12	0.07	0.06
Nitrate (mg/kg)	37	15	9.2	2.5	2.2
Sulfate (%)	30	36	68	90	48
Moisture Content	5	12	8	8	8
Disp Ratio (R1)	0.43	0.59	0.55	0.55	0.58
Gravel >2mm (%)	7	12	12	6	6
CS >50µm (%)	37	16	22	93	31
CS>20µm (%)	59	28	40	94	45
2-50µm-Silt (%)	38	25	38	4	36
2-20µm-Silt (%)	17	12	21	2	22
Clay <2µm (%)	25	60	40	3	33

Table A-9: Land Summary SMU Chr3

Item	Description
Representative Site	8
Representative Site photograph	
Location GDA94 ZONE 56H	296583 6430933
Current Use	Forestry, Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Tall eucalyptus woodlands
Disturbance	Semi disturbed
Landform element /pattern	Undulating plain, upper slope
Micro relief	Nil
Drainage	Well to moderate
Erosion Observed	Nil
Slope (%)	6/10
Surface coarse fragments	Nil coarse fragments
Surface condition	Soft to firm
ASC Order (s)	Red Chromosol; Shallow Thick, Silty, Moderate
Land suitability summary	Land and Soil Capability: 4 Agricultural Suitability: 3
Erosion potential	Topsoil: Low to moderate Subsoil: Low to moderate
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00 mbgl Recommended topsoil use: No rehabilitation stripping recommendations for topsoils. Recommended subsoil strip depth: 0.00 mbgl. Amelioration treatment such as input of organic matter may improve soil structure for supporting topsoil placement. Recommended subsoil use: No rehabilitation stripping recommendations for subsoils. Soils from 0.00 to 0.50 mbgl, suitable for capping waste rock. Amelioration treatment such as input of organic matter may improve soil structure for supporting topsoil placement.
Total area (ha)	28

Soil Profile Morphology Summary								
								
Horizon Depth (m), Boundary (Bdy)	**Field Texture**	**Structure Strength**	**Inclusions Segregations**	**Colour, Mottle, Bleaching**	**Moisture Drainage**	**Roots**	**Field pH per horizon**	**Notes**
A11 0.00-0.13 Abrupt	Sandy loam	Massive, loose	1% coarse fragments <5mm	7.5YR3/3 Dark brown Nil mottles/bleach	Dry, rapid	Common, fine	6	Nil
A12 0.13-0.36 Abrupt	Sandy loam	Massive, loose	1% coarse fragments <5mm	7.5YR3/4 Dark reddish brown Nil mottles/bleach	Dry, well to moderate	Few, fine	6	
B21 0.36-0.47 Abrupt	Clay loam sandy	Massive, loose	Nil	5YR5/4 Reddish brown Nil mottles/bleach	Dry, well to moderate	Nil	6.5	
B22 0.47-0.52 EOBH	Clayey sand	Massive, loose	Nil	5YR5/6 Yellowish red Nil mottles/bleach	Dry, well to moderate	Nil	6.5	

Table A-10: Soil Chemistry Results for SMU Chr3, Representative Site 8

Analysis (Unit)	8-0.00-0.10	8-0.20-0.30	8-0.36-0.46	8-0.47-0.52
Soil pH (H20)	5.52	6.24	6.29	6.43
Soil pH (0.01M)	4.7	5.4	5.5	5.5
Soil EC (dS/m)	0.051	0.036	0.056	0.051
Soil Cl (mg/kg)	21	27	57	50
Exch.Ca (meq/100g)	3.8	5.4	5.4	6.9
Exch. Mg (meq/100g)	0.9	1.0	1.4	1.7
Exch. K (meq/100g)	0.3	<0.12	<0.12	<0.12
Exch. Na (meq/100g)	<0.065	0.11	0.18	0.23
CEC (meq/100g)	5.4	6.6	7.0	9.0
ESP (%Na/CEC)	1.1	1.7	2.5	2.6
Ca/Mg (ratio)	4.1	5.5	3.9	4.1
Zinc (mg/kg)	2.1	<0.5	<0.5	<0.5
Manganese (mg/kg)	99	48	44	44
Iron (mg/kg)	197	39	16	15
Copper (mg/kg)	0.32	<0.1	0.14	<0.1

Analysis (Unit)	8-0.00-0.10	8-0.20-0.30	8-0.36-0.46	8-0.47-0.52
Boron (mg/kg)	0.39	0.21	0.19	0.23
Silicon (mg/kg)	33	32	42	47
Total Organic Carbon (%)	3.0	0.84	0.69	0.54
P (Colwell) (mg/kg)	18	11	9.5	8.9
P (Olsen) (mg/kg)	4.7	2.6	2.3	2.8
PBI Ratio	33	29	32	47
Total S (%)	205	93	85	101
Sulfate-S (mg/kg)	11	5.7	11	15
Fizz Hcl (Y/N)	N	N	N	N
Emerson Ag Test (No.)	5	5	5	5
Total Nitrogen %	0.18	0.08	0.06	0.06
Nitrate (mg/kg)	7.8	6.2	5.5	2.8
Sulfate (%)	11	5.7	11	15
Moisture Content	2	4	6	7
Disp Ratio (R1)	0.51	0.60	0.65	0.65
Gravel >2mm (%)	0	0	2	1
CS >50µm (%)	67	66	55	59
CS>20µm (%)	70	74	62	64
2-50µm-Silt (%)	14	18	16	13
2-20µm-Silt (%)	10	9	9	8
Clay <2µm (%)	20	16	29	28

Table A-11: Land Summary SMU Chr4

Item	Description
Representative Site	13
Representative Site photograph	
Location GDA94 ZONE 56H	297494 6432095
Current Use	Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Tall eucalyptus woodlands
Disturbance	Semi to extensively disturbed
Landform element /pattern	Undulating plain, simple slope
Micro relief	Nil
Drainage	Well to moderate
Erosion Observed	Nil
Slope (%)	7/9
Surface coarse fragments	Nil coarse fragments
Surface condition	Hard
ASC Order (s)	Eutrophic Red Chromosol; Thick Clayey Deep
Land suitability summary	Land and Soil Capability: 3 Agricultural Suitability: 3
Erosion potential	Topsoil: Low to moderate Subsoil: Low to moderate
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00 mbgl Recommended topsoil use: No rehabilitation stripping recommendations for topsoils. Amelioration treatment such as input of organic matter may improve soil structure for supporting topsoil placement. Recommended subsoil strip depth: 0.60-0.80 mbgl Recommended subsoil use: Soil profile is complicated where review of the horizons identified presents a suitable supporting subsoil at depth 0.60 to 0.80 mbgl. Soils of 0.00-0.50 mbgl and below 0.90 mbgl presents undesirable attributes and suitable for capping waste rock. Amelioration treatment such as input of organic matter may improve soil structure for supporting subsoil

Item	Description
	placement.
Total area (ha)	121
Soil Profile Morphology Summary	

Horizon Depth (m), Boundary (Bdy)	Field Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A11 0.00-0.15 Abrupt	Sandy loam	Massive, loose	Nil	10YR3/3 Dark brown Nil mottles/bleach	Dry, well	Common, fine	5.5	Nil
A12 0.15-0.54 Abrupt	Sandy loam	Massive, loose	Nil	10YR4/4 Dark yellowish brown Nil mottles/bleach	Dry, well to moderate	Few, fine	5.5	
B21 0.54-0.86 Abrupt	Light clay	Moderate, firm, <20 sub-angular	Nil	5YR4/6 Yellowish red Nil mottles/bleach	Dry, moderate	Nil	6.0	
B3 0.86-1.00 EOBH	Sandy clay	Massive, loose	Nil	10YR6/4 Light yellowish brown Nil mottles/bleach	Dry, moderate	Nil	7.5	

Table A-12: Soil Chemistry Results for SMU Chr4, Representative Site 13

Analysis (Unit)	13-0.00-0.10	13-0.20-0.30	13-0.55-0.65	13-0.70-0.80	13-0.90-1.00
Soil pH (H20)	6.05	6.14	7.03	7.25	7.49
Soil pH (0.01M)	5.1	4.9	6.0	6.2	6.5
Soil EC (dS/m)	0.035	0.011	0.029	0.039	0.043
Soil Cl (mg/kg)	25	12	25	36	53
Exch.Ca (meq/100g)	3.9	2.0	6.0	8.1	4.6
Exch. Mg (meq/100g)	1.0	0.6	2.5	3.7	2.3
Exch. K (meq/100g)	0.5	0.2	0.2	0.2	0.3
Exch. Na (meq/100g)	<0.065	<0.065	0.21	0.34	0.16
CEC (meq/100g)	5.5	2.9	8.9	12	7.30
ESP (%Na/CEC)	1.0	1.5	2.3	2.7	2.2
Ca/Mg (ratio)	3.9	3.6	2.4	2.2	2.0
Zinc (mg/kg)	3.9	<0.5	<0.5	0.50	<0.5

Analysis (Unit)	13-0.00-0.10	13-0.20-0.30	13-0.55-0.65	13-0.70-0.80	13-0.90-1.00
Manganese (mg/kg)	52	10	2.5	1.8	1.2
Iron (mg/kg)	134	28	56	18	17
Copper (mg/kg)	0.37	0.24	0.47	0.48	0.29
Boron (mg/kg)	0.43	0.18	0.26	0.41	0.68
Silicon (mg/kg)	43	31	54	47	67
Total Organic Carbon (%)	2.4	0.49	0.32	0.36	3.0
P (Colwell) (mg/kg)	13	7.9	8.5	9.5	8.5
P (Olsen) (mg/kg)	4.9	2.1	1.9	1.8	4.7
PBI Ratio	35	26	54	66	88
Total S (%)	198	<50	<50	<50	261
Sulfate-S (mg/kg)	4.7	<1	3.3	5.3	5.0
Fizz Hcl (Y/N)	N	N	N	N	N
Emerson Ag Test (No.)	5	5	5	5	5
Total Nitrogen %	0.19	0.05	0.04	0.05	0.24
Nitrate (mg/kg)	2.7	1.0	0.57	0.52	0.54
Sulfate (%)	4.7	<1	3.3	5.3	5.0
Moisture Content	2	3	8	10	8
Disp Ratio (R1)	0.43	0.60	0.61	0.74	0.77
Gravel >2mm (%)	6	8	12	1	0
CS >50µm (%)	64	70	52	39	53
CS>20µm (%)	70	74	58	42	58
2-50µm-Silt (%)	23	19	14	11	10
2-20µm-Silt (%)	17	15	8	8	5
Clay <2µm (%)	13	11	34	50	37

Table A-13: Land Summary SMU Chr5

Item	Description
Representative Site	5
Representative Site photograph	
Location GDA94 ZONE 56H	291839 6430297
Current Use	Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Grasses, sparse tall eucalyptus woodlands
Disturbance	Extensive to complete disturbance
Landform element /pattern	Undulating plain, simple / lower slopes to depressions
Micro relief	Nil
Drainage	Well to moderate
Erosion Observed	Nil
Slope (%)	11/14
Surface coarse fragments	Nil coarse fragments
Surface condition	Soft to firm, minor cracking
ASC Order (s)	Haplic, Eutrophic, Red Chromosol; Thin, Clayey, Moderate
Land suitability summary	Land and Soil Capability: 4 Agricultural Suitability: 3
Erosion potential	Topsoil: Low to moderate Subsoil: Low to moderate
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00-0.15 mbgl Recommended topsoil use: Suitable support regrowth of native vegetation and grasses. Recommended subsoil strip depth: 0.00 mbgl Recommended subsoil use: No rehabilitation stripping recommendations for subsoils. Subsoils may be marginal for use as supporting subsoils on level plains however structure indicates clayey, massive soils which may be undesirable without further treatment. Organic matter amelioration of subsoils may improve the soil structure and potential reuse for supporting topsoil placement.

Item	Description
Total area (ha)	84
Soil Profile Morphology Summary	

Horizon Depth (m), Boundary (Bdy)	Field Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A1 0.00-0.06 Abrupt	Silty loam	Weak, firm <5mm sub-angular	<1% coarse fragments <2mm	7.5YR2.5/3 Very dark brown Nil mottles/ bleaching	Dry, well	Common, fine	-	Nil
B21 0.06-0.22 Abrupt	Silty loam clay	Massive, loose	1% coarse fragments <2mm	5YR4/4 Reddish brown Nil mottles/ bleaching	Dry, well to moderate	Few, fine	-	
B22 0.22-0.81 Abrupt	Light clay	Massive, loose	2% coarse fragments <2mm	2.5Y4/4 Reddish brown Nil mottles/ bleaching	Dry, moderate	Nil	-	
B3 0.81-0.93 Abrupt	Silty clay loam	Massive, loose	5% coarse fragments	7.5Y4/6 Strong brown Nil mottles/ bleaching	Dry, moderate to imperfect	Nil	-	
BC 0.93-1.00 EOBH	Silty clay loam	Massive, loose	5% coarse fragments	7.5Y4/6 Strong brown Nil mottles/ bleaching	Dry, moderate to imperfect	Nil	-	

Table A-14: Soil Chemistry Results for SMU Chr5, Representative Site 5

Analysis (Unit)	5-0.00-0.10	5-0.20-0.30	5-0.22-0.30	5-0.50-0.60	5-0.81-0.91	5-0.93-1.00
Soil pH (H20)	6.39	6.52	6.51	6.84	7.36	7.60
Soil pH (0.01M)	5.8	5.7	5.8	6.5	7.0	7.2
Soil EC (dS/m)	0.172	0.076	0.130	0.406	0.735	0.864
Soil Cl (mg/kg)	118	65	170	576	959	1,207
Exch.Ca (meq/100g)	12.6	8.1	8.7	9.9	6.3	6.1
Exch. Mg (meq/100g)	5.6	4.0	4.4	4.6	3.5	3.2
Exch. K (meq/100g)	1.8	1.3	1.2	0.9	0.5	0.4
Exch. Na (meq/100g)	0.59	0.20	0.34	0.31	0.46	0.43
CEC (meq/100g)	21	14	15	16	10.77	10.21
ESP (%Na/CEC)	2.9	1.5	2.3	2.0	4.3	4.2
Ca/Mg (ratio)	2.3	2.0	2.0	2.1	1.8	1.9
Zinc (mg/kg)	17	1.1	1.5	3.3	2.5	2.8

Analysis (Unit)	5-0.00-0.10	5-0.20-0.30	5-0.22-0.30	5-0.50-0.60	5-0.81-0.91	5-0.93-1.00
Manganese (mg/kg)	48	13	16	12	6.3	8.7
Iron (mg/kg)	351	32	21	1,412	760	18
Copper (mg/kg)	2.0	0.86	1.8	2.9	2.0	0.88
Boron (mg/kg)	0.58	0.48	0.53	0.78	0.81	0.73
Silicon (mg/kg)	70	51	47	24	19	24
Total Organic Carbon (%)	7.2	2.0	1.6	1.0	0.7	1.5
P (Colwell) (mg/kg)	49	18	13	9.8	11	12
P (Olsen) (mg/kg)	19	5.1	4.0	2.6	2.5	4.0
PBI Ratio	50	54	57	87	80	65
Total S (%)	696	182	171	190	169	236
Sulfate-S (mg/kg)	24	14	25	68	115	113
Fizz Hcl (Y/N)	N	N	N	N	N	N
Emerson Ag Test (No.)	5	5	5	5	5	5
Total Nitrogen %	0.60	0.14	0.11	0.09	0.08	0.13
Nitrate (mg/kg)	14	3.6	3.0	1.5	1.7	2.7
Sulfate (%)	24	14	25	68	115	113
Moisture Content	7	7	8	10	9	9
Disp Ratio (R1)	0.55	0.62	0.69	0.61	0.70	0.55
Gravel >2mm (%)	13	1	0	16	3	0
CS >50µm (%)	23	24	13	10	21	19
CS>20µm (%)	35	29	16	12	28	27
2-50µm-Silt (%)	38	26	27	22	26	27
2-20µm-Silt (%)	26	21	23	20	19	19
Clay <2µm (%)	39	51	61	68	53	54

Table A-15: Land Summary SMU Kb

Item	Description
Representative Site	9
Representative Site photograph	
Location GDA94 ZONE 56H	295630 6430973
Current Use	Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Tall eucalyptus woodlands
Disturbance	Semi disturbed
Landform element /pattern	Undulating plain, upper slope
Micro relief	Nil
Drainage	Well
Erosion Observed	Nil
Slope (%)	8/9
Surface coarse fragments	Nil coarse fragments
Surface condition	Soft to firm
ASC Order (s)	Haplic Mellic Brown Kandosol; Thick, Clay loamy, Deep
Land suitability summary	Land and Soil Capability: 3 Agricultural Suitability: 3
Erosion potential	Topsoil: Low to moderate Subsoil: Low to moderate
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00-0.10 mbgl Recommended topsoil use: Suitable support regrowth of native vegetation and grasses. Topsoil may improve further with organic matter input. Recommended subsoil strip depth: 0.00 mbgl Recommended subsoil use: No rehabilitation stripping recommendations for subsoils. Subsoils below 0.10 to 1.00 mbgl, suitable for capping waste rock. Organic matter amelioration of subsoils may improve the soil structure and potential reuse for supporting topsoil placement.

Item	Description
Total area (ha)	145
Soil Profile Morphology Summary	

Horizon Depth (m), Boundary (Bdy)	Field Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A11 0.00-0.10 Abrupt	Clayey sand	Massive to weak, loose	1 / 1% coarse fragments <2 / <5mm	7.5YR3/3 Dark brown Nil mottles/bleach	Dry, rapid	Common, fine	5.5	Nil
A12 0.10-0.49 Sharp	Clayey sand	Massive to weak, loose	Nil	7.5YR4/6 Strong brown Nil mottles/bleach	Dry, well	Few, fine	5.5	
B21 0.49-1.00 EOBH	Clay loam sandy	Massive to weak, loose	Nil	10YR5/6 Yellowish brown Nil mottles/bleach	Dry, well	Nil	8	

Table A-16: Soil Chemistry Results for SMU Kb, Representative Site 9

Analysis (Unit)	9-0.00-0.10	9-0.20-0.30	9-0.50-0.60	9-0.70-0.75	9-0.90-1.00
Soil pH (H20)	5.26	8.43	8.88	8.88	8.76
Soil pH (0.01M)	4.8	7.7	7.9	8.0	7.9
Soil EC (dS/m)	0.418	0.142	0.122	0.179	0.235
Soil Cl (mg/kg)	293	65	55	162	246
Exch.Ca (meq/100g)	10.0	10.0	7.0	5.9	6.9
Exch. Mg (meq/100g)	2.1	1.7	1.0	0.9	1.3
Exch. K (meq/100g)	1.0	0.7	0.3	0.3	0.3
Exch. Na (meq/100g)	0.11	0.13	0.15	0.19	0.18
CEC (meq/100g)	13	12.58	8.45	7.29	8.69
ESP (%Na/CEC)	0.9	1.0	1.8	2.7	2.1
Ca/Mg (ratio)	4.7	5.9	7.3	6.3	5.4
Zinc (mg/kg)	4.2	0.52	<0.5	0.51	0.73
Manganese (mg/kg)	65	7.7	4.7	5.0	6.0
Iron (mg/kg)	333	8.4	4.0	3.5	5.5
Copper (mg/kg)	0.38	0.16	0.14	<0.1	0.12
Boron (mg/kg)	1.2	0.25	0.32	0.33	0.40
Silicon (mg/kg)	68	12	11	11	14

Analysis (Unit)	9-0.00-0.10	9-0.20-0.30	9-0.50-0.60	9-0.70-0.75	9-0.90-1.00
Total Organic Carbon (%)	5.4	1.0	0.9	1.5	1.0
P (Colwell) (mg/kg)	24	9.2	11	8.5	9.2
P (Olsen) (mg/kg)	4.6	2.8	2.4	2.7	2.8
PBI Ratio	33	75	270	372	362
Total S (%)	571	131	133	138	159
Sulfate-S (mg/kg)	106	10	9.9	28	40
Fizz Hcl (Y/N)	N	Y	Y	Y	Y
Emerson Ag Test (No.)	5	5	5	5	5
Total Nitrogen %	0.39	0.08	0.05	0.06	0.06
Nitrate (mg/kg)	46	2.8	1.3	1.1	1.5
Sulfate (%)	106	10	9.9	28	40
Moisture Content	4	7	4	4	4
Disp Ratio (R1)	0.46	0.56	0.62	0.62	0.57
Gravel >2mm (%)	5	11	34	30	29
CS >50µm (%)	62	51	61	65	59
CS>20µm (%)	69	56	64	69	67
2-50µm-Silt (%)	19	17	17	18	20
2-20µm-Silt (%)	13	12	14	14	11
Clay <2µm (%)	19	31	22	17	22

Table A-17: Land Summary SMU Sb

Item	Description
Representative Site	4
Representative Site photograph	
Location GDA94 ZONE 56H	293010 6430944
Current Use	Forestry, Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Tall eucalyptus woodlands
Disturbance	Nil
Landform element /pattern	Undulating plain, lower slope to depression
Micro relief	Nil
Drainage	Well to moderate
Erosion Observed	Nil
Slope (%)	11/14
Surface coarse fragments	Nil coarse fragments
Surface condition	Hard, minor cracking
ASC Order (s)	Eutrophic Brown Sodosol; Medium, Slightly gravelly, Clayey, Deep
Land suitability summary	Land and Soil Capability: 4 Agricultural Suitability: 3
Erosion potential	Topsoil: Low to moderate Subsoil: Moderate
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00-0.15 mbgl Recommended topsoil use: Suitable support regrowth of native vegetation and grasses. Topsoil may improve further with organic matter input. Recommended subsoil strip depth: 0.00 mbgl Recommended subsoil use: No rehabilitation stripping recommendations for subsoils. Potential reuse as capping for waste rock due to limitations to a depth of 1.00 mbgl. Gypsum amelioration of subsoils may improve the soil structure and reduce dispersive attributes for supporting topsoil placement.

Item	Description
Total area (ha)	48
Soil Profile Morphology Summary	

Horizon Depth (m), Boundary (Bdy)	Field Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A1 0.00-0.15 Abrupt	Silty loam	Massive – weak, loose <5mm	<2% coarse fragments <5mm	10YR3/3 Dark brown Nil mottles/ bleaching	Dry, well	Common, fine	5.0	Nil
B21 0.15-0.49 Abrupt	Light clay	Moderate, very firm, sub-angular, <10mm	Nil	7.5YR3/4 Dark reddish brown Nil mottles/ bleaching	Dry, well to moderate	Few, fine	5.5	
B22 0.49-0.72 Abrupt	Light clay	Weak, firm, sub-angular <20mm	<1% calcium carbonate	2.5Y4/4 Reddish brown Nil mottles/ bleaching	Dry, moderate	Nil	8.0	
B23 0.72-1.00 EOBH	Light clay	Weak, firm, sub-angular <20mm	1% calcium carbonate	2.5YR5/4 Reddish brown Reddish brown Nil mottles/ bleaching	Dry, moderate	Nil	8.0	

Table A-18: Soil Chemistry Results for SMU Sb, Representative Site 4

Analysis (Unit)	4-0.00-0.10	4-0.20-0.30	4-0.54-0.60	4-0.72-0.80	4-0.90-1.00
Soil pH (H20)	6.65	7.18	9.07	9.07	9.12
Soil pH (0.01M)	6.1	6.5	8.3	8.4	8.5
Soil EC (dS/m)	0.061	0.248	0.160	0.607	0.616
Soil Cl (mg/kg)	43	386	67	857	908
Exch.Ca (meq/100g)	7.1	6.9	3.8	1.6	1.6
Exch. Mg (meq/100g)	6.6	14.8	8.5	4.4	4.6
Exch. K (meq/100g)	0.7	0.4	0.5	0.2	0.2
Exch. Na (meq/100g)	0.17	1.7	0.36	0.43	0.43
CEC (meq/100g)	15	24	13.16	6.70	6.82
ESP (%Na/CEC)	1.2	7.3	2.8	6.4	6.3
Ca/Mg (ratio)	1.1	0.47	0.4	0.4	0.3
Zinc (mg/kg)	7.8	0.94	<0.5	<0.5	0.71
Manganese (mg/kg)	23	11	5.3	2.4	3.1
Iron (mg/kg)	65	22	6.1	5.4	5.6

Analysis (Unit)	4-0.00-0.10	4-0.20-0.30	4-0.54-0.60	4-0.72-0.80	4-0.90-1.00
Copper (mg/kg)	0.55	1.00	0.60	0.54	0.66
Boron (mg/kg)	0.48	0.48	0.31	0.31	0.23
Silicon (mg/kg)	69	25	9.1	5.4	8.1
Total Organic Carbon (%)	3.6	1.1	0.50	0.53	1.3
P (Colwell) (mg/kg)	14	8.9	10	9.2	8.5
P (Olsen) (mg/kg)	4.5	2.0	2.2	2.0	2.2
PBI Ratio	38	89	58	109	77
Total S (%)	261	129	75	111	69
Sulfate-S (mg/kg)	8.0	16	4.8	29	23
Fizz Hcl (Y/N)	N	N	Y	Y	Y
Emerson Ag Test (No.)	3	2	2	2	2
Total Nitrogen %	0.26	0.11	0.07	0.08	0.08
Nitrate (mg/kg)	3.3	0.93	1.0	0.79	0.98
Sulfate (%)	8.0	16	4.8	29	23
Moisture Content	5	11	7	11	11
Disp Ratio (R1)	0.52	0.69	0.65	0.78	0.71
Gravel >2mm (%)	2	0	2	10	6
CS >50µm (%)	38	18	33	14	12
CS>20µm (%)	52	26	44	17	15
2-50µm-Silt (%)	36	27	27	29	30
2-20µm-Silt (%)	22	20	17	26	27
Clay <2µm (%)	26	54	39	57	58

Table A-19: Land Summary SMU Sr

Item	Description
Representative Site	20
Representative Site photograph	
Location GDA94 ZONE 56H	298399 6433626
Current Use	Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Grasses, sparse tall eucalyptus woodlands
Disturbance	Extensive to complete disturbance
Landform element /pattern	Undulating plain, simple slope
Micro relief	Nil
Drainage	Well to moderate
Erosion Observed	Nil
Slope (%)	6/6
Surface coarse fragments	Nil coarse fragments
Surface condition	Firm, minor cracking
ASC Order (s)	Subnatric, Red Sodosol; Thin Clayey, Moderate
Land suitability summary	Land and Soil Capability: 4 Agricultural Suitability: 3
Erosion potential	Topsoil: Moderate Subsoil: Moderate
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00 mbgl Recommended topsoil use: Not suitable due to sodic limitations. Gypsum amelioration may be applied to topsoil to improve the soil structure and reduce dispersive attributes for potential support of topsoil placement. Recommended subsoil strip depth: 0.00 mbgl Recommended subsoil use: No rehabilitation stripping recommendations for subsoils. Soils from 0.00 to 0.60 mbgl, suitable for capping waste rock. Gypsum amelioration may be applied to topsoil and subsoils to improve the soil structure and reduce dispersive attributes for potential support of topsoil placement.

Item	Description
Total area (ha)	70

Soil Profile Morphology Summary								
								
Horizon Depth (m), Boundary (Bdy)	**Field Texture**	**Structure Strength**	**Inclusions Segregations**	**Colour, Mottle, Bleaching**	**Moisture Drainage**	**Roots**	**Field pH per horizon**	**Notes**
A1 0.00-0.10 Abrupt	Clay loam	Weak, firm <10mm sub-round	<1% coarse fragments <5mm	7.5YR3/3 Dark brown Nil mottles/ bleaching	Dry, well	Common, fine	5.0	Nil
B21 0.10-0.31 Abrupt	Medium clay	Moderate, firm <10mm sub-round	<1% coarse fragments <5mm	2.5YR4/4 Reddish brown Nil mottles/ bleaching	Dry, well to moderate	Few, fine	7.5	
B22 0.31-0.66 EOBH	Medium clay	Moderate, very firm <20mm sub-angular	<2% coarse fragments <10mm <2% coarse fragments 10-20mm	5YR4/6 Yellowish red Nil mottles/ bleaching	Dry, moderate	Few, fine	8.5	

Table A-20: Soil Chemistry Results for SMU Sr, Representative Site 20

Analysis (Unit)	20-0.00-0.10	20-0.20-0.30	20-0.50-0.60
Soil pH (H20)	6.47	8.28	8.76
Soil pH (0.01M)	6.1	7.7	8.0
Soil EC (dS/m)	0.103	0.197	0.157
Soil Cl (mg/kg)	53	44	49
Exch.Ca (meq/100g)	11.7	13.0	10.2
Exch. Mg (meq/100g)	3.0	4.9	4.6
Exch. K (meq/100g)	1.4	1.3	0.7
Exch. Na (meq/100g)	0.08	0.10	0.08
CEC (meq/100g)	16	19.27	15.64
ESP (%Na/CEC)	8.7	6.9	4.8
Ca/Mg (ratio)	3.9	2.7	2.2
Zinc (mg/kg)	4.6	<0.5	<0.5
Manganese (mg/kg)	64	9.3	5.4
Iron (mg/kg)	57	8.2	4.7

Analysis (Unit)	20-0.00-0.10	20-0.20-0.30	20-0.50-0.60
Copper (mg/kg)	1.1	1.1	0.87
Boron (mg/kg)	0.45	0.32	0.48
Silicon (mg/kg)	70	8.2	6.3
Total Organic Carbon (%)	4.2	1.5	3.1
P (Colwell) (mg/kg)	15	9.5	10
P (Olsen) (mg/kg)	6.0	2.6	2.4
PBI Ratio	50	133	137
Total S (%)	316	80	77
Sulfate-S (mg/kg)	8.2	5.5	7.7
Fizz Hcl (Y/N)	N	Y	Y
Emerson Ag Test (No.)	5	5	5
Total Nitrogen %	0.33	0.11	0.08
Nitrate (mg/kg)	15	2.8	2.2
Sulfate (%)	8.2	5.5	7.7
Moisture Content	3	11	7
Disp Ratio (R1)	0.40	0.69	0.55
Gravel >2mm (%)	6	5	25
CS >50µm (%)	36	5	24
CS>20µm (%)	48	14	29
2-50µm-Silt (%)	32	22	26
2-20µm-Silt (%)	20	13	21
Clay <2µm (%)	32	73	50

Table A-21: Land Summary SMU Vb1

Item	Description
Representative Site	3
Representative Site photograph	
Location GDA94 ZONE 56H	293512 6430753
Current Use	Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Grasses with extensively cleared woodland
Disturbance	Extensively to complete disturbed
Landform element /pattern	Undulating plain, mid-slope
Micro relief	Nil
Drainage	Well to moderate
Erosion Observed	Nil
Slope (%)	15/17
Surface coarse fragments	Nil coarse fragments
Surface condition	Soft to firm, cracking
ASC Order (s)	Epipedal Brown Vertosol; Very fine, Deep Phase, Site 18: Epipedal Brown Vertosol; Very fine, Moderate
Land suitability summary	SMU Vb1 — SMU Phase, VbShp, Site 18 Land and Soil Capability: 4 — Land and Soil Capability: 4 Agricultural Suitability: 3 — Agricultural Suitability: 4
Erosion potential	Topsoil: Low Subsoil: Moderate
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00-0.10 mbgl Recommended topsoil use: Highly suitable support regrowth of native vegetation and grasses. Organic matter amelioration may be applied to topsoil to improve the organic carbon levels for topsoil placement. Recommended subsoil strip depth: 0.10 – 0.50 mbgl Recommended subsoil use: Suitable for support subsoils for topsoil placement, level plains. Subsoils below 0.50 mbgl present dispersive attributes, suitable for capping waste rock. Gypsum

	amelioration may be applied to subsoils below 0.50 mbgl to improve the soil structure and reduce dispersive attributes.
Total area (ha)	371
Soil Profile Morphology Summary	

Horizon Depth (m), Boundary (Bdy)	Field Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A1 0.00-0.14 Abrupt	Light clay	Strong, firm, blocky	Nil	7.5YR4/3 Brown Nil mottles/ bleaching	Dry, well	Common, fine	5.0	Nil
B21 0.14-0.35 Abrupt	Light clay	Moderate, very firm, <10mm	Nil	7.5YR4/4 Reddish brown Nil mottles/ bleaching	Dry, well to moderate	Common, fine	6.5	
B22 0.35-0.75 Abrupt	Silty clay	Weak, soft, sub-angular	Nil	10YR5/6 Yellowish brown Nil mottles/ bleaching	Dry, moderate	Nil	8.5	
B23 0.75-1.00 EOBH	Silty clay	Weak, soft, sub-angular	5% <5 coarse fragments	7.5YR4/6 Yellowish red Strong brown Nil mottles/ bleaching	Dry, moderate	Nil	8.5	

Table A-22: Soil Chemistry Results for SMU Vb1, Representative Site 3

Analysis (Unit)	3-0.00-0.10	3-0.20-0.30	3-0.50-0.60	1-0.75-0.85
Soil pH (H20)	7.07	7.34	8.84	9.25
Soil pH (0.01M)	6.1	6.4	8.2	8.4
Soil EC (dS/m)	0.070	0.057	0.558	0.292
Soil Cl (mg/kg)	53	42	764	287
Exch.Ca (meq/100g)	10.0	5.6	0.9	3.1
Exch. Mg (meq/100g)	13.8	9.5	1.8	10.3
Exch. K (meq/100g)	1.8	1.1	0.1	0.5
Exch. Na (meq/100g)	0.19	0.21	0.24	0.83
CEC (meq/100g)	26	16.42	3.02	14.69
ESP (%Na/CEC)	0.8	1.3	7.9	5.6
Ca/Mg (ratio)	0.73	0.6	0.5	0.3
Zinc (mg/kg)	0.98	<0.5	0.50	<0.5
Manganese (mg/kg)	22	15	7.2	5.1

Analysis (Unit)	3-0.00-0.10	3-0.20-0.30	3-0.50-0.60	1-0.75-0.85
Iron (mg/kg)	29	17	9.8	7.4
Copper (mg/kg)	2.0	1.7	0.89	0.64
Boron (mg/kg)	0.54	0.52	0.47	0.32
Silicon (mg/kg)	46	32	7.2	8.8
Total Organic Carbon (%)	1.8	1.1	0.9	2.6
P (Colwell) (mg/kg)	11	12	9.2	12
P (Olsen) (mg/kg)	3.9	2.3	1.9	3.0
PBI Ratio	72	68	153	73
Total S (%)	252	157	141	100
Sulfate-S (mg/kg)	9.0	6.0	28	22
Fizz Hcl (Y/N)	N	N	Y	Y
Emerson Ag Test (No.)	5	3	2	1
Total Nitrogen %	0.17	0.12	0.09	0.07
Nitrate (mg/kg)	2.6	2.6	0.86	1.2
Sulfate (%)	9.0	6.0	28	22
Moisture Content	10	10	11	8
Disp Ratio (R1)	0.55	0.63	0.63	0.71
Gravel >2mm (%)	0	1	0	0
CS >50µm (%)	8	18	16	25
CS>20µm (%)	10	25	18	32
2-50µm-Silt (%)	25	27	25	32
2-20µm-Silt (%)	23	20	22	25
Clay <2µm (%)	67	55	59	43

Table A-23: Land Summary SMU Vb2

Item	Description
Representative Site	11
Representative Site photograph	
Location GDA94 ZONE 56H	295846 6431790
Current Use	Grazing
Site survey type	Detailed, 50 mm hand auger.
Vegetation	Tall eucalyptus woodlands
Disturbance	Semi to complete disturbed
Landform element /pattern	Undulating plain, simple slope
Micro relief	Nil
Drainage	Well
Erosion Observed	Nil
Slope (%)	7/10
Surface coarse fragments	Nil coarse fragments
Surface condition	Soft, cracking
ASC Order (s)	Haplic Brown Vertosol; Deep
Land suitability summary	Land and Soil Capability: 4 Agricultural Suitability: 3
Erosion potential	Topsoil: Low to moderate Subsoil: Low to moderate
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00-0.10 mbgl Recommended topsoil use: Suitable support regrowth of native vegetation and grasses. Organic matter amelioration may be applied to improve topsoil structure. Recommended subsoil strip depth: 0.10 -0.50 mbgl Recommended subsoil use: Suitable for support subsoils for topsoil placement, level plains. Subsoils below 0.50 mbgl present dispersive attributes and undesirable structure, suitable for capping waste rock. Gypsum amelioration may be applied to subsoils below 0.50 mbgl to improve the soil structure and reduce dispersive attributes.

Item	Description
Total area (ha)	34
Soil Profile Morphology Summary	

Horizon Depth (m), Boundary (Bdy)	Field Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A11 0.00-0.11 Abrupt	Clay loam	Weak to moderate, firm, <10mm sub-angular	Nil	7.5YR3/3 Dark brown Nil mottles/bleach	Dry, well	Common, fine	6.0	Nil
B21 0.11-0.50 Abrupt	Light clay	Moderate, firm, <20mm sub-angular	Nil	7.5YR3/4 Dark reddish brown Nil mottles/bleach	Dry, well to moderate	Few, fine	6.0	
B31 0.50-0.85 Abrupt	Sandy loam	Massive, loose	Nil	10YR5/6 Yellowish brown Nil mottles/bleach	Dry, moderate	Nil	8.0	
B32 0.85-1.00 EOBH	Clay loam	Massive, loose	<10% <1mm coarse fragments	10YR6/3 Pale brown Nil mottles/bleach	Dry, moderate	Nil	8.0	

Table A-24: Soil Chemistry Results for SMU Vb2, Representative Site 11

Analysis (Unit)	11-0.00-0.10	11-0.20-0.30	11-0.50-0.60	11-0.70-0.80	11-0.90-1.00
Soil pH (H20)	6.47	7.61	9.06	9.17	9.31
Soil pH (0.01M)	5.8	7.0	8.2	8.3	8.4
Soil EC (dS/m)	0.103	0.201	0.169	0.220	0.362
Soil Cl (mg/kg)	54	100	179	262	397
Exch.Ca (meq/100g)	14.6	13.6	6.9	4.8	6.6
Exch. Mg (meq/100g)	7.8	11.0	7.3	6.4	11.7
Exch. K (meq/100g)	1.8	1.6	0.3	0.3	0.5
Exch. Na (meq/100g)	0.14	0.43	0.31	0.40	1.26
CEC (meq/100g)	24	26.53	14.78	11.95	19.96
ESP (%Na/CEC)	0.6	1.6	2.1	3.3	6.3
Ca/Mg (ratio)	1.9	1.2	0.9	0.8	0.6
Zinc (mg/kg)	2.9	<0.5	<0.5	<0.5	<0.5

Analysis (Unit)	11-0.00-0.10	11-0.20-0.30	11-0.50-0.60	11-0.70-0.80	11-0.90-1.00
Manganese (mg/kg)	40	14	2.6	2.0	1.4
Iron (mg/kg)	61	19	4.3	3.5	4.0
Copper (mg/kg)	1.4	1.1	0.22	0.21	0.33
Boron (mg/kg)	0.57	0.48	0.41	0.50	0.57
Silicon (mg/kg)	83	16	6.9	7.1	12
Total Organic Carbon (%)	5.3	1.5	1.1	1.3	0.7
P (Colwell) (mg/kg)	26	9.2	8.9	7.9	9.2
P (Olsen) (mg/kg)	8.7	2.4	1.9	2.0	1.8
PBI Ratio	66	139	45	49	35
Total S (%)	455	164	51	<50	51
Sulfate-S (mg/kg)	11	13	7.8	7.9	13
Fizz Hcl (Y/N)	N	N	Y	Y	Y
Emerson Ag Test (No.)	5	3	3	3	2
Total Nitrogen %	0.41	0.14	0.07	0.06	0.07
Nitrate (mg/kg)	13	12	1.9	1.3	1.6
Sulfate (%)	11	13	7.8	7.9	13
Moisture Content	9	15	6	6	8
Disp Ratio (R1)	0.42	0.52	0.53	0.50	0.58
Gravel >2mm (%)	14	20	15	14	38
CS >50µm (%)	28	18	67	62	51
CS>20µm (%)	42	25	70	64	56
2-50µm-Silt (%)	32	18	14	15	24
2-20µm-Silt (%)	18	11	10	13	19
Clay <2µm (%)	40	64	20	23	25

Table A-25: Land Summary SMU Db

Item	Description
Representative Site	82
Location GDA94 ZONE 56H	300223 6429777
Current Use	Cultivation, pastures
Site survey type	Batter, exposed profile
Vegetation	Native pastures with cleared scrub and woodlands
Disturbance	Complete to extensive clearing
Landform element /pattern	Gently undulating plains
Micro relief	n/a
Drainage	n/a
Erosion Observed	Nil
Slope (%)	3.0
Surface coarse fragments	n/a
Surface condition	Firm
ASC Order (s)	Eutrophic Brown Dermosol
Land suitability summary	Land and Soil Capability: 3 Agricultural Suitability: 2
Erosion potential	Topsoil: Low to moderate Subsoil: Low
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00-0.15 mbgl Recommended topsoil use: Suitable support regrowth of native vegetation and grasses. Recommended subsoil strip depth: 0.15-0.40 mbgl Recommended subsoil use: Suitable for support subsoils for topsoil placement, level plains.
Total area (ha)	271

Soil Profile Morphology Summary

Horizon Depth (m), Boundary (Bdy)	Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A1 0.00 – 0.15	Silty clay loam	Strong pedality (polyhedral, 2 - 5 mm)	Nil	7.5YR3/2 Dark brown Nil mottles/ bleaching	Moderately moist	Common <1 mm, Many size 1-2 mm Few size 2-5 mm	5.5	Nil
B2 0.15 – 0.40	Light clay	Strong pedality (polyhedral, 2 - 5 mm)	Nil	7.5YR4/2 Brown Nil mottles/ bleaching	Moderately moist	Few size <1 mm common size 1-2 mm few	6.0	

Item		Description						
						size 2-5 mm		
B3 0.40 – 0.80 EOBH	Light medium clay	Moderate pedality (polyhedral, 2 - 5 mm,	Nil	7.5YR4/2 Brown Nil mottles/ bleaching	Moderately moist	Few sizes 2-5 mm	6.5	

Table A-26: Land Summary SMU Rr

Item	Description
Representative Site	85
Location GDA94 ZONE 56H	293432 6429167
Current Use	Grazing, native pastures
Site survey type	Road cutting, exposed profile
Vegetation	Native pastures with scrub and woodlands
Disturbance	limited clearing
Landform element /pattern	Hillcrest on gently undulating plains
Micro relief	Nil
Drainage	n/a
Erosion Observed	Nil
Slope (%)	3.0
Surface coarse fragments	n/a
Surface condition	Hard set
ASC Order (s)	Acidic Paralithic Leptic Rudosol
Land suitability summary	Land and Soil Capability: 5 Agricultural Suitability: 4
Erosion potential	Topsoil: Low Subsoil: Low
Soil quality for mine rehabilitation	Recommended topsoil strip depth: 0.00-0.45 mbgl Recommended topsoil use: Suitable to support regrowth of native vegetation and grasses. Recommended subsoil strip depth: 0.45-0.95 mbgl Recommended subsoil use: Suitable for support subsoils for topsoil placement, level plains.
Total area (ha)	2

Soil Profile Morphology Summary

Horizon Depth (m), Boundary (Bdy)	Texture	Structure Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Field pH per horizon	Notes
A 0.00 – 0.90 EOBH	Fine light sandy clay loam	Weak pedality (sub-angular blocky, 5 - 10 mm, fabric is rough faced peds)	Very few (< 2%), as substrate, weakly weathered, sub-angular tabular, fine gravel (2-6 mm), gravel (6-20 mm)	5YR4/3 Reddish brown Nil mottles/bleach	Dry / n/a	n/a	5.0	Hydrophobic

Appendix B – Detailed site descriptions

SITE 1

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chr1	294380 6429809	Haplic Eutrophic Red Chromosol; Thick, Clayey	Detailed hand auger	25/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Forest Undulating plain, mid-lower slope Near gully 13%	Eucalyptus Species Ironbark silver leaf	Nil microrelief Semi-disturbed Minor sheet erosion	Firm, minor cracking Nil coarse fragments	A1 0.00-0.08 Abrupt	Sandy loam	Massive to weak, Loose	Nil	10YR3/3 Dark brown Nil mottles /bleach	Dry, Well	Common, fine	6.0	0.00-.008 0.20-0.30 0.50-.0.60 0.70-0.80	No recovery at 0.85m Laboratory site
				A2 0.08-0.40 Abrupt	Sandy clay loam	Massive to weak, soft, sub-angular	Nil	7.5YR3/2 Dark brown Nil mottles /bleach	Dry, well to moderate	Few, very fine	6.0		
				B2 0.40-0.70 Abrupt	Medium heavy clay	Moderate, firm, sub-angular <30mm	<1% <2mm gravels	2.5YR4/8 Red Nil mottles /bleach	Dry, moderate	Few, very fine	6.0		
				B3 0.70-0.85 EOBH	Loamy sand	Massive, loose	<2% weathered rock	10YR5/4 Yellowish brown Nil mottles /bleach	Dry, rapid	Nil	8.5		

SITE 2

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chr2	296026 6429715	Eutrophic Red Chromosol; Medium, Silty	Detailed hand auger	25/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Forest Undulating plain, mid slope 8/9%	Eucalyptus Species	Nil microrelief Semi-disturbed Nil erosion	Firm, very minor cracking No coarse fragments	A1 0.00-0.15 Abrupt	Loam	Weak, firm, sub-angular <10mm	Nil	7.5YR3/3 Dark brown Nil mottles /bleach	Dry, well	Common, fine	5.5	0.00-.0.10 0.20-0.30 0.54-.0.60 0.90-1.00	Nil Laboratory site
				B21 0.15-0.54 Abrupt	Light clay	Weak, firm, sub-angular <10mm	<1 coarse fragment	5YR3/4 Dark reddish brown Nil mottles /bleach	Dry, moderate	Common, fine	6.0		
				B22 0.54-0.81 Abrupt	Light clay	Weak, soft, sub-angular <10mm	<1 coarse fragment	10YR5/4 Yellowish brown Nil mottles /bleach	Dry, moderate	Nil	8.5		
				B23 0.81-1.00 EOBH	Sandy clay loam	Weak, soft, sub-angular <10mm	1% calcium carbonate	10YR5/5 Yellowish brown Nil mottles /bleach	Dry, moderate	Nil	8.5		

SITE 3

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Vb1	293512 6430753	Epipedal Brown Vertosol; Very fine, Deep	Detailed hand auger	25/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Forest Undulating plain, upper slope 17/15%	Grasses	Nil microrelief Extensive to complete disturbance Nil erosion	Soft to firm, with cracking	A1 0.00-0.14 Abrupt	Light clay	Strong, firm, blocky	Nil	7.5YR4/3 Brown Nil mottles /bleach	Dry, well	Common, fine	5.0	0.00-.0.10 0.20-0.30 0.50-.0.60 0.75-0.85	Nil Laboratory site
				B21 0.14-0.35 Abrupt	Light clay	Moderate, very firm, <10mm	Nil	7.5YR4/4 Reddish brown Nil mottles /bleach	Dry, well to moderate	Common, fine	6.5		
				B22 0.35-0.75 Abrupt	Silty clay	Weak, soft, sub-angular	Nil	10YR5/6 Yellowish brown Nil mottle s/bleach	Dry, moderate	Nil	8.5		
				B23 0.75-1.00 EOBH	Silty clay	Weak, soft, sub-angular	5% <5 coarse fragments	7.5YR4/6 Yellowish red Strong brown Nil mottles /bleach	Dry, moderate	Nil	8.5		

SITE 4

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Sb	293010 6430944	Eutrophic Brown Sodosol; Medium, Slightly gravelly, Clayey, Deep	Detailed hand auger	26/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Forest Depression 11/14%	Eucalyptus Species	Nil microrelief Nil disturbance Nil erosion	Hard, minor cracking	A1 0.00-0.15 Abrupt	Silty loam	Massive – weak, loose <5mm	<2% coarse fragments <5mm	10YR3/3 Dark brown Nil mottles /bleach	Dry, well	Common, fine	5.0	0.00-.0.10 0.20-0.30 0.50-.0.60 0.72-0.80 0.90-1.00	Nil Laboratory site
				B21 0.15-0.49 Abrupt	Light clay	Moderate, very firm, sub-angular, <10mm	Nil	7.5YR3/4 Dark reddish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	5.5		
				B22 0.49-0.72 Abrupt	Light clay	Weak, firm, sub-angular <20mm	<1% calcium carbonate	2.5Y4/4 Reddish brown Nil mottles /bleach	Dry, moderate	Nil	8.0		
				B23 0.72-1.00 EOBH	Light clay	Weak, firm, sub-angular <20mm	1% calcium carbonate	2.5YR5/4 Reddish brown Nil mottles /bleach	Dry, moderate	Nil	8.0		

SITE 5

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chr5	291839 6430297	Haplic, Eutrophic, Red Chromosol; Thin, Clayey, Moderate	Detailed hand auger	26/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Depression 11/14%	Grasses, Sparse tall woodland	Nil microrelief Extensive to complete disturbed Nil erosion	Soft to firm, minor cracking	A1 0.00-0.06 Abrupt	Silty loam	Weak, firm <5mm sub-angular	<1% coarse fragments <2mm	7.5YR2.5/3 Very dark brown Nil mottles /bleach	Dry, well	Common, fine	-	0.00-.0.06 0.10-0.20 0.22-.0.30 0.50-0.60 0.81-0.91 0.93-1.00	Nil Laboratory site
				B21 0.06-0.22 Abrupt	Silty loam clay	Massive, loose	1% coarse fragments <2mm	5YR4/4 Reddish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	-		
				B22 0.22-0.81 Abrupt	Light clay	Massive, loose	2% coarse fragments <2mm	2.5Y4/4 Reddish brown Nil mottles /bleach	Dry, moderate	Nil	-		
				B3 0.81-0.93 Abrupt	Silty clay loam	Massive, loose	5% coarse fragments	7.5Y4/6 Strong brown Nil mottles /bleach	Dry, moderate to imperfect	Nil	-		
				BC 0.93-1.00 EOBH	Silty clay loam	Massive, loose	5% coarse fragments	7.5Y4/6 Strong brown Nil mottles /bleach	Dry, moderate to imperfect	Nil	-		

SITE 6

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chr1	292241 6429822	Haplic Eutrophic Red Chromosol; Thick, Clayey	Detailed hand auger	26/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Simple slope 5/6%	Silver leaf Ironbark	Nil microrelief Semi-disturbed Nil erosion	Firm, cracking	A11 0.00-0.06 Abrupt	Sandy loam	Massive, loose	Nil	10YR3/3 Dark brown Nil mottles /bleach	Dry, well	Common, fine	6.0	0.00-.0.06 0.10-0.20 0.21-.0.30 0.50-0.60 0.80-0.90	Nil
				A12 0.06-0.21 Abrupt	Sandy clay loam	Weak, weak, <1mm sub-angular	Nil	10YR5/5 Yellowish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	6.0		
				B21 0.21-0.70 Abrupt	Light medium clay	Moderate, firm <20mm sub-angular	Nil	5YR4/6 Yellowish red Nil mottles /bleach	Dry, moderate	Nil	8.5		
				B22 0.70-1.00 EOBH	Light medium clay	Moderate, firm <20mm sub-angular	Nil	10YR4/3 Brown Nil mottles /bleach	Dry, moderate	Nil	8.5		

SITE 7

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Kb	292888 6430137	Haplic Mellic Brown Kandosol; Thick, Clay loamy, Deep	Detailed hand auger	26/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, mid-slope 9/10%	Grasses Tall woodland, mixed	Nil microrelief Semi-disturbed Nil erosion	Soft to firm, minor cracking	A11 0.00-0.10 Abrupt	Silty loam (sandy)	Massive, <10mm sub-angular	Nil	10YR3/3 Dark brown Nil mottles /bleach	Dry, well	Fine, fine	6.0	0.00-.0.10 0.20-.0.30 0.52-0.60 0.76-0.85 0.90-1.00	Nil
				A12 0.10-0.52 Abrupt	Sandy clay loam	Weak, firm, <20mm sub-angular	Nil	10YR4/6 Dark yellowish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	6.0		
				B21 0.52-0.76 Abrupt	Clay loam	Weak, soft, sub-rounded <10mm	1% coarse fragments <5mm	10YR5/6 Yellowish brown Nil mottles /bleach	Dry, moderate	Nil	-		
				B22 0.76-1.00 EOBH	Clay loam	Weak, soft, sub-rounded <10mm	Nil	10YR5/4 Yellowish brown Nil mottles /bleach	Dry, moderate	Nil	-		

SITE 8

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chr3	296583 6430933	Red Chromosol; Shallow Thick, Silty, Moderate	Detailed hand auger	27/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Forestry, Grazing Undulating plain, upper slope 6/10%	Eucalyptus species	Nil microrelief Semi-disturbed Nil erosion	Soft to firm, no coarse fragments	A11 0.00-0.13 Abrupt	Sandy loam	Massive, loose	1% coarse fragments <5mm	7.5YR3/3 Dark brown Nil mottles /bleach	Dry, rapid	Common, fine	6.0	0.00-.0.10 0.20-.0.30 0.36-0.46 0.47-0.52	Nil Laboratory site
				A12 0.13-0.36 Abrupt	Sandy loam	Massive, loose	1% coarse fragments <5mm	7.5YR3/4 Dark reddish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	6.0		
				B21 0.36-0.47 Abrupt	Clay loam sandy	Massive, loose	Nil	5YR5/4 Reddish brown Nil mottles /bleach	Dry, well to moderate	Nil	6.5		
				B22 0.47-0.52 EOBH	Clayey sand	Massive, loose	Nil	5YR5/6 Yellowish red Nil mottles /bleach	Dry, well to moderate	Nil	6.5		

SITE 9

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Kb	295630 6430973	Haplic Mellic Brown Kandosol; Thick, Clay loamy, Deep	Detailed hand auger	27/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, upper slope 8/8%	Tall woodlands Eucalyptus species	Nil microrelief Semi-disturbed Nil erosion	Soft to firm, nil coarse fragments	A11 0.00-0.10 Abrupt	Clayey sand	Massive to weak, loose	1 / 1% coarse fragments <2 / <5mm	7.5YR3/3 Dark brown Nil mottles /bleach	Dry, rapid	Common, fine	5.5	0.00-.0.10 0.20-.0.30 0.50-0.60 0.70-0.75 0.90-1.00	Nil Laboratory site
				A12 0.10-0.49 Sharp	Clayey sand	Massive to weak, loose	Nil	7.5YR4/6 Strong brown Nil mottles /bleach	Dry, well	Few, fine	5.5		
				B21 0.49-1.00 EOBH	Clay loam sandy	Massive to weak, loose	Nil	10YR5/6 Yellowish brown Nil mottles /bleach	Dry, well	Nil	8.0		

SITE 10

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chb1	296145 6431161	Haplic, Brown Chromosol; Medium, Clayey, Deep	Detailed hand auger	27/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, simple slope 9/10%	Sparse tall woodland	Nil microrelief Extensive to complete disturbance Nil erosion	Firm, no coarse fragments	A11 0.00-0.10 Abrupt	Clay loam	Strong, very firm, blocky	Nil	10YR4/3 Brown Nil mottles /bleach	Dry, well	Common, fine	6.0	Nil	Nil
				B21 0.10-0.49 Abrupt	Light clay	Moderate, very firm, <10mm	Nil	10YR3/4 Nil mottles /bleach	Dry, well to moderate	Common, fine	6.0		
				B22 0.49-0.70 Abrupt	Light clay	Weak, soft, sub-angular	Nil	7.5YR4/4 Brown Nil mottles /bleach	Dry, moderate	Nil	8.0		
				B23 0.70-0.90 EOBH	Light clay	Weak, soft, sub-angular	5% <5 coarse fragments	7.5YR4/6 Strong brown Nil mottles /bleach	Dry, moderate	Nil	8.0		

SITE 11

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Vb2	295846 6431790	Haplic Brown Vertosol; Deep	Detailed hand auger	27/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, simple slope 7/10%	Grasses, Eucalyptus species	Nil microrelief Extensive to complete disturbance Nil erosion	Soft, cracking, no coarse fragments	A11 0.00-0.11 Abrupt	Clay loam	Weak to moderate, firm, <10mm sub-angular	Nil	7.5YR3/3 Dark brown Nil mottles /bleach	Dry, well	Common, fine	6.0	0.00-0.10 0.20-0.30 0.50-0.60 0.70-0.80 0.90-1.00	Nil Laboratory site
				B21 0.11-0.50 Abrupt	Light clay	Moderate, firm, <20mm sub-angular	Nil	7.5YR3/4 Dark reddish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	6.0		
				B31 0.50-0.85 Abrupt	Sandy loam	Massive, loose	Nil	10YR5/6 Yellowish brown Nil mottles /bleach	Dry, moderate	Nil	8.0		
				B32 0.85-1.00 EOBH	Clay loam	Massive, loose	<10% <1mm coarse fragments	10YR6/3 Pale brown Nil mottles /bleach	Dry, moderate	Nil	8.0		

SITE 12

Soil Mapping Unit:	Location (GDA94 ZONE 56H):		Site Survey Type:	Survey Date:
Chb1	295053 6431885	Haplic, Brown Chromosol; Medium, Clayey, Deep	Detailed hand auger	27/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, upper/mid slope 8/10%	Tall woodlands, Poplar box, Narrow leaf Ironbark	Nil microrelief Semi-extensively disturbance Nil erosion	Firm, no coarse fragments	A11 0.00-0.15 Abrupt	Silty loam	Moderate, firm, <20mm sub-angular	Nil	10YR3/3 Dark brown Nil mottles /bleach	Dry, well	Common, fine	5.5	0.00-0.10 0.20-0.30 0.50-0.60 0.70-0.80 0.90-1.00	Nil Laboratory site
				B21 0.15-0.80 Clear	Light clay	Massive, loose	<2% coarse fragments <5mm	10YR4/4 Dark yellowish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	8.5		
				B22 0.80-1.00 EOBH	Light clay	Massive, loose	<1% coarse fragments <5mm	10YR4/6 Dark yellowish brown Nil mottles /bleach	Dry, moderate	Nil	8.5		

SITE 13

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chr4	297494 6432095	Eutrophic Brown Chromosol; Thick Clayey Deep	Detailed hand auger	27/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, simple / mid slope 7/9%	Silver leaf Ironbark, Sparse tall woodland	Nil microrelief Semi-disturbance Nil erosion	Hard, nil coarse fragments	A11 0.00-0.15 Abrupt	Sandy loam	Massive, loose	Nil	10YR3/3 Dark brown Nil mottles /bleach	Dry, well	Common, fine	5.5	0.00-0.10 0.20-0.30 0.55-0.65 0.70-0.80 0.90-1.00	Nil Laboratory site
				A12 0.15-0.54 Abrupt	Sandy loam	Massive, loose	Nil	10YR4/4 Dark yellowish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	5.5		
				B21 0.54-0.86 Abrupt	Light clay	Moderate, firm, <20 sub-angular	Nil	5YR4/6 Yellowish red Nil mottles /bleach	Dry, moderate	Nil	6.0		
				B3 0.86-1.00 EOBH	Sandy clay	Massive, loose	Nil	10YR6/4 Light yellowish brown Nil mottles /bleach	Dry, moderate	Nil	7.5		

SITE 14

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Vb1	294125 6434267	Epipedal Brown Vertosol; Very fine, Deep	Detailed hand auger	28/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, simple / mid slope 6/9%	Sparse tall woodlands	Nil microrelief Extensive disturbance Nil erosion	Soft to firm, minor cracking, <5mm coarse fragments	A1 0.00-0.24 Abrupt	Light medium clay	Moderate, strong <10mm, sub rounded	Nil	10YR3/3 Dark brown Nil mottles/ bleach	Dry, well	Common, fine	5.5	Nil	Nil
				B21 0.24-0.74 Abrupt	Light clay	Weak, firm <10mm, sub rounded	<2% coarse fragments <5mm	2.5Y5/4 Reddish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	8.5		
				B22 0.74-0.85 Abrupt	Light clay	Weak, firm <10mm, sub rounded	Nil	2.5Y6/4 Light reddish brown Nil mottles /bleach	Dry, moderate	Nil	8.5		
				B23 0.85-1.00 EOBH	Light clay	Weak, firm <10mm, sub rounded	Nil	2.5Y5/4 Reddish brown Nil mottles /bleach	Dry, moderate	Nil	8.5		

SITE 15

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Kb	295460 6433096	Haplic Mellic Brown Kandosol; Thick, Clay loamy, Deep	Detailed hand auger	27/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Gently undulating plain, upper slope 4/3%	Grasses	Nil microrelief Extensive – complete disturbance Nil erosion	Firm, no coarse fragments	A11 0.00-0.08 Abrupt	Sandy loam	Massive to weak, firm, <10mm sub-round	Nil	7.5YR3/3 Dark brown Nil mottles /bleach	Dry, well	Common, fine	5.5	0.00-0.08 0.10-0.20 0.30-0.40 0.50-0.60 0.90-1.00	Nil
				A12 0.08-0.25 Abrupt	Clayey sand	Weak, weak, to firm <10mm sub-round	<1% coarse fragments <20mm	7.5YR3/4 Dark reddish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	8.5		
				B21 0.25-0.41 Abrupt	Sandy loam	Weak, weak, to firm <10mm sub-round	Nil	7.5YR4/3 Brown Nil mottles /bleach	Dry, moderate	Few, fine	8.5		
				B22 0.41-0.78 Abrupt	Sandy loam	Massive to weak, soft to firm <20mm, sub-round	<1% coarse fragments <5mm	10YR5/4 Yellowish brown Nil mottles /bleach	Dry, well	Nil	8.5		
				B3 0.78-1.00 EOBH	Sandy loam	Massive to weak, soft to firm <20mm, sub-round	<1% coarse fragments <5mm	10YR6/3 Pale brown Nil mottles /bleach	Dry, well	Nil	8.5		

SITE 16

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Vb1	296635 6432894	Epipedal Brown Vertosol; Very fine, Deep	Detailed hand auger	28/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, upper slope 6/9%	Eucalyptus species Sparse tall woodland	Nil microrelief Extensive disturbance Nil erosion	Soft, crusting, nil coarse fragments	A1 0.00-0.13 Abrupt	Light medium clay	Strong, very firm, <10mm sub-round	Nil	10YR4/3 Brown Nil mottles /bleach	Dry, well	Common, fine	6.0	0.00-0.10 0.20-0.30 0.50-0.60 0.80-0.90	Nil Laboratory site
				B21 0.13-0.49 Abrupt	Medium clay	Moderate, strong, <20mm sub-round	1% calcium carbonate	10YR4/3 Brown Nil mottles /bleach	Dry, well to moderate	Few, fine	8.5		
				B22 0.49-0.72 Abrupt	Medium clay	Moderate, strong, <20mm sub-round	2% calcium carbonate	10YR4/4 Dark yellowish brown Nil mottles /bleach	Dry, moderate	Few, fine	8.5		
				B3 0.72-0.92 EOBH	Sandy loam	Weathered rock	5% coarse fragments <10mm	7.5Y4/4 Brown Nil mottles /bleach	Dry, imperfect	Nil	8.5		

SITE 17

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chb1	298029 6432783	Haplic, Brown Chromosol; Medium, Clayey, Deep	Detailed hand auger	28/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, upper slope 6/7%	Grasses, Tall woodland	Nil microrelief Semi-disturbance Nil erosion	Firm, minor cracking, nil coarse fragments	A1 0.00-0.10 Abrupt	Clay loam	Moderate, very firm, <10mm sub-round	Nil	10YR4/4 Dark yellowish brown Nil mottles /bleach	Dry, well	Common, fine	6.0	0.00-0.10 0.20-0.30 0.50-0.60 0.80-0.90	Nil
				B21 0.10-0.30 Abrupt	Medium clay	Moderate, very firm, <10mm sub-round	Nil	10YR4/6 Dark yellowish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	6.0		
				B22 0.30-0.71 Abrupt	Medium clay	Moderate, very firm, <20mm sub-round	1% calcium carbonate	10YR4/3 Brown Nil mottles /bleach	Dry, moderate	Few, fine	7.0		
				B3 0.71-0.90 EOBH	Clayey sand	Weathered rock, massive, loose	2% coarse fragments <5mm	10YR5/4 Yellowish brown Nil mottles /bleach	Dry, imperfect	Nil	7.5		

SITE 18

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
VbShp	295863 6434639	Epipedal Brown Vertosol; Very fine, Moderate	Detailed hand auger	28/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Depth (m) / Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, upper / mid slope 5/6%	Grasses,	Nil microrelief Complete disturbance Nil erosion	Soft, cracking, sparse crust, nil coarse fragments	A1 0.00-0.12 Abrupt	Light medium clay	Moderate to strong, very firm <10mm sub-angular	Nil	10YR3/3 Dark brown Nil mottles /bleach	Dry, well	Common, fine	6.0	0.00-0.10 0.20-0.30 0.48-0.58 0.58-0.62	Nil
				B21 0.12-0.47 Abrupt	Medium clay	Moderate to strong, very firm <20mm sub-angular	Nil	10YR3/4 Dark yellowish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	7.5		
				B22 0.47-0.58 Abrupt	Medium clay	Moderate to strong, very firm <20mm sub-angular	2-5% calcium carbonate	10YR4/4 Dark yellowish brown Nil mottles /bleach	Dry, moderate	Few, fine	8.5		
				B3 0.58-0.62 EOBH	Clay loam	Weak, soft, <5mm sub-angular	Nil	10YR5/6 Yellowish brown Nil mottles /bleach	Dry, moderate	Nil	8.5		

SITE 19

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chb1	297146 6434029	Haplic, Brown Chromosol; Medium, Clayey, Deep	Detailed hand auger	28/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, mid slope 7/8%	Tall woodland, Ironbark Silverleaf	Nil microrelief Semi-disturbance Sheet erosion nearby	Soft, cracking, sparse crust, nil coarse fragments	A1 0.00-0.08 Abrupt	Loam	Weak, firm <5mm sub-angular	Nil	10YR3/3 Dark brown Nil mottles /bleach	Dry, well	Common, fine	6.0	0.00-0.08 0.20-0.30 0.50-0.60 0.70-0.80 0.90-1.00	Nil
				B21 0.08-0.33 Abrupt	Light clay	Massive, loose	Nil	10YR2/2 Nil mottles /bleach	Dry, well to moderate	Few, fine	7.5		
				B22 0.33-0.86 Abrupt	Medium clay	Moderate, very firm <20mm sub-angular	Nil	10YR3/4 1% Pale brown mottles, Nil bleaching	Dry, moderate	Few, fine	8.5		
				B23 0.86-1.00 EOBH	Medium clay	Moderate, very firm <20mm sub-angular	Nil	10YR4/6 Dark yellowish brown 2% Pale brown mottles, Nil bleaching	Dry, moderate	Nil	8.5		

SITE 20

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Sr	298399 6433626	Subnatric, Red Sodosol; Thin Clayey, Moderate	Detailed hand auger	28/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Undulating plain, lower slope 6/6%	Grasses	Nil microrelief Extensive to complete disturbance Sheet erosion nearby	Firm, minor cracking, nil coarse fragments	A1 0.00-0.10 Abrupt	Clay loam	Weak, firm <10mm sub-round	<1% coarse fragments <5mm	7.5YR3/3 Dark brown Nil mottles /bleach	Dry, well	Common, fine	5.0	0.00-0.10 0.20-0.30 0.50-0.60	Nil Laboratory site
				B21 0.10-0.31 Abrupt	Medium clay	Moderate, firm <10mm sub-round	<1% coarse fragments <5mm	2.5YR4/4 Reddish brown Nil mottles /bleach	Dry, well to moderate	Few, fine	7.5		
				B22 0.31-0.66 EOBH	Medium clay	Moderate, very firm <20mm sub-angular	<2% coarse fragments <10mm <2% coarse fragments 10-20mm	5YR4/6 Yellowish red Nil mottles /bleach	Dry, moderate	Few, fine	8.5		

SITE 21

Soil Mapping Unit:	Location (GDA94 ZONE 56H):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chr2	293372 6429241	Eutrophic Red Chromosol; Medium, Silty	Detailed hand auger	27/11/2019

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing Gently undulating plain, upper to mid slope 9/9%	Eucalyptus species	Nil microrelief XXXX disturbance Nil erosion	Soft to firm, Nil coarse fragments	A11 0.00-0.16 Abrupt	Clay loam	Massive, loose	Nil	10YR3/3 Dark brown Nil mottles/bleach	Dry, well	Common, fine	5.5	0.00-0.10 0.20-0.30 0.55-0.65 0.70-0.80 0.88-0.96	Nil
				B21 0.16-0.53 Abrupt	Medium clay	Moderate, very firm <20mm sub-angular	Nil	5YR5/6 Yellowish red Nil mottles /bleach	Dry, well to moderate	Few, fine	6.0		
				B22 0.53-0.69 Abrupt	Light medium clay	Moderate, very firm <20mm sub-angular	Nil	7.5YR5/6 Yellowish red Nil mottles /bleach	Dry, moderate	Few, fine	6.0		
				B31 0.69-0.88 Abrupt	Sandy clay loam	Massive, loose	<1% coarse fragments <5mm	10YR5/6 Yellowish brown Nil mottles /bleach	Dry, moderate	Nil	8.5		
				B32 0.88-0.96 EOBH	Loam	Massive, loose	<2% coarse fragments <5mm	10YR6/6 Brownish yellow Nil mottles /bleach	Dry, moderate	Nil	8.5		

SITE B1

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299322 mE 6434365 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	Backhoe excavated	4/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing, Undulating plain, Simple slope 2.0 % 3.0 %	Extensive cleared.	Nil microrelief Extensive Cleared Nil Erosion	Soft, No coarse fragments	A11 0.00 – 0.14 Abrupt	Silty clay loam	Moderate, subangular peds <20mm, strong	Nil	7.5YR3/2 Dark brown Nil mottles /bleach	Dry Moderately to Well drained	Common, medium	6.5	0.00 – 0.05 0.05 – 0.14 0.25 – 0.35 0.45 – 0.55 0.90 – 1.00	Nil Laboratory site
				A12 0.14 – 0.38 Abrupt	Silty clay loam	Moderate, subangular peds <20mm, strong	Nil	7.5YR3/1 Very dark grey Nil mottles /bleach	Dry Moderately to Well drained	Few, fine	7.5		
				B21 0.38 – 0.76 Abrupt	Medium clay	Moderate, subangular peds <20mm, strong	Nil	7.5YR3/1 Very dark grey Nil mottles /bleach	Dry Moderately to imperfect drained	Few, fine	7.5		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
				B22 0.76-1.10 EOBH	Medium clay	Moderate, subangular peds <20mm, strong	Nil	7.5YR3/2 Dark brown Nil mottles /bleach	Dry Moderately to imperfect Drained	Very few, very fine	0.9 / 8.0		

SITE B2

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299714 mE 6433934 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	Backhoe excavated	4/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH per horizon	Sample (m)	Observations
Grazing, Undulating plain, Drainage line / open depression 2.0 % 3.0 %	Extensive cleared.	Nil microrelief Extensive Cleared Nil Erosion	Minor cracking, No coarse fragments	A11 0.00 – 0.16 Abrupt	Silty clay loam	Weak peds <30mm, weak	Nil	7.5YR3/1 Very dark grey Nil mottles /bleach	Dry Moderately to Well drained	Common, fine	0.05 / 6.5	0.00 – 0.05 0.15 – 0.25 0.30 – 0.40 0.70 – 0.80 0.90 – 1.00	Nil
				A12 0.16 – 0.66 Abrupt	Silty clay loam	Weak peds <20mm, weak	Nil	7.5YR3/1 Very dark grey Nil mottles /bleach	Dry Moderately to Well drained	Few, fine	0.40 / 6.5		
				A21 0.66 – 0.90 Abrupt	Sandy clay loam	Massive, weak	Nil	7.5YR4/2 Brown Nil mottles /bleach	Dry Moderately drained	Very few, fine	0.8 / 7.5		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH per horizon	Sample (m)	Observations
				B2 0.90-1.20 EOBH	Medium clay	Moderate, subangular peds 5-30mm, firm	<2% <2mm mixed coarse fragments	7.5YR3/2 Dark brown Nil mottles /bleach	Humid Moderately to imperfect drained	-	1.0 / 7.5		

SITE B3

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chr2	Hunter	299321 mE 6433849 mN	Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	Backhoe excavated	3/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing, Undulating plain, Lower slope 8.0 % 5.0 %	Extensive cleared.	Nil microrelief Extensive Cleared Nil Erosion	Soft, No coarse fragments	A11 0.00 – 0.11 Abrupt	Clayey sand	Massive, weak	Nil	7.5YR3/2 Dark brown Nil mottles /bleach	Dry Well drained	Few, fine	7.5	0.00 – 0.05 0.15 – 0.25 0.30 – 0.40 0.60 – 0.70 0.90 – 1.00	Nil
				A12 0.11 – 0.28 Abrupt	Clayey sand	Massive, weak	<1% coarse fragments 5-20mm	7.5YR4/4 Brown Nil mottles /bleach	Dry Well drained	Few, fine	7.0		
				B2 0.28 – 1.10 EOBH	Silty clay loam	Moderate, subangular blocky smooth faced peds 10-20 mm, strong	<2% black nodules <1mm <2% calcium carbonate at 0.9m-1.1m	5YR4/4 Reddish brown Nil mottles /bleach	Dry Moderately drained	Very few, very fine	7.0		

SITE B4

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299189 mE 6433268 mN	Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	Backhoe excavated	4/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing, Undulating plain, Lower slope 4.0 % 3.0 %	Extensive cleared.	Nil microrelief Extensive Cleared Nil Erosion	Soft, No coarse fragments	A11 0.00 – 0.13 Abrupt	Clayey sand	Massive, weak	Nil	7.5YR3/2 Dark brown Nil mottles /bleach	Dry Well drained	Common, medium	6.5	0.00 – 0.05 0.05 – 0.13 0.20 – 0.30 0.35 – 0.45 0.60 – 0.70	Nil
				A12 0.13 – 0.33 Abrupt	Clayey sand	Massive, loose to weak	Nil	7.5YR4/3 Brown Nil mottles /bleach	Dry Well drained	Few, fine	6.5		
				A21 0.33 – 0.45 Abrupt	Loamy sand	Massive, loose	<2% <10mm coarse fragments, pale white nodules	7.5YR4/4 Brown Nil mottles /bleach	Dry Moderately to imperfect drained	Few, fine	7.0		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
				B2 0.45-1.00 EOBH	Silty clay loam	Moderate, subangular, platy peds <20mm, strong	<5% calcium carbonate	5YR4/6 Yellowish red Mottles <5% 7.5YR4/8 Red <2% 7.5YR4/6 Strong brown Nil bleaching	Dry Imperfect Drained	Very few, very fine	1.0 / 7.0		

SITE B5

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299866 mE 6433205 mN	Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	Backhoe excavated	3/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing, Undulating plain, mid slope 9.0 % 7.0 %	Extensive cleared.	Nil microrelief Extensive Cleared Nil Erosion	Soft, No coarse fragments	A11 0.00 – 0.15 Abrupt	Clayey Sand	Weak, subangular, soft 5-30mm	Nil	7.5YR3/2 Dark brown Nil mottles /bleach	Dry Well drained	Few, fine	6.5	0.00 – 0.05 0.05 – 0.15 0.30 – 0.40 0.55 – 0.65 0.90 – 1.00	Nil
				A12 0.15 – 0.43 Abrupt	Clayey Sand (coarse)	Weak, subangular, soft <20mm	Nil	7.5YR4/2 Brown Nil mottles /bleach	Dry Well drained	Few, fine	6.5		
				B21 0.43 – 0.695 Abrupt	Silty clay loam	Moderate, subangular blocky peds 10-20 mm, strong	20% <2mm coarse fragments (mixed) <2% <5mm black nodules	7.5YR4/4 Brown Nil mottles /bleach	Dry Moderately drained	Few, very fine	6.5		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
				C 0.695-1.10 EOBH	Substrate (Sandstone)	Moderate, subangular blocky smooth faced peds 10-20 mm, strong, fine crack	Nil	7.5YR7/2 Pinkish grey Nil mottles /bleach	Dry Very poor drained	Nil	Nil		

SITE B6

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299190 mE 6432644 mN	Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	Backhoe excavated	4/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Field pH per horizon	Sample (m)	Observations
Grazing, Undulating plain, Crest 2.0 % 1.0 %	Extensive cleared.	Nil microrelief Extensive Cleared Nil Erosion	Firm, No coarse fragments	A1 0.00 – 0.18 Abrupt	Clayey sand	Massive, weak	10% coarse fragments 5-10mm	7.5YR3/1 Very dark grey Nil mottles /bleach	Dry Well drained	Few, fine	6.5	0.00 – 0.05 0.05 – 0.15 0.30 – 0.40 0.50 – 0.60	Nil
				A2 0.18 – 0.44 Abrupt	Silty clay loam	Massive, loose to weak	Nil	7.5YR4/3 Brown Nil mottles /bleach	Dry Well drained	Very few, very fine	7.0		
				B2 0.44 – 0.60 Abrupt	Light clay	Moderate, subangular, platy peds <20mm, strong	50% coarse fragments 5-20mm 10% calcium carbonate	7.5YR5/3 Brown Mixed mottles <10% Nil bleaching	Dry Moderately drained	Very few, very fine	7.0		
				C 0.60-0.80 EOBH	Substrate Sandstone	Nil	Nil	7.5YR6/1 Grey Nil mottles /bleach	Dry Very poor drained	Nil	Nil		

SITE B7

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299777 mE 6432530 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	Backhoe excavated	4/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH per horizon	Sample (m)	Observations
Grazing, Undulating plain, mid slope 10.0 % 10.0 %	Extensive cleared.	Nil microrelief Extensive Cleared Nil Erosion	Soft, No coarse fragments	A11 0.00 – 0.10 Abrupt	Silty clay loam	Moderate, subangular blocky, peds 5-20 mm, strong	<2 % calcium carbonate 2-6mm	10R3/3 Dark brown No mottles Nil mottles /bleach	Dry Well drained	Common, fine	6.0	0.00 – 0.05 0.15 – 0.25 0.40 – 0.50 0.60 – 0.70 0.90 – 1.00	30.0m nearby, slope is recorded as 12.0 % / 12.0%
				A12 0.10 – 0.28 Abrupt	Silty clay loam	Moderate, subangular blocky smooth faced peds 10-20 mm, strong, medium crack	Nil	10R3/3 Dark brown Nil mottles /bleach	Dry Moderately drained	Few, fine	6.0		
				B21 0.28 – 0.60 Abrupt	Medium clay	Moderate, subangular blocky smooth faced peds 10-20 mm, strong, fine crack	Nil	7.5YR3/3 Brown Nil mottles /bleach	Dry Moderately drained	Few, very fine	6.5		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH per horizon	Sample (m)	Observations
				B22 0.60-1.00 EOBH	Medium Clay (see Observations)	Moderate, subangular blocky smooth faced peds 10-20 mm, strong, fine crack	Nil	7.5YR4/4 Brown Nil mottles /bleach	Dry Moderately Drained	Very few, very fine	7.0		

SITE B8

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299537 mE 6432354 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	Backhoe excavated	4/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH per horizon	Sample (m)	Observations
Grazing, Undulating plain, lower slope 10.0 % 10.0 %	Extensive cleared.	Nil microrelief Extensive Cleared Nil Erosion	Minor cracking <2mm, No coarse fragments	A1 .00 – 0.13 Abrupt	Silty clay loam	Moderate, subangular blocky, peds 5-20 mm, firm	Nil	7.5YR3/2 Dark brown Nil mottles /bleach	Dry Well drained	Common, fine	6.0	0.00 – 0.05 0.05 – 0.13 0.15 – 0.25 0.30 – 0.40 0.75 – 0.85	Nil additional observations
				B21 0.13 – 0.27 Abrupt	Medium clay	Moderate, subangular blocky peds 10-20 mm, strong	<1% coarse fragments 6-10mm	7.5YR4/2 Brown Nil mottles /bleach	Dry Moderately drained	Few, fine	6.0		
				B22 0.27 – 0.60 Abrupt	Medium clay	Moderate, subangular blocky peds 10-20 mm, strong	<2% coarse fragments 2-6mm including black nodules <2% calcium carbonate	7.5YR4/3 Brown Nil mottles /bleach	Dry Moderately drained	Very few, very fine	6.0 6.5		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH per horizon	Sample (m)	Observations
				C 0.60-1.15 EOBH	Sandstone	Nil	Nil	7.5YR6/1 Grey Nil mottles /bleach	Dry Very poor drained	Nil	Nil		

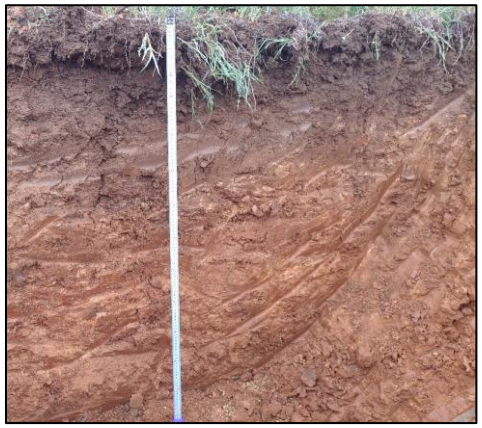
SITE B9

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299535 mE 6431702 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	Backhoe excavated	4/04/2018

Landscape

Surface

Soil Profile



Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH per horizon	Sample (m)	Observations
Grazing, Undulating plain, lower slope 6.0 % 4.0 %	Extensive cleared.	Nil microrelief Extensive Cleared Nil Erosion	Minor cracking <2mm, No coarse fragments	A1 0.00 – 0.26 Abrupt	Silty clay loam	Moderate, subangular blocky, peds 5-20 mm, strong	<5% pale red nodules. 0.05-0.15 <5% black nodules	7.5YR4/2 Brown Nil mottles /bleach	Dry Well drained	Fine, few	6.5	0.00 – 0.05 0.05 – 0.15 0.30 – 0.40 0.60 – 0.70 0.90 – 1.00	Nil additional observations
				B21 0.26 – 0.50 Gradual	Medium clay	Moderate, subangular blocky smooth faced peds 10-20 mm, strong, medium crack	<2% calcium carbonate	7.5YR4/3 Brown Nil mottles /bleach	Dry Moderately drained	Very few, fine	8.0		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Field Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH per horizon	Sample (m)	Observations
				B22 0.50 – 1.20 EOBH	Medium clay	Moderate, subangular blocky smooth faced peds 10-20 mm, strong, fine crack	<5% coarse fragments 2-6mm <5% calcium carbonate	5YR4/4 Reddish brown Nil mottles /bleach	Dry Moderately Drained	Very few, very fine	8.0 8.0		

Appendix C – Check site descriptions

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C1	294398 6429852	Chr1	Undulating plains, Eucayltpus species Firm, Sandy loam surface	-
C2	296019 6429540	Chr2	Undulating plains, mid slope 7% Eucayltpus species, Semi disturbed Firm very minor crust, Loam surface	

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C3	296207 6429589	Chr1	Forest, undulating plains, lower slope Eucayltpus species Gully erosion, Minor cracking Firm, loamy surface	
C4	296112 6430177	Chr2	Forest, Undulating plains, midlsope 11/10% Silverleaf Ironbark, Firm to hard, very minor cracking, loamy surface	

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C5	295754 6429788	Chr2	Forest, Undulating plains, midlsope 5/6% Silverleaf Ironbark, Firm to hard, very minor cracking, loamy surface	-
C6	295763 6429704	Chr2	Forest, Undulating plains, midlsope 6/7% Silverleaf Ironbark, Firm to hard, very minor cracking, loamy surface	-
C7	294814 6429619	GSS/1	Crest, extensive disturbance	
C8	293650 6430953	Vb1	Undulating plain, Eucayltpus species Semi distrubance, Hard, minor cracking surface	

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C9	294003 6430909	Vb1	Undualting plain, midslope 9/9% Grasses, extensive disturbance, Soft, minor cracking surface	
C10	294245 6430896	Vb1	Drainage line, Eucayltpus species, gully eorsion, soft, minor cracking surface	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C11	293706 6430940	Vb1	Drainage line, Eucayltpus species, gully erosion	
C12	293116 6430802	Sb	Undulating plain, upper slope, grasses, extensive disturbance, soft to firm with minor cracking.	-
C13	292507 6430890	Kb	Undulating plain, upper slope 9/10%, grasses, extensive disturbance, soft with custing.	-
C14	292460 6430762	Chr2	Undulating plain, depression 10/8%, gully erosion, hard with minor cracking	-
C15	291864 6430868	Chr2	Undulating plain, midslope, sparse grasses, extensive disturbance, soft with crusting	-
C16	292298 6430538	Chr2	Undulating plain, upper slope, sparse grasses, extensive disturbance, soft with crusting	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C17	292088 6430092	Chr2	Lower slope, depression, She Oak, gully erosion, hard with minor cracking	
C18	291951 6429439	Chr1	Grazing, depression, Eucayltpus species, Mount Coolibah, Gully erosion, yellow to brown clay earths	-
C19	296578 6431085	Chr3	Lower slope 10%, Sparse woodlands, gully erosion nearby, firm coarse fragements <20mm	-
C20	295487 6430847	Chb1	Undulating plains, mid slope, firm, minor cracking/crust	-
C21	295600 6430929	Chb1	Boundary of SMUs	-
C22	295850 6430682	Chb1	Depression, lower slope, Eucayltpus species Silver leaf Ironbark, hard	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C23	295934 6430986	Chb1	Undulating plain, upper slope, Eucayltpus species Silver leaf Ironbark, semi disturbed, hard with very minor cracking	-
C24	296373 6432096	Chr4	Grazing, Undaulting plain, upper slope, 11/14%, Eucayltpus species, semi disturbed, hard	
C25	296081 6432587	Chb1	Grazing, Undulating plain, midslope, 8/7%, sparse tall woodland, extensive disturbance, hard	-
C26	295733 6431720	Vb2	No notes recorded	-
C27	295074 6431734	Chb1	Grazing, Undulating plain, upper slope, 8/7%, Eucayltpus species, extensive disturbance, firm with cracking surface	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C28	295229 6431434	Chb1	Undulating plain, midslope, <10%, mixed, non-eucayltpus species, extensive disturbance, firm with minor cracking	
C29	295185 6431192	Chb1	Undulating plain, lower slope, 9/11%, Poplar box, semi disturbance, firm with minor cracking	-
C30	297469 6431796	Chb1	Depression, Silver leaf Ironbark, Eucayltpus species, Hard	-
C31	296257 6430581	Chb1	Undulating plain, upper slope, 12%, Silverleaf Ironbark, semi disturbance, firm with minor cracking	-
C32	292739 6429149	GSS/7	Undulating plain, mid slope, 4/5%, Narrow leaf Ironbar, Poplar box, semi disturbance	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C33	292401 6428594	GSS/7	Undulating plain, upper slope, 9%, sparse Eucayltpus species, extensive disturbance	
C34	291976 6428086	GSS/7	Gently undulating plain, mid slope, 3%, sparse mixed Eucayltpus species	-
C35	293068 6425403	GSS/3	Undulating plain, upper slope, 6%, white Eucayltpus species,	-
C36	295736 6433090	Kb	Undulating plain, mid slope, 11/10%, semi disturbed, Narrow leaf Ironbark, Eucayltpus species,	-
C37	295923 6433060	Vb1	Grazing, depression, lower slope, Eucayltpus species, semi-disturbed	-
C38	296087 6433037	Vb1	Grazing, undaulting plain, mid-slope, Eucayltpus species, semi-disturbed	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C39	296314 6433006	Vb1	Crest, Silver leaf ironbark, semi to extensive disturbed	
C40	296455 6434636	Chr2	Alluvial plain, depsression, mixed vegtation, gully erosion	-
C41	297097 6434546	Chr2	Alluvial plain, depsression, sparse mixed vegtation, extensive – complete disturbance	-
C42	297141 6433720	Chb1	Undulating plains, midslope to upper slope, 3%, firm, minor cracking surface,	-
C43	297110 6433478	Chb1	Undulating plain, upper slope leading to crest, grasses present, extensive to complete disturbance.	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C44	298966 6434115	Chr2	Undulating plain, mid-slope, 7/7%, grasses present, complete disturbance, firm, no cracking.	
C45	298531 6433930	Chr2	Grazing, simple slope, 5/5%, grasses, complete disturbance, firm, minor cracking	-
C46	293311 6429359	Chr2	Forestry, Undualting plain, upper slope, Narrowleaf Ironbark, firm, minor cracking	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C47	292721 6429528	Chr1	Foresty/grazing, undualting plain, lower slope, 6/7%, silverleaf ironbark, semi disturbed, firm, minor cracking, brown sandy loam	
C48	292707 6429703	Chr2	Grazing, crest, silverleaf ironbark, extensive to complete distrubance, hard, minor cracking dark brown silty loam	-
C49	293066 6429715	Chr2	Grazing, upper slope 9/11%, cleared with grasses, soft with cracking, brown light 10YR3/3 medium clay	-
C50	293066 6429784	Vb1	Grazing, crest, narrowleaf ironbark, ni disturbance, firm, minor cracking, brown 10YR3/4 light clay. Boundary at treeline approxiamtely,	-
C51	292955 6429629	Chr2	Grazing, lower slope, poplar box, complete disturbance, blade plowed, hard, cracking, clay loam	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C52	292952 6429539	Chr1	Grazing, lower slope, depression, grasses, gully erosion, firm with minor cracking.	
C53	292429 6429982	Chr2	Depression, gully, Eucayltpus species, gully erosion	-
C54	292260 6430100	Chr2	Grazing, undaulting plains, mid-slope, silver leaf Ironbark, semi to extensive distrubance, firm , minor cracking, pH 5.5	-
C55	291849 6430710	Chr2	Undulating plains, upper slope 8/9%, grasses, complete disturbance, firm, minor cracking loam, 10YR3/3	-
C56	291399 6430725	Chr2	Undulating plains, upper slope 6/6%, grasses, complete disturbance, firm, minor cracking silty loam 10YR3/3	-
C57	291506 6431007	Chr2	Undulating, mid slope, grasses, complete disturbance, firm, minor cracking, pH 5.5	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C58	291954 6429655	Chr2	Grazing, undulating plain, lower slope, silverleaf ironbark, gully erosion, firm, minor cracking clay loam 10YR4/3	
C59	292512 6429810	Chr2	Undulating plain, mid-slope 9%, Eucayltpus species, semi-disturbed, firm, minor cracking	-
C60	295061 6434646	Vb1	Grazing, undualting plain, mid-slope 13/11%, grasses, complete disturbance, firm, minor cracking, brown clay loam, pH 5.5/6	-
C61	295443 6434636	Vb1	Grazing, mid-slope, grasses, complete disturbance, minor gully erosion nearby, soft to firm with cracking brown light clay	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C62	295760 6434358	Vb1	Grazing, mid-slope, very sparse Eucayltpus species, complete disturbance, firm, cracking light clay, 10YR3/4	
C63	295854 6434225	Vb1	Grazing, plain, grasses, extensive disturabnce with blade plough, <5% coarse fragments <2mm silty loam	-
C64	296247 6434489	Vb1	Grazing, undualting plain, mid-slope 13/11%, grasses, complete disturbance, firm, minor cracking, brown clay loam, pH 5.5/6	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C65	297503 6434347	Chr2	Grazing, undualting plain, simple slope 7/7%, grasses, complete disturbance, Firm, minor cracking, silty loam	
C66	297548 6433974	Chb1	Wide depression, silverleaf ironbark, compete distrubance, soft to firm, very minor cracking, sandy loam, pH 5.5	-
C67	297740 6433745	Chb1	Crest, grasses, complete disturbance, firm to hard, minor cracking, silty loam, pH 5.5	-
C68	297568 6433301	Chb1	Crest, to upper slope, 5%, grasses, minor weed, extensive to complete disturbance, firm to hard, minor cracking loam, pH 5.5	-
C69	298381 6433951	Chr2	Drainage line grasses and white barked gums.	-
C70	298290 6434214	Chr2	Undulating plain, lower slope to depression, white eucayltpus gums, extenisve disturbance, soft to firm, minor cracking clay loam, pH 5.5	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C71	297980 6433659	Sr	Undulating plain, mid-slope 8%, grasses, complete disturbance, soft to firm, minor cracking, clay loam	
C72	298190 6433209	Sr	Undulating plain, mid-slope 9/8%, grasses, complete disturbance, soft to firm, crust, clay loam	-
C73	298499 6433162	Chr2	Crest, grasses, sparse white gum, extensive to complete disturbance, hard, rocks 60-200 mm sandy loam / brown clayey sand, pH 5.5	-
C74	298810 6432983	Chr2	Grazing, gently undulating plain, mid-slope, grasses, complete disturbance, soft to firm with minor cracking, brown clay loam, pH 5.5	-
C75	298800 6433135	Chr2	Lower slope, gully erosion	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C76	298851 6433655	Sr	Mid slope, 5/6%, grasses and wees, semi distrubance, soft to firm, minor cracking, brown clay loam, pH 5.0	
C77	299066 6432604	Chr2	Mid-slope, grasses and eucayltpus species, semi-disturbed, firm, very minor cracking	-
C78	297133 6432859	Vb1	Lower slope, white barked eucayltpus species, semi to extensive disturbance, soft to firm, minor cracking	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C79	293529 6434136	Chr2	Upper to mid slope, sparse mixed woodland, extensive disturbance and gully erosion, firm with cracking.	
C80	294095 6433927	VbShp	Crest, grasses and yellow/white gums, extensive disturbance, firn and cracking	-
C81	294590 6433679	VbShp	Mid -slope, 12%, silverleaf ironbark, semi disturbance, soft to firm, crust	-
C82	294850 6433299	Chb1	Depression 7%, Ironbark, semi disturbance, firm, crust	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C83	295290 6433150	Vb1	Depression, eucayltpus species, semi disturbance, soft to firm, cracking	
C84	297674 6432353	Chr4	Wide depression, sparse tall woodland, extensive disturbance, gully erosion, firm	-
C85	297019 6431589	Chr4	Upper to mid-slope, silver leaf ironbark, semi erosion, hard, minor cracking, sandy loam	-
C86	297169 6432362	Chr4	Mid slope, silver leaf ironbark, sandy loam, hard, nil coarser fragments	-
C87	Check site number not recorded			
C88	Check site number not recorded			
C89	Check site number not recorded			

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C90	296705 6432337	Chr4	Undualting plain, upper slope, 11%, grasses, extensive disturbance, firm, sandy brown loam, pH 5.5	
C91	297253 6432458	Chr4	Upper slope, 14%, grasses, exetensive to complete disturbance, firm, crust	-
C92	299171 6432019	Chr2	Grazing, simple slope, grasses, white barked gums, semi disturbance	-
C93	299433 6431589	Chb1	Grazing, upper slope, silver leaf ironbark, extesnive diturbance	
C94	298077 6428539	Db	Flat plain, cropping, complete disturbance	-
C95	293840 6424768	Db	Flat plain, cropping, complete disturbance	-

Site No.	Location - mE, mN (GDA94 Zone 56H)	Soil Mapping Unit	Comments	Plates
C96	292801 6426284	GSS/1	Mixed vegetaiton including poplar box	

SITE BC1

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chr2	Hunter	299159 mE 6434046 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	50mm hand auger	3/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
Grazing	Previously cleared	Nil Microrelief, disturbance or erosion	Soft, minor cracking, no coarse fragments	A1 0.00 - 0.27 Abrupt	Silty clay loam	Massive to moderate, weak	20% rocks 5-20mm	7.5YR3/3 Dark brown	Dry, rapidly drained	Few, very fine	-	-	-
				B2 0.27 – 0.50	Light clay	Moderate, prismatic peds 5-20mm, weak	10% coarse fragments 2-6mm, 20% at 0.4 - 0.5m depth	5YR4/4 Reddish brown	Dry, Moderately well drained	Few, very fine	-		

SITE BC2

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299164 mE 6434561 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	50mm hand auger	3/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
Grazing, flat plain 0% slope	Grass	Nil Microrelief, disturbance or erosion	Sift to firm, no coarse fragments, no cracking evident	A11 0.10 – 0.30 Abrupt	Silty clay loam	Massive, loose	<2% coarse fragments <10mm	7.5YR3/2 Brown	Dry, Moderately well drained	Few, very fine	-	-	-
				A12 0.30 – 0.60 Gradual	Silty clay loam	Weak <20mm peds, strong	<2% coarse fragments <10mm	7.5YR3/2 Brown	Dry, Moderately well drained	Few, very fine	-		
				A13 0.60 – 0.70 Abrupt	Silty clay loam	Weak <20mm peds, strong	-	7.5YR4/2	Dry, Moderately well drained	Few, very fine	-		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
				B20.70 – 1.00	Medium clay	Moderate <20mm peds, strong	-	7.5YR3/2 Reddish brown	Dry, Moderately well drained	Few, very fine	-		

SITE BC3

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
ChSb1	Hunter	300068 mE 6433667 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	50mm hand auger	3/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
Grazing, mid slope <4%, adjacent to drainage line	Grass	Minor sheet erosion Nil Microrelief or disturbance	Soft, no coarse fragments or cracking	A11 0.00 – 0.30 Abrupt	Silty clay loam	Weak, subangular, soft 5-30mm	Nil	7.5YR4/1 Dark grey No mottles	Dry Well drained	Few, fine	0.05 / 6.5	-	-
				A12 0.30 – 0.50 Abrupt	Silty clay loam	Weak, subangular, soft <20mm	Nil	7.5YR4/1 Dark grey No mottles	Dry Well drained	Few, fine	0.30 / 6.5		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
				B2 0.50 – 0.70	Light clay	Moderate, subangular blocky peds 10-20 mm, strong	20% <2mm coarse fragments (mixed) <2% <5mm black nodules	7.5YR3/2 Dark bown No mottles	Dry Moderately drained	Few, very fine	0.6 / 6.5		

SITE BC4

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299633 mE 6433252 mN	Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	50mm hand auger	3/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
Grazing, upper slope 4%	Cleared with grass	Nil Microrelief, disturbance or erosion No evidence of active disturbance,	Soft, no coarse fragments or cracking	A1 0.00 – 0.10 Abrupt	Clayey sand	Loose, massive	20% rocks 5-20mm	10YR3/1	Dry, rapidly drained	Few, very fine	-	-	-
				B21 0.10 – 0.50 Abrupt	Silty clay loam	Massive to moderate, weak	10% coarse fragments 2-6mm, 20% at 0.4 - 0.5m depth	10YR3/2	Dry, Moderately well drained	Few, very fine	-		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
		but within 100m of farm sheds		B22 0.50 – 0.60	Medium clay	Moderate prismatic peds 5-20mm, weak	-	10YR4/3	Dry, Moderately well drained	-	-		

SITE BC5

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chr2	Hunter	299185 mE 6432234 mN	Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	50mm hand auger	3/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
Grazing, mid slope 8% downhill, 9% uphill	Grass	Nil Microrelief, disturbance or erosion	Soft, no cracking <2% rocks 50-200mm in area	A11 0.00 – 0.12 Abrupt	Clayey sand	Loose, massive	2% rocks 5-10mm	7.5YR3/2 Dark brown	Dry, rapidly drained	Few, very fine	-	-	-
				A12 0.12 – 0.25 Abrupt	Clayey sand	Massive to moderate, weak	10% coarse fragments 2-6mm, 20% at 0.4 - 0.5m depth	7.5YR4/3 Brown	Dry, Moderately well drained	Few, very fine	-		

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
				B2 0.25 – 0.70	Silty clay loam	Moderate prismatic peds 5-20mm, weak	-	5YR4/4 Reddish brown	Dry, Moderately well drained	-	-		

SITE BC6

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chr2	Hunter	299299 mE 6431830 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	50mm hand auger	3/04/2018

Landscape

Surface

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
Grazing, undulating plain, simple slope 9/9% uphill/downhill	Grass	Nil Microrelief, disturbance or erosion	soft with no coarse fragments, minor cracking	A1 0.00 – 0.13 Abrupt	Silty clay loam	Weak, strong, peds <10mm subangular blocky	<2% black nodules	7.5YR3/2 Dark brown Nil mottles/ bleach	Dry Well drained	Few, very fine	-	-	-
				B2 0.13 – 0.50	Medium clay	Weak, strong, peds <20mm subangular blocky	Nil	5YR4/4 Reddish brown Nil mottles/ bleach	Dry Moderately drained	Few, very fine	-		

SITE BC7

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299386 mE 6432728 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	Surface observation and field texture	4/04/2018
Comments	Mid slope 4% Surface texture – silty clay loam				

SITE BC8

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299386 mE 6432728 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	Surface observation and field texture	4/04/2018
Comments	Simple slope 8% Surface texture – silty clay loam				

SITE BC9

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class.:	Site Survey Type:	Survey Date:
Chb1	Hunter	299386 mE 6432728 mN	Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	Surface observation and field texture	4/04/2018
Comments	Upper slope 9% Surface texture – silty clay loam				

SITE BC10

Soil Mapping Unit: Chb1	**Land System (NSW eSPADE):** Hunter	**Location (GDA94 ZONE 56):** 299386 mE 6432728 mN	**Aust. Soil Class.:** Haplic Eutrophic Brown Chromosol; medium, non-gravelly, silty, clayey, deep	**Site Survey Type:** Surface observation and field texture	**Survey Date:** 4/04/2018
Comments	Simple slope 8% Surface texture – silty clay loam				

SITE BC11

Soil Mapping Unit: Chb1	**Land System (NSW eSPADE):** Hunter	**Location (GDA94 ZONE 56):** 299386 mE 6432728 mN	**Aust. Soil Class:** Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	**Site Survey Type:** Surface observation and field texture	**Survey Date:** 4/04/2018
Comments	Simple slope 8% Surface texture – clayey sand				

SITE BC12

Soil Mapping Unit: Chb1	**Land System (NSW eSPADE):** Hunter	**Location (GDA94 ZONE 56):** 299386 mE 6432728 mN	**Aust. Soil Class:** Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	**Site Survey Type:** Surface observation	**Survey Date:** 4/04/2018
Comments	Simple slope 6% Surface texture – clayey sand (fine grains)				

SITE BC13

Soil Mapping Unit: Chb1	**Land System (NSW eSPADE):** Hunter	**Location (GDA94 ZONE 56):** 299386 mE 6432728 mN	**Aust. Soil Class:** Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	**Site Survey Type:** Surface observation and field texture	**Survey Date:** 4/04/2018
Comments	Simple slope 7% Surface texture – clayey sand (fine grains)				

SITE BC14

Soil Mapping Unit: Chr2	**Land System (NSW eSPADE):** Hunter	**Location (GDA94 ZONE 56):** 299273 mE 6433972 mN	**Aust. Soil Class:** Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	**Site Survey Type:** Surface observation and field texture	**Survey Date:** 4/04/2018
Comments	Simple slope 5% Surface texture – clayey sand (fine grains)				

SITE BC15

Soil Mapping Unit:	Land System (NSW eSPADE):	Location (GDA94 ZONE 56):	Aust. Soil Class:	Site Survey Type:	Survey Date:
Chr2	Hunter	299324 mE 6433404 mN	Haplic Eutrophic Brown Chromosol; medium. non-gravelly, sandy, silty, moderate	50mm hand auger	4/04/2018

Landscape

Drainage Line Cutting

Soil Profile

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
Grazing, drainage line, open depressing, 4/4%	Grass	Gully erosion	Hard setting, with coarse fragments	A1 0.00 – 0.20 Abrupt	Clayey sand	Massive to moderate, weak	10% coarse fragments 2-6mm, 20% at 0.4 - 0.5m depth	7.5YR4/3 Brown	Dry, Moderately well drained	Few, very fine	-	-	-

Land use Landform Pattern, Element, Slope	Vegetation	Microrelief Disturbance Erosion	Surface condition, surface rock	Soil Profile Description									
				Horizon Depth (m), Boundary	Texture	Structure, Strength	Inclusions Segregations	Colour, Mottle	Moisture, Drainage	Roots	Depth (m) / Field pH	Sample (m)	Observations
uphill/downhill			<20%, <20mm, no cracking	B2 0.20 – 1.00	Medium clay	Moderate prismatic peds 5-20mm, weak	-	5YR4/4 Reddish brown	Dry, Moderately well drained	-	-		

Appendix D – eSPADE soil profiles

NSW SOIL AND LAND INFORMATION SYSTEM

Soil Profile Report

SITE DETAILS

Site Location:	Roxburgh Road, at road cutting on crest
Profile Details:	Hunter Soil and Land Resources Survey (1005268), Profile 85, collected from a batter by Mr Mark Young on 24 May, 2016
Map Reference:	MGA Grid Reference: Zone 56, 293432E, 6429167N.
Physiography:	hillcrest under woodland grass understorey on sandstone-lithic lithology and used for volun./native pasture. Slope 3.0% (measured, Inclinometer), local relief low (30-90 m), elevation 257.0 m. Surface condition is hard set, profile is mod. well drained, and no salting evident
Vegetation/Land Use:	limited clearing at the site, used for volun./native pasture, with timber/scrub/unused, volun./native pasture and quarry/mining in the general area
Surface Condition:	hard set when described, ground cover is 85%
Erosion/Land Degradation:	erosion at site is none
Soil Hydrology:	profile is moderately permeable and mod. well drained, no free water, run on is low and runoff is moderate
Soil Type:	Acidic Paralithic Leptic Rudosol (ASC), Lithosol (GSG)
Base of observation:	
Profile Field Notes:	

SOIL DESCRIPTION

Layer 0		
0.00 - 0.00 m		
Layer 1	Horizon: A	
0.00 - 0.90 m	Texture:	fine light sandy clay loam
	Colour:	reddish brown (dull reddish brown) (5YR 4/3) [moist] with no recorded mottles
	Structure:	weak pedality (sub-angular blocky, 5 - 10 mm, fabric is rough-faced peds)
	Coarse Fragments:	very few (< 2%), as substrate, weakly weathered, sub-angular tabular, fine gravel (2-6 mm), gravel (6-20 mm),
	Pans:	not evident
	Segregations:	not evident,
	Soil fauna:	Activity is nil
	Cracks/Macropores:	Cracks are nil, macropores are nil

Moisture/Consistence:	dry, disruptive test result was moderately firm force,
Erodibility Tests:	Crumb (EAT) test showed no change,
Field chemical tests:	Field pH is 5.0 (Raupach),
Sample taken:	bulked
Layer Notes:	Hydrophobic

LABORATORY TESTS

None available

For information on laboratory test data and units of measure, please see: Soil survey standard test methods

Report generated on 27/01/2020 at 02:18 PM

To contact us, email: soils@environment.nsw.gov.au

NSW SOIL AND LAND INFORMATION SYSTEM

Soil Technical Report

SITE DETAILS:

Survey:	Hunter Soil and Land Resources (1005268)
Profile:	85
Location:	Roxburgh Road, at road cutting on crest

PROFILE MAP DETAILS:

1:100,000 Mapsheet:		Locational Accuracy:	GPS
MGA Easting:	293432	MGA Northing:	6429167
MGA Zone:	56		

PROFILE DETAILS:

Described by:	Mr Mark Young	Profile Date:	24 May, 2016
Nature of Exposure:	batter	Photo Taken:	both site & profile
Base of observation:		No of Layers:	2

SOIL AND MAP CODES:

Geology Map Code:		Soil Map Code:	cfza
Aust. Soil Classification:	Rudosol, Leptic, Paralithic, Acidic, non gravelly, clay loamy, very shallow, All required data available		
Great Soil Group:	Lithosol	Northcote PPF:	
Soil Taxonomy:		Atlas(Northcote) Code:	
Atlas (A&M) Code:			

TOPOGRAPHY:

Slope:	3% (measured, Inclinometer)		
Elevation:	257.0 m	Aspect:	

LANDFORM:

Site Morphology:	crest	Site Process:	residual
Slope Morphology:	waxing	Local Relief:	low (30-90 m)
Landform Pattern:		Landform Element:	hillcrest
Plan Curvature:		Position in Landform Element:	
Microrelief:		Microrelief depth:	

Microrelief extent:

LITHOLOGY:

Solum PM:	sandstone-lithic	Substrate:	sandstone-lithic
Rock Outcrop:	2% - 10%	Rock Outcrop (BSAL):	
Outcrop Same As:		Substrate Strength:	
Weathering & Alteration:			
Discontinuities:			
Fragment Amount:			

VEGETATION:

Vegetation Formation:	woodland grass understorey
Vegetation Community:	
Growth Form(s):	tree, tussock grass
Crown Separation Ratio:	
Upper Stratum Height:	

SITE CONDITION:

Ground Cover %:	85.00	Site Disturbance:	limited clearing
Current Condition:	hard set	Expected Dry Condition:	
Expected Wet Condition:	hard set	Estimated Effective Rooting Depth:	

LAND USE:

Site:	volun./native pasture	General Area:	timber/scrub/unused, volun./native pasture, quarry/mining
Land Use Vegetation Species:		Prior Land Use:	

HYDROLOGY:

Presence of Free Water:	none	Free Water Depth:	
Run-on:	low	Runoff:	moderate
Permeability:	moderately permeable	Profile Drainage:	mod. well drained
Free Water pH:		Free Water EC:	

EROSION:

Wind exposure:

Erosion Hazard:

SALINITY:

Salinity: no salting evident

Salt Outbreak Mapping:

Salt Outbreak Vegetation Species:

EM Measurement 1 Type:

EM Measurement 1 horizontal:

EM Measurement 1 vertical:

EM Measurement 2 Type:

EM Measurement 2 horizontal:

EM Measurement 2 vertical:

FIELD NOTES:

LAYER 0

Depth: 0.00 - 0.00 m

Layer Notes:

Vesicles:

Ped porosity:

LAYER 1

A horizon

Depth: 0.00 - 0.90 m

Layer Notes: Hydrophobic

TEXTURE: fine light sandy clay loam

COLOUR:

Moist: reddish brown (dull reddish brown) (5YR 4/3)

FIELD CHEMICAL TESTS:

pH: 5.0 (Raupach)

Field EC:

HCl:

H2O2:

AgNO3:

STRUCTURE:

Grade of Pedality: weak pedality

Fabric: rough-faced peds

Dominant Peds: 5 - 10 mm, sub-angular blocky

Subdominant Peds:

Artificial Aggregates:

SOILpak score:

Vesicles:

Ped porosity:

COARSE FRAGMENTS:

Type: as substrate

Amount: very few (< 2%)

Distribution:		Orientation:	
Weathering:	weakly weathered	Shape:	sub-angular tabular
Size:	fine gravel (2-6 mm)		

PANS:

Type:	not evident	Cementation:	
Continuity:		Structure:	

SEGREGATIONS:

Type:	not evident	Amount:	
Strength:		Form:	
Size:			

CONSISTENCE:

Degree of Plasticity:		Stickiness:	
Texture Modifier:		Disruptive Test:	moderately firm force
Shearing Test:		Toughness:	

SOIL WATER STATUS: dry

ERODIBILITY TESTS:

Crumb Test:	no change	Bolus Formation:	
Field Dilatency:			

SAMPLE TAKEN: bulked

LABORATORY TESTS

None available

For information on laboratory test data and units of measure, please see: Soil survey standard test methods

Report generated on 27/01/2020 at 02:19 PM

To contact us, email: soils@environment.nsw.gov.au

NSW SOIL AND LAND INFORMATION SYSTEM

Soil Profile Report

SITE DETAILS

Site Location:	Kayuga Road, approx.70 m NW of Rosebrook Creek
Profile Details:	Hunter Soil and Land Resources Survey (1005268), Profile 82, collected from a batter by Mr Mark Young on 24 May, 2016
Map Reference:	MGA Grid Reference: Zone 56, 300223E, 6429777N.
Physiography:	plain on alluvium lithology and used for improved pasture. Slope 3.0% (estimated), local relief extremely low (< 9m). Surface condition is firm, profile is mod. well drained, erosion hazard is slight, and no salting evident
Vegetation/Land Use:	occasional cultivation and cleared, no cultivation at the site, used for improved pasture, with improved pasture, cropping in the general area
Surface Condition:	firm when described, ground cover is 100%
Erosion/Land Degradation:	slight, erosion at site is none
Soil Hydrology:	profile is moderately permeable and mod. well drained, no free water, run on is low and runoff is low
Soil Type:	Eutrophic Brown Dermosol (ASC), Prairie Soil (GSG)
Base of observation:	layer continues
Profile Field Notes:	Floodplain

SOIL DESCRIPTION

Layer 0		
0.00 - 0.00 m		
	Coarse Fragments:	not evident,
Layer 1	Horizon: A1	
0.00 - 0.15 m	Texture:	silty clay loam
	Colour:	dark brown (brownish black) (7.5YR 3/2) [moist] with not evident mottles, and not evident subdominant mottles
	Structure:	strong pedality (polyhedral, 2 - 5 mm, fabric is rough-faced peds)
	Coarse Fragments:	not evident,
	Pans:	not evident
	Segregations:	not evident,
	Roots:	common (10-25/10x10cm) (Root size <1 mm), many (25-100/10x10cm) (Root size 1-2 mm), few (1-10/10x10cm) (Root size 2-5 mm),

	Soil fauna:	Activity is nil
	Cracks/Macropores:	Cracks are none(width <5 mm), none(width 5-10 mm), none (width 10-20 mm), none(width 20-50 mm), none(width >50 mm), none(unspecified amount), macropores are none(width <1 mm), none(width 1-2 mm), none(width 2-5 mm), none(width >5 mm), none(unspecified amount),
	Moisture/Consistence:	moderately moist, disruptive test result was moderately firm force, shearing test result was crumbly,
	Erodibility Tests:	Crumb (EAT) test showed no change,
	Field chemical tests:	Field pH is 5.5 (Raupach),
	Sample taken:	disturbed
Layer 2	Horizon: B2	
0.15 - 0.40 m	Texture:	light clay
	Colour:	brown (greyish brown) (7.5YR 4/2) [moist] with not evident mottles, and not evident subdominant mottles
	Structure:	strong pedality (polyhedral, 2 - 5 mm, also crumb, < 2 mm, fabric is rough-faced peds)
	Coarse Fragments:	not evident,
	Pans:	not evident
	Segregations:	not evident,
	Roots:	few (1-10/10x10cm) (Root size <1 mm), common (10-25/10x10cm) (Root size 1-2 mm), few (1-10/10x10cm) (Root size 2-5 mm),
	Soil fauna:	Activity is nil
	Cracks/Macropores:	Cracks are none(width <5 mm), none(width 5-10 mm), none (width 10-20 mm), none(width 20-50 mm), none(width >50 mm), none(unspecified amount), macropores are none(width <1 mm), none(width 1-2 mm), none(width 2-5 mm), none(width >5 mm), none(unspecified amount),
	Moisture/Consistence:	moderately moist, disruptive test result was moderately firm force, shearing test result was crumbly,
	Erodibility Tests:	Crumb (EAT) test showed no change,
	Field chemical tests:	Field pH is 6.0 (Raupach),
	Sample taken:	disturbed
	Lower Boundary:	smooth gradual (50-100 mm) boundary to ...
Layer 3	Horizon: B3	
0.40 - 0.80 m	Texture:	light medium clay
	Colour:	brown (greyish brown) (7.5YR 4/2) [moist] with not evident mottles
	Structure:	moderate pedality (polyhedral, 2 - 5 mm, also crumb, < 2 mm, fabric is rough-faced peds)
	Coarse Fragments:	very few (< 2%), as parent material, sub-rounded, gravel (6-20 mm),
	Pans:	not evident
	Segregations:	not evident,
	Roots:	few (1-10/10x10cm) (Root size 2-5 mm),
	Soil fauna:	Activity is nil

Cracks/Macropores:	Cracks are none(width <5 mm), none(width 5-10 mm), none (width 10-20 mm), none(width 20-50 mm), none(width >50 mm), none(unspecified amount), macropores are none(width <1 mm), none(width 1-2 mm), none(width 2-5 mm), none(width >5 mm), none(unspecified amount),
Moisture/Consistence:	moderately moist, disruptive test result was very weak force, shearing test result was crumbly,
Erodibility Tests:	Crumb (EAT) test showed no change,
Field chemical tests:	Field pH is 6.5 (Raupach),
Sample taken:	disturbed

LABORATORY TESTS

None available

For information on laboratory test data and units of measure, please see: Soil survey standard test methods

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NSW SOIL AND LAND INFORMATION SYSTEM

Soil Technical Report

SITE DETAILS:

Survey:	Hunter Soil and Land Resources (1005268)
Profile:	82
Location:	Kayuga Road, approx.70 m NW of Rosebrook Creek

PROFILE MAP DETAILS:

1:100,000 Mapsheet:		Locational Accuracy:	GPS
MGA Easting:	300223	MGA Northing:	6429777
MGA Zone:	56		

PROFILE DETAILS:

Described by:	Mr Mark Young	Profile Date:	24 May, 2016
Nature of Exposure:	batter	Photo Taken:	both site & profile
Base of observation:	layer continues	No of Layers:	4

SOIL AND MAP CODES:

Geology Map Code:		Soil Map Code:	huz
Aust. Soil Classification:	Dermosol, Brown, Eutrophic, Class Undetermined, medium, non gravelly, clay loamy, clayey, very deep, No data available but sufficient kr		
Great Soil Group:	Prairie Soil	Northcote PPF:	
Soil Taxonomy:		Atlas(Northcote) Code:	
Atlas (A&M) Code:			

TOPOGRAPHY:

Slope:	3% (estimated)		
Elevation:		Aspect:	

LANDFORM:

Site Morphology:	flat	Site Process:	alluvial
Slope Morphology:		Local Relief:	extremely low (< 9m)
Landform Pattern:		Landform Element:	plain
Plan Curvature:		Position in Landform Element:	
Microrelief:		Microrelief depth:	

Microrelief extent:

LITHOLOGY:

Solum PM:	alluvium	Substrate:	alluvium
Rock Outcrop:	Nil	Rock Outcrop (BSAL):	
Outcrop Same As:		Substrate Strength:	
Weathering & Alteration:			
Discontinuities:			
Fragment Amount:			

VEGETATION:

Vegetation Formation:

Vegetation Community:

Growth Form(s):

Crown Separation Ratio:

Upper Stratum Height:

SITE CONDITION:

Ground Cover %:	100.00	Site Disturbance:	occasional cultivation, cleared, no cultivation
Current Condition:	firm	Expected Dry Condition:	
Expected Wet Condition:		Estimated Effective Rooting Depth:	

LAND USE:

Site:	improved pasture	General Area:	improved pasture, cropping
Land Use Vegetation Species:		Prior Land Use:	

HYDROLOGY:

Presence of Free Water:	none	Free Water Depth:	
Run-on:	low	Runoff:	low
Permeability:	moderately permeable	Profile Drainage:	mod. well drained
Free Water pH:		Free Water EC:	

EROSION:

Wind exposure:

Erosion Hazard: slight

SALINITY:

Salinity: no salting evident

Salt Outbreak Mapping:

Salt Outbreak Vegetation Species:

EM Measurement 1 Type:

EM Measurement 1 horizontal:

EM Measurement 1 vertical:

EM Measurement 2 Type:

EM Measurement 2 horizontal:

EM Measurement 2 vertical:

FIELD NOTES: Floodplain

LAYER 0

Depth: 0.00 - 0.00 m

Layer Notes:

Vesicles:

Ped porosity:

COARSE FRAGMENTS:

Type: not evident

Amount:

Distribution:

Orientation:

Weathering:

Shape:

Size:

LAYER 1 A1 horizon

Depth: 0.00 - 0.15 m

Layer Notes:

TEXTURE: silty clay loam

COLOUR:

Moist: dark brown (brownish black) (7.5YR 3/2)

MOTTLES:

Dominant Mottles:

Type: not evident

Colour:

Contrast:

Abundance:

Subdominant Mottles:

Type: not evident

Colour:

Contrast:

Abundance:

FIELD CHEMICAL TESTS:

pH:	5.5 (Raupach)	Field EC:	
HCl:		H2O2:	
AgNO3:			

STRUCTURE:

Grade of Pedality:	strong pedality	Fabric:	rough-faced peds
Dominant Peds:	2 - 5 mm, polyhedral	Subdominant Peds:	
Artificial Aggregates:		SOILpak score:	
Vesicles:		Ped porosity:	

COARSE FRAGMENTS:

Type:	not evident	Amount:	
Distribution:		Orientation:	
Weathering:		Shape:	
Size:			

PANS:

Type:	not evident	Cementation:	
Continuity:		Structure:	

SEGREGATIONS:

Type:	not evident	Amount:	
Strength:		Form:	
Size:			

ROOTS:

<1 mm size:	common (10-25/10x10cm)	1-2 mm size:	many (25-100/10x10cm)
2-5 mm size:	few (1-10/10x10cm)	>5 mm size:	

CRACKS AND MACROPORES:

Cracks:

<5 mm width:	none	5-10 mm width:	none
10-20 mm width:	none	20-50 mm width:	none
>50 mm width:	none	Unspecified width:	none

Macropores:

<1 mm size:	none	1-2 mm size:	none
2-5 mm size:	none	>5 mm size:	none
Unspecified size:	none		

CONSISTENCE:

Degree of Plasticity:		Stickiness:	
Texture Modifier:		Disruptive Test:	moderately firm force
Shearing Test:	crumbly	Toughness:	

SOIL WATER STATUS: moderately moist

ERODIBILITY TESTS:

Crumb Test: no change Bolus Formation:

Field Dilatency:

SAMPLE TAKEN: disturbed

BOUNDARY:

Distinctiveness: clear (20-50 mm) Shape:

LAYER 2 B2 horizon

Depth: 0.15 - 0.40 m

Layer Notes:

TEXTURE: light clay

COLOUR:

Moist: brown (greyish brown) (7.5YR 4/2)

MOTTLES:

Dominant Mottles:

Type: not evident Colour:

Contrast: Abundance:

Subdominant Mottles:

Type: not evident Colour:

Contrast: Abundance:

FIELD CHEMICAL TESTS:

pH: 6.0 (Raupach) Field EC:

HCl: H2O2:

AgNO3:

STRUCTURE:

Grade of Pedality: strong pedality Fabric: rough-faced peds

Dominant Peds: 2 - 5 mm, polyhedral Subdominant Peds: < 2 mm, crumb

Artificial Aggregates: SOILpak score:

Vesicles: Ped porosity:

COARSE FRAGMENTS:

Type: not evident Amount:

Distribution: Orientation:

Weathering: Shape:

Size:

PANS:

Type: not evident Cementation:

Continuity:		Structure:	

SEGREGATIONS:

Type:	not evident	Amount:	
Strength:		Form:	
Size:			

ROOTS:

<1 mm size:	few (1-10/10x10cm)	1-2 mm size:	common (10-25/10x10cm)
2-5 mm size:	few (1-10/10x10cm)	>5 mm size:	

CRACKS AND MACROPORES:

Cracks:

<5 mm width:	none	5-10 mm width:	none
10-20 mm width:	none	20-50 mm width:	none
>50 mm width:	none	Unspecified width:	none

Macropores:

<1 mm size:	none	1-2 mm size:	none
2-5 mm size:	none	>5 mm size:	none
Unspecified size:	none		

CONSISTENCE:

Degree of Plasticity:		Stickiness:	
Texture Modifier:		Disruptive Test:	moderately firm force
Shearing Test:	crumbly	Toughness:	

SOIL WATER STATUS: moderately moist

ERODIBILITY TESTS:

Crumb Test:	no change	Bolus Formation:	
Field Dilatency:			

SAMPLE TAKEN: disturbed

BOUNDARY:

Distinctiveness:	gradual (50-100 mm)	Shape:	smooth

LAYER 3 B3 horizon

Depth: 0.40 - 0.80 m

Layer Notes:

TEXTURE: light medium clay

COLOUR:

Moist: brown (greyish brown) (7.5YR 4/2)

MOTTLES:

Dominant Mottles:

Type:	not evident	Colour:	
Contrast:		Abundance:	

FIELD CHEMICAL TESTS:

pH:	6.5 (Raupach)	Field EC:	
HCl:		H2O2:	
AgNO3:			

STRUCTURE:

Grade of Pedality:	moderate pedality	Fabric:	rough-faced peds
Dominant Peds:	2 - 5 mm, polyhedral	Subdominant Peds:	< 2 mm, crumb
Artificial Aggregates:		SOILpak score:	
Vesicles:		Ped porosity:	

COARSE FRAGMENTS:

Type:	as parent material	Amount:	very few (< 2%)
Distribution:		Orientation:	
Weathering:		Shape:	sub-rounded
Size:	gravel (6-20 mm)		

PANS:

Type:	not evident	Cementation:	
Continuity:		Structure:	

SEGREGATIONS:

Type:	not evident	Amount:	
Strength:		Form:	
Size:			

ROOTS:

<1 mm size:		1-2 mm size:	
2-5 mm size:	few (1-10/10x10cm)	>5 mm size:	

CRACKS AND MACROPORES:

Cracks:

<5 mm width:	none	5-10 mm width:	none
10-20 mm width:	none	20-50 mm width:	none
>50 mm width:	none	Unspecified width:	none

Macropores:

<1 mm size:	none	1-2 mm size:	none
2-5 mm size:	none	>5 mm size:	none
Unspecified size:	none		

CONSISTENCE:

Degree of Plasticity:		Stickiness:	
Texture Modifier:		Disruptive Test:	very weak force

Shearing Test:	crumbly	Toughness:
SOIL WATER STATUS:	moderately moist	
ERODIBILITY TESTS:		
Crumb Test:	no change	Bolus Formation:
Field Dilatency:		
SAMPLE TAKEN:	disturbed	
BOUNDARY:		
Distinctiveness:	gradual (50-100 mm)	Shape:

LABORATORY TESTS

None available

For information on laboratory test data and units of measure, please see: Soil survey standard test methods

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Appendix E – Laboratory certificates

ESSA Pty Ltd /EAL NATA (ASPAC certified)

For Info Refer ESSA Pty Ltd
PO Box 442 Sunnybank Q 4109

Phone: 0403245560

email: e.s.s.a@bigpond.net.au

References: I8824 Sheet 1 of 4

Date Received: 10/12/2019
Date Completed: 10/01/2020

FINAL REPORT

Project:
Project -20MP

All results in this report relate only to the items tested. Results are expressed on an "as received basis".

Client Name: GT Environmental
Contact: Mr Reece Mc Cann
Sample Type: Soil

Number of samples: 55 Tested

ESSA /EAL Pty Ltd **(NATA, ASPAC Approved)**

Soil Analysis Report
Batch Numbers: I8824

Client: GTE 20MP- Results Page 1 of 4

ESSA Ref	field ref	Soil pH	Soil EC	Soil Cl	Exch.Ca	Exch. Mg	Exch.K	Exch. Na	CEC	ESP	Ca/Mg	Cation
	depth (m)	H20	dS/m	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%Na/CEC	Ratio	Method
i8824/1	1 0-0.080	5.79	0.042	23	4.0	1.5	0.5	0.08	6.2	1.3	2.8	15D3
i8824/2	1 0.2-0.30	5.58	0.052	42	2.3	1.2	0.3	0.17	4.1	4.0	1.9	15D3
i8824/3	1 0.5-0.60	5.74	0.078	33	8.5	5.4	0.3	0.82	16	5.3	1.6	15D3
i8824/4	1 0.7-0.80	7.91	0.164	37	5.2	2.1	0.3	0.43	7.97	5.4	2.5	15C1
i8824/5	2-0.0-0.10	5.47	0.199	87	10.9	3.3	1.4	0.26	16	1.6	3.4	15D3
i8824/6	2-0.20-0.30	7.67	0.326	165	7.7	4.2	1.4	0.27	13.64	2.0	1.8	15C1
i8824/7	2-0.54-0.60	8.50	0.411	472	9.9	6.3	0.9	0.40	17.46	2.3	1.6	15C1
i8824/8	2-0.70-0.80	8.60	0.637	843	8.7	7.1	0.4	0.75	16.96	4.4	1.2	15C1
i8824/9	2-0.90-1.00	8.68	0.646	1,014	8.1	7.2	0.4	0.60	16.35	3.6	1.1	15C1
i8824/10	3-0.0-0.10	7.07	0.070	53	10.0	13.8	1.8	0.19	26	0.8	0.73	15D3
i8824/11	3-0.20-0.30	7.34	0.057	42	5.6	9.5	1.1	0.21	16.42	1.3	0.6	15C1
i8824/12	3-0.50-0.60	8.84	0.558	764	0.9	1.8	0.1	0.24	3.02	7.9	0.5	15C1
i8824/13	3-0.75-0.85	9.25	0.292	287	3.1	10.3	0.5	0.83	14.69	5.6	0.3	15C1
i8824/14	4-0.0-0.10	6.65	0.061	43	7.1	6.6	0.7	0.17	15	1.2	1.1	15D3
i8824/15	4-0.20-0.30	7.18	0.248	386	6.9	14.8	0.4	1.7	24	7.3	0.47	15D3
i8824/16	4-0.50-0.60	9.07	0.160	67	3.8	8.5	0.5	0.36	13.16	2.8	0.4	15C1
i8824/17	4-0.72-0.80	9.07	0.607	857	1.6	4.4	0.2	0.43	6.70	6.4	0.4	15C1
i8824/18	4-0.90-1.00	9.12	0.616	908	1.6	4.6	0.2	0.43	6.82	6.3	0.3	15C1
i8824/19	5-0.0-0.10	6.39	0.172	118	12.6	5.6	1.8	0.59	21	2.9	2.3	15D3
i8824/20	5-0.10-0.20	6.52	0.076	65	8.1	4.0	1.3	0.20	14	1.5	2.0	15D3
i8824/21	5-0.22-0.30	6.51	0.130	170	8.7	4.4	1.2	0.34	15	2.3	2.0	15D3
i8824/22	5-0.50-0.60	6.84	0.406	576	9.9	4.6	0.9	0.31	16	2.0	2.1	15D1
i8824/23	5-0.81-0.91	7.36	0.735	959	6.3	3.5	0.5	0.46	10.77	4.3	1.8	15C1
i8824/24	5-0.93-1.00	7.60	0.864	1,207	6.1	3.2	0.4	0.43	10.21	4.2	1.9	15C1
i8824/25	8-0.0-0.10	5.52	0.051	21	3.8	0.9	0.3	<0.065	5.4	1.1	4.1	15D3
i8824/26	8-0.20-0.30	6.24	0.036	27	5.4	1.0	<0.12	0.11	6.6	1.7	5.5	15D3
i8824/27	8-0.36-0.46	6.29	0.056	57	5.4	1.4	<0.12	0.18	7.0	2.5	3.9	15D3
i8824/28	8-0.47-0.52	6.43	0.051	50	6.9	1.7	<0.12	0.23	9.0	2.6	4.1	15D3
i8824/29	9-0.0-0.10	5.26	0.418	293	10.0	2.1	1.0	0.11	13	0.9	4.7	15D1
i8824/30	9-0.20-0.30	8.43	0.142	65	10.0	1.7	0.7	0.13	12.58	1.0	5.9	15C1
i8824/31	9-0.50-0.60	8.88	0.122	55	7.0	1.0	0.3	0.15	8.45	1.8	7.3	15C1
i8824/32	9-0.70-0.75	8.88	0.179	162	5.9	0.9	0.3	0.19	7.29	2.7	6.3	15C1
i8824/33	9-0.90-1.00	8.76	0.235	246	6.9	1.3	0.3	0.18	8.69	2.1	5.4	15C1
i8824/34	11-0.0-0.10	6.47	0.103	54	14.6	7.8	1.8	0.14	24	0.6	1.9	15D3
i8824/35	11-0.20-0.30	7.61	0.201	100	13.6	11.0	1.6	0.43	26.53	1.6	1.2	15C1
i8824/36	11-0.50-0.60	9.06	0.169	179	6.9	7.3	0.3	0.31	14.78	2.1	0.9	15C1
i8824/37	11-0.70-0.80	9.17	0.220	262	4.8	6.4	0.3	0.40	11.95	3.3	0.8	15C1
i8824/38	11-0.90-1.00	9.31	0.362	397	6.6	11.7	0.5	1.26	19.96	6.3	0.6	15C1
i8824/39	12-0.0-0.10	6.79	0.146	58	9.3	5.4	0.7	0.11	15	0.7	1.7	15D3
i8824/40	12-0.20-0.30	8.88	0.154	62	9.8	9.5	0.5	0.38	20.19	1.9	1.0	15C1
i8824/41	12-0.50-0.60	9.08	0.220	176	6.3	9.5	0.4	0.36	16.48	2.2	0.7	15C1
i8824/42	12-0.70-0.80	9.15	0.310	317	4.4	8.5	0.4	0.50	13.76	3.6	0.5	15C1
i8824/43	12-0.90-1.00	9.24	0.357	404	5.3	13.5	0.4	0.95	20.24	4.7	0.4	15C1
i8824/44	13-0.0-0.10	6.05	0.035	25	3.9	1.0	0.5	<0.065	5.5	1.0	3.9	15D3
i8824/45	13-0.20-0.30	6.14	0.011	12	2.0	0.6	0.2	<0.065	2.9	1.5	3.6	15D3
i8824/46	13-0.55-0.65	7.03	0.029	25	6.0	2.5	0.2	0.21	8.9	2.3	2.4	15D3
i8824/47	13-0.70-0.80	7.25	0.039	36	8.1	3.7	0.2	0.34	12	2.7	2.2	15D3
i8824/48	13-0.90-1.00	7.49	0.043	53	4.6	2.3	0.3	0.16	7.30	2.2	2.0	15C1
i8824/49	16-0.00-0.10	6.97	0.127	33	18.2	11.8	1.4	0.70	32	2.2	1.5	15D3
i8824/50	16-0.20-0.30	8.62	0.576	580	10.3	11.5	0.8	1.60	24.12	6.6	0.9	15C1
i8824/51	16-0.50-0.60	8.81	1.174	1,599	5.4	9.6	0.5	1.82	17.36	2.7	0.6	15C1
i8824/52	16-0.80-0.90	8.99	0.963	1,249	5.8	12.1	0.5	2.33	20.68	2.3	0.5	15C1
i8824/53	20-0.00-0.10	6.47	0.103	53	11.7	3.0	1.4	0.08	16	8.7	3.9	15D3
i8824/54	20-0.20-0.30	8.28	0.197	44	13.0	4.9	1.3	0.10	19.27	6.9	2.7	15C1
i8824/55	20-0.50-0.60	8.76	0.157	49	10.2	4.6	0.7	0.08	15.64	4.8	2.2	15C1

ESSA Ref	field ref	Soil pH	Soil EC	Soil Cl	Exch.Ca	Exch. Mg	Exch.K	Exch. Na	CEC	ESP	Ca/Mg	Cation
	depth (m)	H20	dS/m	mg/kg	meq/100g	meq/100 g	meq/100g	meq/100g	meq/100g	%Na/CEC	Ratio	Method

ESSA Ref	field ref	Zinc	Mn	Iron	Copper	Boron	Silicon C	Tot O C Org M	Org Matter	P Colwell	P Olsen	PBI Ratio
	depth (m)	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%	mg/kg	mg/kg	
i8824/1	1 0-0.080	2.7	40	179	0.39	0.32	48	3.2	0.0	16	4.7	30
i8824/2	1 0.2-0.30	0.54	18	62	0.24	0.18	28	0.92	0.0	9.8	2.6	29
i8824/3	1 0.5-0.60	<0.5	2.2	355	0.36	0.42	61	0.45	0.0	8.2	1.8	152
i8824/4	1 0.7-0.80	<0.5	12	287	0.16	0.17	9.8	0.28	0.0	9.2	2.4	68
i8824/5	2-0.0-0.10	11	62	309	1.1	0.70	90	6.4	0.0	31	9.6	45
i8824/6	2-0.20-0.30	0.76	8.1	31	0.83	0.42	17	1.5	0.0	11	3.7	89
i8824/7	2-0.54-0.60	1.5	5.8	19	0.47	0.48	11	1.4	0.0	12	4.5	76
i8824/8	2-0.70-0.80	<0.5	2.5	8.2	0.40	0.48	9.4	0.7	0.0	9.2	2.9	69
i8824/9	2-0.90-1.00	<0.5	2.1	8.1	0.49	0.39	9.7	0.9	0.0	9.5	2.6	69
i8824/10	3-0.0-0.10	0.98	22	29	2.0	0.54	46	1.8	0.0	11	3.9	72
i8824/11	3-0.20-0.30	<0.5	15	17	1.7	0.52	32	1.1	0.0	12	2.3	68
i8824/12	3-0.50-0.60	0.50	7.2	9.8	0.89	0.47	7.2	0.9	0.0	9.2	1.9	153
i8824/13	3-0.75-0.85	<0.5	5.1	7.4	0.64	0.32	8.8	2.6	0.0	12	3.0	73
i8824/14	4-0.0-0.10	7.8	23	65	0.55	0.48	69	3.6	0.0	14	4.5	38
i8824/15	4-0.20-0.30	0.94	11	22	1.00	0.48	25	1.1	0.0	8.9	2.0	89
i8824/16	4-0.50-0.60	<0.5	5.3	6.1	0.60	0.31	9.1	0.50	0.0	10	2.2	58
i8824/17	4-0.72-0.80	<0.5	2.4	5.4	0.54	0.31	5.4	0.53	0.0	9.2	2.0	109
i8824/18	4-0.90-1.00	0.71	3.1	5.6	0.66	0.23	8.1	1.3	0.0	8.5	2.2	77
i8824/19	5-0.0-0.10	17	48	351	2.0	0.58	70	7.2	0.0	49	19	50
i8824/20	5-0.10-0.20	1.1	13	32	0.86	0.48	51	2.0	0.0	18	5.1	54
i8824/21	5-0.22-0.30	1.5	16	21	1.8	0.53	47	1.6	0.0	13	4.0	57
i8824/22	5-0.50-0.60	3.3	12	1,412	2.9	0.78	24	1.0	0.0	9.8	2.6	87
i8824/23	5-0.81-0.91	2.5	6.3	760	2.0	0.81	19	0.7	0.0	11	2.5	80
i8824/24	5-0.93-1.00	2.8	8.7	18	0.88	0.73	24	1.5	0.0	12	4.0	65
i8824/25	8-0.0-0.10	2.1	99	197	0.32	0.39	33	3.0	0.0	18	4.7	33
i8824/26	8-0.20-0.30	<0.5	48	39	<0.1	0.21	32	0.84	0.0	11	2.6	29
i8824/27	8-0.36-0.46	<0.5	44	16	0.14	0.19	42	0.69	0.0	9.5	2.3	32
i8824/28	8-0.47-0.52	<0.5	44	15	<0.1	0.23	47	0.54	0.0	8.9	2.8	47
i8824/29	9-0.0-0.10	4.2	65	333	0.38	1.2	68	5.4	0.0	24	4.6	33
i8824/30	9-0.20-0.30	0.52	7.7	8.4	0.16	0.25	12	1.0	0.0	9.2	2.8	75
i8824/31	9-0.50-0.60	<0.5	4.7	4.0	0.14	0.32	11	0.9	0.0	11	2.4	270
i8824/32	9-0.70-0.75	0.51	5.0	3.5	<0.1	0.33	11	1.5	0.0	8.5	2.7	372
i8824/33	9-0.90-1.00	0.73	6.0	5.5	0.12	0.40	14	1.0	0.0	9.2	2.8	362
i8824/34	11-0.0-0.10	2.9	40	61	1.4	0.57	83	5.3	0.0	26	8.7	66
i8824/35	11-0.20-0.30	<0.5	14	19	1.1	0.48	16	1.5	0.0	9.2	2.4	139
i8824/36	11-0.50-0.60	<0.5	2.6	4.3	0.22	0.41	6.9	1.1	0.0	8.9	1.9	45
i8824/37	11-0.70-0.80	<0.5	2.0	3.5	0.21	0.50	7.1	1.3	0.0	7.9	2.0	49
i8824/38	11-0.90-1.00	<0.5	1.4	4.0	0.33	0.57	12	0.7	0.0	9.2	1.8	35
i8824/39	12-0.0-0.10	1.3	45	29	0.84	0.37	53	2.6	0.0	14	4.6	30
i8824/40	12-0.20-0.30	<0.5	7.4	4.8	0.67	<0.1	24	0.8	0.0	8.5	2.0	86
i8824/41	12-0.50-0.60	<0.5	3.7	4.4	0.63	0.18	5.6	0.6	0.0	7.9	2.0	85
i8824/42	12-0.70-0.80	<0.5	2.1	4.3	0.39	0.47	7.9	0.6	0.0	7.9	2.2	73
i8824/43	12-0.90-1.00	<0.5	2.0	4.4	0.40	0.51	8.4	1.2	0.0	7.5	2.0	73
i8824/44	13-0.0-0.10	3.9	52	134	0.37	0.43	43	2.4	0.0	13	4.9	35
i8824/45	13-0.20-0.30	<0.5	10	28	0.24	0.18	31	0.49	0.0	7.9	2.1	26
i8824/46	13-0.55-0.65	<0.5	2.5	56	0.47	0.26	54	0.32	0.0	8.5	1.9	54
i8824/47	13-0.70-0.80	0.50	1.8	18	0.48	0.41	47	0.36	0.0	9.5	1.8	66
i8824/48	13-0.90-1.00	<0.5	1.2	17	0.29	0.68	67	3.0	0.0	8.5	4.7	88
i8824/49	16-0.00-0.10	<0.5	5.2	11	0.60	0.33	38	0.2	0.0	9.8	2.0	22
i8824/50	16-0.20-0.30	<0.5	1.8	6.2	0.59	0.32	7.3	1.5	0.0	11	2.7	130
i8824/51	16-0.50-0.60	<0.5	1.7	5.5	0.46	0.58	4.7	1.0	0.0	9.5	1.8	133
i8824/52	16-0.80-0.90	4.3	61	79	1.0	0.66	6.6	0.8	0.0	13	2.2	93
i8824/53	20-0.00-0.10	4.6	64	57	1.1	0.45	70	4.2	0.0	15	6.0	50
i8824/54	20-0.20-0.30	<0.5	9.3	8.2	1.1	0.32	8.2	1.5	0.0	9.5	2.6	133
i8824/55	20-0.50-0.60	<0.5	5.4	4.7	0.87	0.48	6.3	3.1	0.0	10	2.4	137

ESSA Ref	field ref	Soil pH	Soil EC	Soil Cl	Exch.Ca	Exch. Mg	Exch.K	Exch. Na	CEC	ESP	Ca/Mg	Cation
	depth (m)	H20	dS/m	mg/kg	meq/100g	meq/100 g	meq/100g	meq/100g	meq/10 0g	%Na/CE C	Ratio	Method

ESSA Ref	field ref	Tot S	Soil pH CaCl2	Soil pH H2O	Fizz Hcl	Emerson	Tot Nitrogen	Nitrate N	Sulfate SO4S
	depth (m)	mg/kg	0.01M		Y/N	No.	%	mg/kg	%
i8824/1	1 0-0.080	193	4.9	5.79	N	5	0.20	3.0	6.8
i8824/2	1 0.2-0.30	75	4.7	5.58	N	5	0.07	4.2	12
i8824/3	1 0.5-0.60	110	4.7	5.74	N	5	0.04	0.57	36
i8824/4	1 0.7-0.80	<50	7.2	7.91	N	5	0.04	0.61	16
i8824/5	2-0.0-0.10	583	4.9	5.47	N	5	0.50	37	30
i8824/6	2-0.20-0.30	210	7.2	7.67	N	5	0.13	15	36
i8824/7	2-0.54-0.60	235	7.9	8.50	Y	5	0.12	9.2	68
i8824/8	2-0.70-0.80	202	8.0	8.60	Y	5	0.07	2.5	90
i8824/9	2-0.90-1.00	131	8.1	8.68	Y	5	0.06	2.2	48
i8824/10	3-0.0-0.10	252	6.1	7.07	N	5	0.17	2.6	9.0
i8824/11	3-0.20-0.30	157	6.4	7.34	N	3	0.12	2.6	6.0
i8824/12	3-0.50-0.60	141	8.2	8.84	Y	2	0.09	0.86	28
i8824/13	3-0.75-0.85	100	8.4	9.25	Y	1	0.07	1.2	22
i8824/14	4-0.0-0.10	261	6.1	6.65	N	3	0.26	3.3	8.0
i8824/15	4-0.20-0.30	129	6.5	7.18	N	2	0.11	0.93	16
i8824/16	4-0.50-0.60	75	8.3	9.07	Y	2	0.07	1.0	4.8
i8824/17	4-0.72-0.80	111	8.4	9.07	Y	2	0.08	0.79	29
i8824/18	4-0.90-1.00	69	8.5	9.12	Y	2	0.08	0.98	23
i8824/19	5-0.0-0.10	696	5.8	6.39	N	5	0.60	14	24
i8824/20	5-0.10-0.20	182	5.7	6.52	N	5	0.14	3.6	14
i8824/21	5-0.22-0.30	171	5.8	6.51	N	5	0.11	3.0	25
i8824/22	5-0.50-0.60	190	6.5	6.84	N	5	0.09	1.5	68
i8824/23	5-0.81-0.91	169	7.0	7.36	N	5	0.08	1.7	115
i8824/24	5-0.93-1.00	236	7.2	7.60	N	5	0.13	2.7	113
i8824/25	8-0.0-0.10	205	4.7	5.52	N	5	0.18	7.8	11
i8824/26	8-0.20-0.30	93	5.4	6.24	N	5	0.08	6.2	5.7
i8824/27	8-0.36-0.46	85	5.5	6.29	N	5	0.06	5.5	11
i8824/28	8-0.47-0.52	101	5.5	6.43	N	5	0.06	2.8	15
i8824/29	9-0.0-0.10	571	4.8	5.26	N	5	0.39	46	106
i8824/30	9-0.20-0.30	131	7.7	8.43	Y	5	0.08	2.8	10
i8824/31	9-0.50-0.60	133	7.9	8.88	Y	5	0.05	1.3	9.9
i8824/32	9-0.70-0.75	138	8.0	8.88	Y	5	0.06	1.1	28
i8824/33	9-0.90-1.00	159	7.9	8.76	Y	5	0.06	1.5	40
i8824/34	11-0.0-0.10	455	5.8	6.47	N	5	0.41	13	11
i8824/35	11-0.20-0.30	164	7.0	7.61	N	3	0.14	12	13
i8824/36	11-0.50-0.60	51	8.2	9.06	Y	3	0.07	1.9	7.8
i8824/37	11-0.70-0.80	<50	8.3	9.17	Y	3	0.06	1.3	7.9
i8824/38	11-0.90-1.00	51	8.4	9.31	Y	2	0.07	1.6	13
i8824/39	12-0.0-0.10	235	6.3	6.79	N	5	0.20	31	17
i8824/40	12-0.20-0.30	83	8.1	8.88	Y	3	0.09	1.7	7.8
i8824/41	12-0.50-0.60	73	8.3	9.08	Y	3	0.07	1.2	15
i8824/42	12-0.70-0.80	64	8.4	9.15	Y	3	0.07	1.6	23
i8824/43	12-0.90-1.00	78	8.4	9.24	Y	3	0.06	1.6	20
i8824/44	13-0.0-0.10	198	5.1	6.05	N	5	0.19	2.7	4.7
i8824/45	13-0.20-0.30	<50	4.9	6.14	N	5	0.05	1.0	<1
i8824/46	13-0.55-0.65	<50	6.0	7.03	N	5	0.04	0.57	3.3
i8824/47	13-0.70-0.80	<50	6.2	7.25	N	5	0.05	0.52	5.3
i8824/48	13-0.90-1.00	261	6.5	7.49	N	5	0.24	0.54	5.0
i8824/49	16-0.00-0.10	<50	6.3	6.97	N	3	0.03	13	27
i8824/50	16-0.20-0.30	183	7.9	8.62	Y	3	0.12	6.5	88
i8824/51	16-0.50-0.60	431	8.3	8.81	Y	3	0.07	2.0	67
i8824/52	16-0.80-0.90	267	8.4	8.99	Y	3	0.04	15	13
i8824/53	20-0.00-0.10	316	6.1	6.47	N	5	0.33	15	8.2
i8824/54	20-0.20-0.30	80	7.7	8.28	Y	5	0.11	2.8	5.5
i8824/55	20-0.50-0.60	77	8.0	8.76	Y	5	0.08	2.2	7.7

ESSA Ref	field ref	Soil pH	Soil EC	Soil Cl	Exch.Ca	Exch. Mg	Exch.K	Exch. Na	CEC	ESP	Ca/Mg	Cation
	depth (m)	H20	dS/m	mg/kg	meq/100g	meq/100 g	meq/100g	meq/100g	meq/10 0g	%Na/CE C	Ratio	Method

Lab No	Sample No	Moisture	R1	Gravel	Sand	Sand	Silt	Silt	Clay
	Depth (m)	Content	Ratio	> 2 mm	> 50 µm	> 20 µm	2−50 µm	2−20 µm	< 2 µm
					<2mm	<2mm	<2mm	<2mm	<2mm
i8824/1	1 0-0.080	2	0.38	0	60	71	23	11	17
i8824/2	1 0.2-0.30	3	0.54	1	59	68	21	13	19
i8824/3	1 0.5-0.60	14	0.56	12	33	38	9	4	58
i8824/4	1 0.7-0.80	7	0.65	1	62	66	9	5	29
i8824/5	2-0.0-0.10	5	0.43	7	37	59	38	17	25
i8824/6	2-0.20-0.30	12	0.59	12	16	28	25	12	60
i8824/7	2-0.54-0.60	8	0.55	12	22	40	38	21	40
i8824/8	2-0.70-0.80	8	0.55	6	93	94	4	2	3
i8824/9	2-0.90-1.00	8	0.58	6	31	45	36	22	33
i8824/10	3-0.0-0.10	10	0.55	0	8	10	25	23	67
i8824/11	3-0.20-0.30	10	0.63	1	18	25	27	20	55
i8824/12	3-0.50-0.60	11	0.63	0	16	18	25	22	59
i8824/13	3-0.75-0.85	8	0.71	0	25	32	32	25	43
i8824/14	4-0.0-0.10	5	0.52	2	38	52	36	22	26
i8824/15	4-0.20-0.30	11	0.69	0	18	26	27	20	54
i8824/16	4-0.50-0.60	7	0.65	2	33	44	27	17	39
i8824/17	4-0.72-0.80	11	0.78	10	14	17	29	26	57
i8824/18	4-0.90-1.00	11	0.71	6	12	15	30	27	58
i8824/19	5-0.0-0.10	7	0.55	13	23	35	38	26	39
i8824/20	5-0.10-0.20	7	0.62	1	24	29	26	21	51
i8824/21	5-0.22-0.30	8	0.69	0	13	16	27	23	61
i8824/22	5-0.50-0.60	10	0.61	16	10	12	22	20	68
i8824/23	5-0.81-0.91	9	0.70	3	21	28	26	19	53
i8824/24	5-0.93-1.00	9	0.55	0	19	27	27	19	54
i8824/25	8-0.0-0.10	2	0.51	0	67	70	14	10	20
i8824/26	8-0.20-0.30	4	0.60	0	66	74	18	9	16
i8824/27	8-0.36-0.46	6	0.65	2	55	62	16	9	29
i8824/28	8-0.47-0.52	7	0.65	1	59	64	13	8	28
i8824/29	9-0.0-0.10	4	0.46	5	62	69	19	13	19
i8824/30	9-0.20-0.30	7	0.56	11	51	56	17	12	31
i8824/31	9-0.50-0.60	4	0.62	34	61	64	17	14	22
i8824/32	9-0.70-0.75	4	0.62	30	65	69	18	14	17
i8824/33	9-0.90-1.00	4	0.57	29	59	67	20	11	22
i8824/34	11-0.0-0.10	9	0.42	14	28	42	32	18	40
i8824/35	11-0.20-0.30	15	0.52	20	18	25	18	11	64
i8824/36	11-0.50-0.60	6	0.53	15	67	70	14	10	20
i8824/37	11-0.70-0.80	6	0.50	14	62	64	15	13	23
i8824/38	11-0.90-1.00	8	0.58	38	51	56	24	19	25
i8824/39	12-0.0-0.10	3	0.54	20	59	65	14	8	28
i8824/40	12-0.20-0.30	9	0.59	22	20	23	32	28	48
i8824/41	12-0.50-0.60	10	0.66	29	13	16	35	32	52
i8824/42	12-0.70-0.80	10	0.63	43	9	17	42	34	48
i8824/43	12-0.90-1.00	9	0.69	43	13	23	46	36	41
i8824/44	13-0.0-0.10	2	0.43	6	64	70	23	17	13
i8824/45	13-0.20-0.30	3	0.60	8	70	74	19	15	11
i8824/46	13-0.55-0.65	8	0.61	12	52	58	14	8	34
i8824/47	13-0.70-0.80	10	0.74	1	39	42	11	8	50
i8824/48	13-0.90-1.00	8	0.77	0	53	58	10	5	37
i8824/49	16-0.00-0.10	9	0.43	2	18	25	21	14	61
i8824/50	16-0.20-0.30	17	0.53	19	14	16	11	9	74
i8824/51	16-0.50-0.60	17	0.42	38	6	10	17	13	77
i8824/52	16-0.80-0.90	12	0.75	23	14	18	22	19	63
i8824/53	20-0.00-0.10	3	0.40	6	36	48	32	20	32
i8824/54	20-0.20-0.30	11	0.69	5	5	14	22	13	73
i8824/55	20-0.50-0.60	7	0.55	25	24	29	26	21	50

ESSA / EAL Pty Ltd (Nata 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
Exch.Ca	15B/C1	7.2	0.18	meq/100g	Exchangeable calcium	1M NH4OAc @ pH 7.0/8.5 leach, AAS
Exch.Mg	15B/C1	4.7	0.31	meq/100g	Exchangeable magnesium	1M NH4OAc @ pH 7.0/8.5 leach, AAS
Exch.Na	15B/C1	9.6	0.09	meq/100g	Exchangeable calcium	1M NH4OAc @ pH 7.0/8.5 leach, AAS
Exch.K	15B/C1	4.8	0.02	meq/100g	Exchangeable calcium	1M NH4OAc @ pH 7.0/8.5 leach, AAS
Org Matter	NA				Leco Furnace	Trimac Furnacew
CEC	15I3	5.7	1.0	meq/100g	Cation Exchange Capacity	KNO3 + Ca(NO3)2 extr, (AA) colorimetric
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 & Sieve
Silt	no ref	16.6	1.0	%	Particle size, silt	Hydrometer, gravimetric
Clay	no ref	12.7	1.0	%	Particle size, clay	Hydrometer, gravimetric
PBI	Moody			Index	P Buffer Index	PBI Cirrected for Colwell P

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)**

For Manager Analytical Services: **D E Baker BSc MASSSI**

Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.

Soluble Salts included in Exchangeable Cations - Except PRE-WASHED (if EC>0.3dS/m).

ESSA / EAL Pty Ltd(NATA 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

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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 1	Sample 2	Sample 3	Sample 4
Sample ID:	1 0.00-0.05	1 0.05-0.14	1 0.15-0.30	1 0.40-0.75
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant

Method	*Nutrient*		*Units*	*G9318/1*	*G9318/2*	*G9318/3*	*G9318/4*
1:5 Water	pH		units	5.33	6.36	7.42	7.95
	Conductivity		dS/m	1.174	0.196	0.155	0.103
15D1, 15D3 or 15C1 as per requirements	Calcium	Ca	$cmol^+/Kg$	14.00	12.23	15.72	20.70
			kg/ha	6287	5489	7057	9294
			mg/kg	2807	2451	3150	4149
	Magnesium	Mg	$cmol^+/Kg$	3.97	6.48	8.74	12.03
			kg/ha	1080	1763	2379	3275
			mg/kg	482	787	1062	1462
	Potassium	K	$cmol^+/Kg$	1.82	2.35	1.72	1.22
			kg/ha	1596	2056	1505	1067
			mg/kg	712	918	672	476
	Sodium	Na	$cmol^+/Kg$	0.05	0.10	0.45	0.92
			kg/ha	26	54	231	475
			mg/kg	12	24	103	212
Calculation	Effective Cation Exchange Capacity (ECEC)		$cmol^+/Kg$	19.84	21.16	26.63	34.87
Base Saturation Calculations	Calcium	Ca	%	70.6	57.8	59.0	59.4
	Magnesium	Mg		20.0	30.6	32.8	34.5
	Potassium	K		9.2	11.1	6.5	3.5
	Sodium - ESP	Na		0.3	0.5	1.7	2.6
Calculation	Calcium / Magnesium Ratio		ratio	3.5	1.9	1.8	1.7

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Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
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	Sample 1	Sample 2	Sample 3	Sample 4
Sample ID:	1 0.00-0.05	1 0.05-0.14	1 0.15-0.30	1 0.40-0.75
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method / *Nutrient* / *Units*	*G9318/1*	*G9318/2*	*G9318/3*	*G9318/4*

EAL Soil Testing Notes

1. All results presented as a 40℃ oven dried weight. Soil sieved and lightly crushed to <2 mm
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods*
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested)
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and Lamonte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts
7. Total Acid Extractable Nutrients indicate a store of nutrients
8. Contaminant Guides based on 'Residential with gardens and accessible soil including childrens daycare centres, preschools, primary schools, town houses or villas' (NSW EPA 1998).
9. Information relating to testing colour codes is available on Sheet 2 - "*Understanding you soil results*"

Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
2. 1 $cmol^+$/Kg = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm
3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calcium
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+$/Kg
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
8. Ca / Mg ratio from the exchangeable $cmol^+$/Kg results

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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 5	Sample 6	Sample 7	Sample 8
Sample ID:	1 0.80-1.00	2 0.00-0.05	2 0.16-0.30	2 0.30-0.60
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*Nutrient*	*Units*	*G9318/5*	*G9318/6*	*G9318/7*	*G9318/8*
1:5 Water	pH	units	8.12	5.57	7.01	7.78
	Conductivity	dS/m	0.544	0.253	0.068	0.049
15D1, 15D3 or 15C1 as per requirements	Calcium Ca	$cmol^+/Kg$	14.15	13.82	14.26	14.15
		kg/ha	6352	6204	6401	6350
		mg/kg	2836	2770	2858	2835
	Magnesium Mg	$cmol^+/Kg$	7.67	7.61	7.56	6.53
		kg/ha	2088	2073	2058	1777
		mg/kg	932	925	919	793
	Potassium K	$cmol^+/Kg$	0.36	1.61	1.20	0.33
		kg/ha	314	1408	1053	287
		mg/kg	140	629	470	128
	Sodium Na	$cmol^+/Kg$	0.65	0.23	0.21	0.26
		kg/ha	336	121	107	134
		mg/kg	150	54	48	60
Calculation	Effective Cation Exchange Capacity (ECEC)	$cmol^+/Kg$	22.83	23.28	23.23	21.26
Base Saturation Calculations	Calcium Ca	%	62.0	59.4	61.4	66.5
	Magnesium Mg		33.6	32.7	32.5	30.7
	Potassium K		1.6	6.9	5.2	1.5
	Sodium - ESP Na		2.9	1.0	0.9	1.2
Calculation	Calcium / Magnesium Ratio	ratio	1.8	1.8	1.9	2.2

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Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 5	Sample 6	Sample 7	Sample 8
Sample ID:	1 0.80-1.00	2 0.00-0.05	2 0.16-0.30	2 0.30-0.60
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method / *Nutrient* / *Units*	*G9318/5*	*G9318/6*	*G9318/7*	*G9318/8*

EAL Soil Testing Notes

1. All results presented as a 40℃ oven dried weight. Soil sieved and lightly crushed to <2 mm
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods*
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested)
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and Lamonte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts
7. Total Acid Extractable Nutrients indicate a store of nutrients
8. Contaminant Guides based on 'Residential with gardens and accessible soil including childrens daycare centres, preschools, primary schools, town houses or villas' (NSW EPA 1998).
9. Information relating to testing colour codes is available on Sheet 2 - "*Understanding you soil results*"

Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
2. 1 $cmol^+$/Kg = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm
3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calc
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+$/Kg
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
8. Ca / Mg ratio from the exchangeable $cmol^+$/Kg results

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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 9	Sample 10	Sample 11	Sample 12
Sample ID:	2 0.70-0.90	2 0.90-1.00	3 0.00-0.05	3 0.15-0.25
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*G9318/9*	*G9318/10*	*G9318/11*	*G9318/12*

Method	Nutrient		Units				
1:5 Water	pH		units	8.40	8.52	5.35	5.86
	Conductivity		dS/m	0.051	0.111	0.140	0.042
15D1, 15D3 or 15C1 as per requirements	Calcium	Ca	$cmol^+/Kg$	11.12	18.15	5.08	4.05
			kg/ha	4989	8149	2279	1816
			mg/kg	2227	3638	1018	811
	Magnesium	Mg	$cmol^+/Kg$	5.99	11.45	1.98	1.32
			kg/ha	1629	3117	540	360
			mg/kg	727	1392	241	161
	Potassium	K	$cmol^+/Kg$	0.27	0.40	1.07	0.72
			kg/ha	238	352	941	631
			mg/kg	106	157	420	282
	Sodium	Na	$cmol^+/Kg$	0.49	2.35	0.13	0.13
			kg/ha	254	1212	67	69
			mg/kg	113	541	30	31
Calculation	Effective Cation Exchange Capacity (ECEC)		$cmol^+/Kg$	17.86	32.36	8.26	6.22
Base Saturation Calculations	Calcium	Ca	%	62.2	56.1	61.4	65.0
	Magnesium	Mg		33.5	35.4	24.0	21.2
	Potassium	K		1.5	1.2	13.0	11.6
	Sodium - ESP	Na		2.8	7.3	1.6	2.1
Calculation	Calcium / Magnesium Ratio		ratio	1.9	1.6	2.6	3.1

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Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
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	Sample 9	Sample 10	Sample 11	Sample 12
Sample ID:	2 0.70-0.90	2 0.90-1.00	3 0.00-0.05	3 0.15-0.25
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*G9318/9*	*G9318/10*	*G9318/11*	*G9318/12*

Nutrient	*Units*

EAL Soil Testing Notes

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Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
2. 1 $cmol^+/Kg$ = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm
3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calc
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+/Kg$
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
8. Ca / Mg ratio from the exchangeable $cmol^+/Kg$ results

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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 13	Sample 14	Sample 15	Sample 16
Sample ID:	3 0.30-0.60	3 0.60-0.90	3 0.90-1.00	4 0.00-0.05
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*G9318/13*	*G9318/14*	*G9318/15*	*G9318/16*
1:5 Water	pH	units	6.98	7.11	8.12	6.00
	Conductivity	dS/m	0.068	0.170	0.387	0.089
15D1, 15D3 or 15C1 as per requirements	Calcium Ca	$cmol^+/Kg$	9.72	7.77	6.14	4.82
		kg/ha	4363	3487	2755	2166
		mg/kg	1948	1557	1230	967
	Magnesium Mg	$cmol^+/Kg$	7.81	7.38	6.11	1.82
		kg/ha	2126	2009	1662	496
		mg/kg	949	897	742	222
	Potassium K	$cmol^+/Kg$	0.53	0.31	0.24	1.11
		kg/ha	468	275	211	971
		mg/kg	209	123	94	433
	Sodium Na	$cmol^+/Kg$	0.92	1.60	1.06	0.15
		kg/ha	474	826	544	78
		mg/kg	212	369	243	35
Calculation	Effective Cation Exchange Capacity (ECEC)	$cmol^+/Kg$	18.98	17.06	13.54	7.91
Base Saturation Calculations	Calcium Ca	%	51.2	45.5	45.3	61.0
	Magnesium Mg		41.1	43.2	45.1	23.1
	Potassium K		2.8	1.8	1.8	14.0
	Sodium - ESP Na		4.8	9.4	7.8	1.9
Calculation	Calcium / Magnesium Ratio	ratio	1.2	1.1	1.0	2.6

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Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 13	Sample 14	Sample 15	Sample 16
Sample ID:	3 0.30-0.60	3 0.60-0.90	3 0.90-1.00	4 0.00-0.05
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*G9318/13*	*G9318/14*	*G9318/15*	*G9318/16*

Method	*Nutrient*	*Units*

EAL Soil Testing Notes

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3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calc
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+$/Kg
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
8. Ca / Mg ratio from the exchangeable $cmol^+$/Kg results

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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 17	Sample 18	Sample 19	Sample 20
Sample ID:	4 0.05-0.13	4 0.15-0.30	4 0.35-0.45	4 0.60-1.00
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*G9318/17*	*G9318/18*	*G9318/19*	*G9318/20*
1:5 Water	pH	units	6.01	6.23	6.51	7.30
	Conductivity	dS/m	0.051	0.030	0.020	0.051
15D1, 15D3 or 15C1 as per requirements	Calcium Ca	$cmol^+/Kg$	2.95	1.85	1.59	4.69
		kg/ha	1325	830	714	2104
		mg/kg	592	371	319	939
	Magnesium Mg	$cmol^+/Kg$	1.41	0.75	0.68	5.72
		kg/ha	385	205	185	1556
		mg/kg	172	92	83	695
	Potassium K	$cmol^+/Kg$	0.76	0.48	0.48	0.31
		kg/ha	662	421	417	270
		mg/kg	296	188	186	120
	Sodium Na	$cmol^+/Kg$	0.13	0.13	0.11	0.68
		kg/ha	66	65	59	351
		mg/kg	30	29	26	157
Calculation	Effective Cation Exchange Capacity (ECEC)	$cmol^+/Kg$	5.25	3.21	2.86	11.39
Base Saturation Calculations	Calcium Ca	%	56.2	57.6	55.6	41.1
	Magnesium Mg		26.9	23.5	23.8	50.2
	Potassium K		14.4	15.0	16.6	2.7
	Sodium - ESP Na		2.5	3.9	4.0	6.0
Calculation	Calcium / Magnesium Ratio	ratio	2.1	2.5	2.3	0.8

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Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 17	Sample 18	Sample 19	Sample 20
Sample ID:	4 0.05-0.13	4 0.15-0.30	4 0.35-0.45	4 0.60-1.00
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*Nutrient*	*Units*	*G9318/17*	*G9318/18*	*G9318/19*	*G9318/20*

EAL Soil Testing Notes

1. All results presented as a 40℃ oven dried weight. Soil sieved and lightly crushed to <2 mm
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods*
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested)
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and Lamonte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts
7. Total Acid Extractable Nutrients indicate a store of nutrients
8. Contaminant Guides based on 'Residential with gardens and accessible soil including childrens daycare centres, preschools, primary schools, town houses or villas' (NSW EPA 1998).
9. Information relating to testing colour codes is available on Sheet 2 - "*Understanding you soil results*"

Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
2. 1 $cmol^+/Kg$ = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm
3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calc
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+/Kg$
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
8. Ca / Mg ratio from the exchangeable $cmol^+/Kg$ results

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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

				Sample 21	Sample 22	Sample 23	Sample 24
			Sample ID:	5 0.00-0.05	5 0.05-0.15	5 0.15-0.40	5 0.45-0.65
			Crop:	N/G	N/G	N/G	N/G
			Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*Nutrient*		*Units*	*G9318/21*	*G9318/22*	*G9318/23*	*G9318/24*
1:5 Water	pH		units	6.27	6.20	6.80	7.01
	Conductivity		dS/m	0.124	0.052	0.031	0.111
15D1, 15D3 or 15C1 as per requirements	Calcium	Ca	$cmol^+/Kg$	7.03	5.01	3.03	11.31
			kg/ha	3155	2248	1362	5075
			mg/kg	1409	1004	608	2266
	Magnesium	Mg	$cmol^+/Kg$	2.43	1.81	1.30	7.38
			kg/ha	662	494	354	2008
			mg/kg	296	220	158	897
	Potassium	K	$cmol^+/Kg$	2.24	1.06	0.51	1.63
			kg/ha	1959	927	447	1431
			mg/kg	875	414	199	639
	Sodium	Na	$cmol^+/Kg$	0.37	0.12	0.23	0.96
			kg/ha	189	62	120	492
			mg/kg	84	28	54	220
Calculation	Effective Cation Exchange Capacity (ECEC)		$cmol^+/Kg$	12.07	8.00	5.08	21.27
Base Saturation Calculations	Calcium	Ca	%	58.3	62.6	59.8	53.1
	Magnesium	Mg		20.2	22.7	25.6	34.7
	Potassium	K		18.5	13.2	10.0	7.7
	Sodium - ESP	Na		3.0	1.5	4.6	4.5
Calculation	Calcium / Magnesium Ratio		ratio	2.9	2.8	2.3	1.5

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Job No:	G9318
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	Sample 21	Sample 22	Sample 23	Sample 24
Sample ID:	5 0.00-0.05	5 0.05-0.15	5 0.15-0.40	5 0.45-0.65
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*G9318/21*	*G9318/22*	*G9318/23*	*G9318/24*

Method	*Nutrient*	*Units*

EAL Soil Testing Notes

1. All results presented as a 40℃ oven dried weight. Soil sieved and lightly crushed to <2 mm
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods*
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested)
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and Lamonte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts
7. Total Acid Extractable Nutrients indicate a store of nutrients
8. Contaminant Guides based on 'Residential with gardens and accessible soil including childrens daycare centres, preschools, primary schools, town houses or villas' (NSW EPA 1998).
9. Information relating to testing colour codes is available on Sheet 2 - "*Understanding you soil results*"

Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
2. 1 $cmol^+$/Kg = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm
3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calc
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+$/Kg
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
8. Ca / Mg ratio from the exchangeable $cmol^+$/Kg results

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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

				Sample 25	Sample 26	Sample 27	Sample 28
			Sample ID:	5 0.70-1.00	6 0.00-0.05	6 0.05-0.15	6 0.20-0.40
			Crop:	N/G	N/G	N/G	N/G
			Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*Nutrient*		*Units*	*G9318/25*	*G9318/26*	*G9318/27*	*G9318/28*
1:5 Water	pH		units	7.10	5.92	6.15	7.56
	Conductivity		dS/m	0.026	0.101	0.054	0.109
15D1, 15D3 or 15C1 as per requirements	Calcium	Ca	$cmol^+/Kg$	2.50	7.66	6.18	7.57
			kg/ha	1121	3437	2774	3398
			mg/kg	500	1535	1239	1517
	Magnesium	Mg	$cmol^+/Kg$	2.04	3.49	5.58	6.17
			kg/ha	556	949	1519	1679
			mg/kg	248	424	678	749
	Potassium	K	$cmol^+/Kg$	0.24	1.17	0.71	0.73
			kg/ha	207	1022	623	639
			mg/kg	93	456	278	285
	Sodium	Na	$cmol^+/Kg$	0.19	0.11	0.31	0.32
			kg/ha	100	58	162	165
			mg/kg	44	26	72	74
Calculation	Effective Cation Exchange Capacity (ECEC)		$cmol^+/Kg$	4.97	12.42	12.79	14.79
Base Saturation Calculations	Calcium	Ca	%	50.2	61.6	48.3	51.2
	Magnesium	Mg		41.1	28.1	43.6	41.7
	Potassium	K		4.8	9.4	5.6	4.9
	Sodium - ESP	Na		3.9	0.9	2.5	2.2
Calculation	Calcium / Magnesium Ratio		ratio	1.2	2.2	1.1	1.2

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Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 25	Sample 26	Sample 27	Sample 28
Sample ID:	5 0.70-1.00	6 0.00-0.05	6 0.05-0.15	6 0.20-0.40
Crop:	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method / *Nutrient* / *Units*	*G9318/25*	*G9318/26*	*G9318/27*	*G9318/28*

EAL Soil Testing Notes

1. All results presented as a 40℃ oven dried weight. Soil sieved and lightly crushed to <2 mm
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods*
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested)
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and Lamonte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts
7. Total Acid Extractable Nutrients indicate a store of nutrients
8. Contaminant Guides based on 'Residential with gardens and accessible soil including childrens daycare centres, preschools, primary schools, town houses or villas' (NSW EPA 1998).
9. Information relating to testing colour codes is available on Sheet 2 - "*Understanding you soil results*"

Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
2. 1 $cmol^+/Kg$ = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm
3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calc
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+/Kg$
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
8. Ca / Mg ratio from the exchangeable $cmol^+/Kg$ results

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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

				Sample 29	Sample 30	Sample 31	Sample 32	Sample 33	Sample 34	Sample 35
			Sample ID:	6 0.45-0.60	7 0.00-0.05	7 0.15-0.25	7 0.30-0.60	7 0.60-0.90	7 0.90-1.00	8 0.00-0.05
			Crop:	N/G	N/G	N/G	N/G	N/G	N/G	N/G
			Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*Nutrient*		*Units*	*G9318/29*	*G9318/30*	*G9318/31*	*G9318/32*	*G9318/33*	*G9318/34*	*G9318/35*
1:5 Water	pH		units	8.89	6.61	6.22	8.25	8.56	8.91	6.61
	Conductivity		dS/m	0.278	0.157	0.057	0.128	0.166	0.669	0.116
15D1, 15D3 or 15C1 as per requirements	Calcium	Ca	$cmol^+/Kg$	7.10	10.17	8.03	9.90	12.87	8.47	12.60
			kg/ha	3186	4566	3603	4446	5778	3800	5655
			mg/kg	1422	2039	1609	1985	2579	1697	2525
	Magnesium	Mg	$cmol^+/Kg$	10.18	4.14	3.60	9.12	13.26	13.36	6.67
			kg/ha	2772	1128	981	2482	3610	3638	1815
			mg/kg	1237	504	438	1108	1612	1624	810
	Potassium	K	$cmol^+/Kg$	0.47	1.17	0.74	0.43	0.52	0.49	0.55
			kg/ha	413	1026	649	377	453	431	479
			mg/kg	185	458	290	168	202	193	214
	Sodium	Na	$cmol^+/Kg$	0.89	0.29	0.24	1.85	2.81	3.68	0.28
			kg/ha	459	150	125	952	1447	1897	142
			mg/kg	205	67	56	425	646	847	64
Calculation	Effective Cation Exchange Capacity (ECEC)		$cmol^+/Kg$	18.64	15.78	12.61	21.30	29.46	26.01	20.09
Base Saturation Calculations	Calcium	Ca	%	38.1	64.5	63.6	46.5	43.7	32.6	62.7
	Magnesium	Mg		54.6	26.3	28.6	42.8	45.0	51.4	33.2
	Potassium	K		2.5	7.4	5.9	2.0	1.8	1.9	2.7
	Sodium - ESP	Na		4.8	1.8	1.9	8.7	9.5	14.2	1.4
Calculation	Calcium / Magnesium Ratio		ratio	0.7	2.5	2.2	1.1	1.0	0.6	1.9

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Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 29	Sample 30	Sample 31	Sample 32	Sample 33	Sample 34	Sample 35
Sample ID:	6 0.45-0.60	7 0.00-0.05	7 0.15-0.25	7 0.30-0.60	7 0.60-0.90	7 0.90-1.00	8 0.00-0.05
Crop:	N/G	N/G	N/G	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*Nutrient*	*Units*	*G9318/29*	*G9318/30*	*G9318/31*	*G9318/32*	*G9318/33*	*G9318/34*	*G9318/35*

EAL Soil Testing Notes

1. All results presented as a 40℃ oven dried weight. Soil sieved and lightly crushed to <2 mm
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3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested)
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5. Guidelines for phosphorus have been reduced for Australian soils
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Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
2. 1 $cmol^+/Kg$ = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm
3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calc
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+/Kg$
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
8. Ca / Mg ratio from the exchangeable $cmol^+/Kg$ results

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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

				Sample 36	Sample 37	Sample 38	Sample 39	Sample 40	Sample 41	Sample 42
			Sample ID:	8 0.05-0.13	8 0.15-0.25	8 0.30-0.60	8 0.75-0.85	9 0.00-0.05	9 0.05-0.15	9 0.26-0.50
			Crop:	N/G	N/G	N/G	N/G	N/G	N/G	N/G
			Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*Nutrient*		*Units*	*G9318/36*	*G9318/37*	*G9318/38*	*G9318/39*	*G9318/40*	*G9318/41*	*G9318/42*
1:5 Water	pH		units	6.86	8.08	8.45	9.11	8.04	8.46	8.56
	Conductivity		dS/m	0.066	0.215	0.163	0.077	0.205	0.158	0.142
15D1, 15D3 or 15C1 as per requirements	Calcium	Ca	$cmol^+/Kg$	14.21	25.69	25.27	3.79	24.93	20.97	21.96
			kg/ha	6379	11533	11345	1703	11192	9413	9856
			mg/kg	2848	5149	5065	760	4997	4202	4400
	Magnesium	Mg	$cmol^+/Kg$	7.34	10.85	10.22	2.31	5.62	9.79	16.44
			kg/ha	1999	2953	2783	629	1530	2666	4475
			mg/kg	892	1318	1242	281	683	1190	1998
	Potassium	K	$cmol^+/Kg$	0.56	0.66	0.59	0.14	0.90	0.58	0.69
			kg/ha	490	578	518	119	785	508	606
			mg/kg	219	258	231	53	350	227	271
	Sodium	Na	$cmol^+/Kg$	0.23	0.36	0.44	0.07	0.17	0.30	0.81
			kg/ha	119	184	225	35	88	153	420
			mg/kg	53	82	101	16	39	68	187
Calculation	Effective Cation Exchange Capacity (ECEC)		$cmol^+/Kg$	22.34	37.56	36.52	6.31	31.62	31.64	39.90
Base Saturation Calculations	Calcium	Ca	%	63.6	68.4	69.2	60.2	78.9	66.3	55.0
	Magnesium	Mg		32.9	28.9	28.0	36.6	17.8	31.0	41.2
	Potassium	K		2.5	1.8	1.6	2.1	2.8	1.8	1.7
	Sodium - ESP	Na		1.0	1.0	1.2	1.1	0.5	0.9	2.0
Calculation	Calcium / Magnesium Ratio		ratio	1.9	2.4	2.5	1.6	4.4	2.1	1.3

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Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

	Sample 36	Sample 37	Sample 38	Sample 39	Sample 40	Sample 41	Sample 42
Sample ID:	8 0.05-0.13	8 0.15-0.25	8 0.30-0.60	8 0.75-0.85	9 0.00-0.05	9 0.05-0.15	9 0.26-0.50
Crop:	N/G	N/G	N/G	N/G	N/G	N/G	N/G
Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
Method	*Nutrient*	*Units*	*G9318/36*	*G9318/37*	*G9318/38*	*G9318/39*	*G9318/40*	*G9318/41*	*G9318/42*

EAL Soil Testing Notes

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Calculations

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3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calc
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+/Kg$
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	G9318
No of Samples:	44
Date Supplied:	13th April 2018
Supplied by:	E.S.S.A

					Sample 43	**Sample 44**
				Sample ID:	9 0.50-0.70	9 0.70-1.00
				Crop:	N/G	N/G
				Client:	ON 18MP Mt Pleasant	ON 18MP Mt Pleasant
	Method	*Nutrient*		*Units*	*G9318/43*	*G9318/44*
	1:5 Water	pH		units	8.75	8.64
		Conductivity		dS/m	0.211	0.648
	15D1, 15D3 or 15C1 as per requirements	Calcium	Ca	cmol⁺/Kg	17.29	9.48
				kg/ha	7761	4254
				mg/kg	3465	1899
		Magnesium	Mg	cmol⁺/Kg	13.47	15.27
				kg/ha	3666	4158
				mg/kg	1637	1856
		Potassium	K	cmol⁺/Kg	0.51	0.41
				kg/ha	445	361
				mg/kg	199	161
		Sodium	Na	cmol⁺/Kg	1.09	1.68
				kg/ha	561	865
				mg/kg	250	386
	Calculation	Effective Cation Exchange Capacity (ECEC)		cmol⁺/Kg	32.35	26.84
	Base Saturation Calculations	Calcium	Ca	%	53.4	35.3
		Magnesium	Mg		41.6	56.9
		Potassium	K		1.6	1.5
		Sodium - ESP	Na		3.4	6.3
	Calculation	Calcium / Magnesium Ratio		ratio	1.3	0.6

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EAL Soil Testing Notes

1. All results presented as a 40℃ oven dried weight. Soil sieved and lightly crushed to <2 mm
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods*
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested)
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and Lamonte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts
7. Total Acid Extractable Nutrients indicate a store of nutrients
8. Contaminant Guides based on 'Residential with gardens and accessible soil including childrens daycare centres, preschools, primary schools, town houses or villas' (NSW EPA 1998).
9. Information relating to testing colour codes is available on Sheet 2 - "*Understanding you soil results*"

Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
2. 1 $cmol^+/Kg$ = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm
3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calc
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+/Kg$
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
8. Ca / Mg ratio from the exchangeable $cmol^+/Kg$ results

Quality Checked: Kris Saville
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