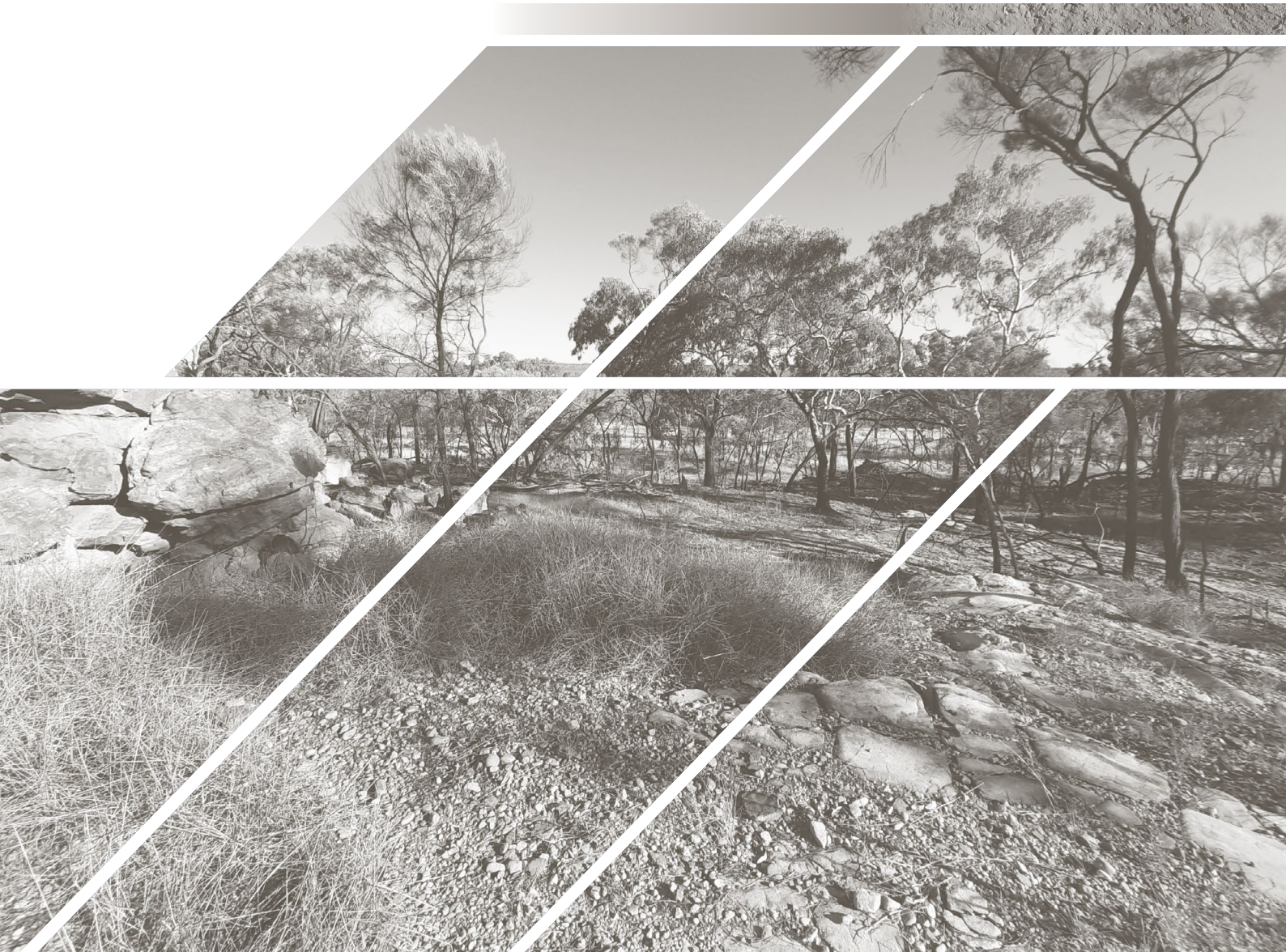
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SOILS REPORT



Soil Report
for the Big Vein South Gold Project

Prepared for Hansen Environmental Consulting
on behalf of Strategic Minerals Corporation Pty Ltd
Prepared by GT Environmental Pty Ltd

30 September 2022

GTenvironmental

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Name of organisation:	Hansen Environmental Consulting
Name of document:	Big Vein South Gold Project Soil Report

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1 INTRODUCTION

GT Environmental (GTE) was commissioned by Strategic Minerals Corporation to complete a soil and land suitability assessment as part of the Environmental Assessment Report (EAR) for the Big Vein South Gold Project (the project).

1.1 Project Overview

The project involves the construction and operation of an open cut gold mine on a greenfield site in North Queensland. The soil study area covers an area of approximately 2,265 hectares (ha) and is located approximately 100 km north of Richmond and 380 km west of Townsville (Figure 1).

Open cut mining will be conducted using excavators and trucks. Gold ore will be processed on site to produce gold dore (solid bars containing gold alloy). The mine's peak production rate will be up to 1.95 million tonnes per annum (Mtpa) of run of mine (ROM) gold ore, yielding up to approximately 100,000 ounces of gold dore per annum. The mine life will be approximately 11 years.

The following mining and ore processing activities will be undertaken as part of the project:

- Developing three open cut pits, as follows:
    - The main Big Vein South Pit (BVS Pit) located in the centre of the soil study area (Figure 2). Waste rock from this pit will be hauled by truck and stored in the Central and Southern Waste Rock Dumps (WRDs).
    - Two small satellite pits, BV1 Pit and BV2 Pit, located in the northern part of the soil study area (Figure 2). Waste rock from these pits will be stored in the Northern WRD.
- Transporting mined ore in haul trucks from the open cut pits to the ROM area ore stockpiles located near the mine processing facilities at the southern end of the soil study area site (Figure 2).
- Processing ore from the BV1 and BV2 Pits in the first 2 years of mining using Heap Leach Pads and gold elution. Processing ore mined from the BVS Pit in an on-site Carbon In-Leach (CIL) Plant from Year 3 onwards. The heap leaching process will generate spent heap leach residues. These residues will be reprocessed in the CIL Plant over the life of the mine. The CIL Plant will generate wet tailings and dewatered tailings. Wet tailings will be pumped to a Tailings Storage Cell. Dewatered tailings will be stored with waste rock in the Central and Southern WRDs.
- Transporting dore bars from the site via plane to a refinery.

The majority of the mine infrastructure will be located at the southern end of the soil study area (Figure 2). Key mine infrastructure will include ore processing facilities, workshop,

warehouse, administration buildings, haul roads and access roads, vehicle servicing, refuelling and wash down facilities, fuel storage facilities, diesel and solar power station, water supply and water management infrastructure. Workforce accommodation and a private airstrip will also be located at the southern end of the soil study area.

1.2 Scope of Work

This purpose of the soil and land suitability assessment is to provide a baseline assessment of the soil types within the soil study area, and the suitability of these soils for agricultural and rehabilitation activities.

The assessment has been undertaken in accordance with the relevant parts of the Queensland guideline *Land – EIS information guideline ESR/2020/5303* (Department of Environment and Science, 2022) (the EIS Information Guideline for Land). The EIS Information Guideline for Land requires that soil types, horizons and profiles are described in accordance with relevant, best-practice guidelines and methods, including the *Australian soil and land survey field handbook* (National Committee on Soil and Terrain, 2009), the *Guidelines for surveying soil and land resources* (McKenzie et al. 2008), the *Australian soil classification* (Isbell, 2016) and the *Queensland soil and land resource survey information guidelines* (Department of Resources 2021).

1.3 Report

The report structure is as follows:

- A description of the project setting (Section 2);
- A description of the assessment methods and relevant guidelines (Section 3);
- Identification and description of soil types, profiles and horizons present within the soil study area (Section 4);
- An assessment of the baseline land suitability class and agricultural land class of the soils within the soil study area (Section 5); and
- An assessment of the soil suitability for reuse in mine rehabilitation activities, including determination of applicable soil stripping depths (Section 6).

2 PROJECT SETTING

2.1 Land Use

The dominant land use in the soil study area is pastoral activity, specifically cattle grazing. A stock route traverses the southern end of the soil study area, alongside a gazetted road reserve. Two farm dams are located in the soil study area, which provide water sources for cattle.

No cropping activities are undertaken within the project site. There are no Strategic Cropping Areas, Priority Agricultural Areas, Priority Living Areas or Strategic Environmental Areas, as defined by the Regional Planning Interests Act 2014 (Qld), within the project site. The land within the soil study area is not subject to any Property or Project Plans approved under the Soil Conservation Act 1986 (Qld).

2.2 Topography and Hydrology

The local topography transitions from elevated rocky plateaus and ridgelines to the flatter, low-lying Woolgar River (as shown in Figure 2).

The Woolgar River is a locally significant watercourse. In the vicinity of the soil study area, the Woolgar River has a well-defined channel that is set within a narrow, discontinuous floodplain. The river channel contains a braided low flow channel with sand sheet deposits, bars and islands that have been formed by the extensive suspended sediment deposition during flow events.

Several plateaus and ridgelines extend into the soil study area and form local catchment boundaries (as shown in Figure 2). Several unnamed tributaries form on the slopes of the plateaus and ridgelines of these catchments (as shown in Figure 2). The unnamed tributaries coalesce on the flatter ground that is located between the plateaus and ridgelines and drain towards the Woolgar River valley.

The Woolgar River and associated drainage features exhibit highly ephemeral, short duration, surface water flows that contain elevated suspended sediment loads. This is expected given the catchment features and geology setting.

2.3 Regional Geology

The soil study area is located at the northern margin of the Eromanga Basin, a sedimentary basin that was deposited in the Mesozoic era. Locally, the Eromanga Basin overlies a Proterozoic basement. The Proterozoic basement is part of the North Australian Craton, one of Australia's major mineral provinces.

The Eromanga Basin and Proterozoic basement have been extensively modified by weathering and erosion. The weathered profile extends to depths of up to 40 m below ground level in the soil study area.

The soil study area stratigraphy includes the following (in descending order):

- Alluvium associated with the Woolgar River and its floodplain.
- The weathered in-situ rocks of the Eromanga Basin and Proterozoic basement (herein called the 'weathered profile').
- Fresh (i.e. unweathered) Jurassic strata of the Eromanga Basin.
- Fresh Proterozoic basement rocks, including the target gold ore.

3 METHODOLOGY

3.1 Overview

The soil assessment comprised a desktop study, a detailed field survey and data analysis and interpretation.

This soil survey was scoped and conducted in accordance with the *Guidelines for Surveying Soil and Land Resources* (McKenzie et al., 2008). These guidelines were developed to provide for 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* (Gunn et al., 1988; National Committee on Soil and Terrain, 2009), *Queensland Soil and Land Resource Survey Information Guideline* (Department of Resources, 2021) and *Queensland Land Resource Assessment Guidelines, Volume 1: Soil and Land Resource Assessment* (Department of Environment and Science, 2021).

Soils have been grouped according to their parent material and position in the landscape and classified in accordance with the *Australian Soil Classification* (Isbell, 2021). Soils have also been correlated to soils identified in key regional soil assessments, previously mapped at a 1:1,000,000 scale (Perry et al., 1964).

Collection of soil samples for laboratory analysis was undertaken based on Land Suitability Assessment Techniques (LSAT) outlined in the *Technical Guidelines for Environmental Management of Exploration and Mining in Queensland* (DME, 1995), *Queensland Soil and Land Resource Survey Information Guideline* (Department of Resources, 2021) and *Queensland Land Resource Assessment Guidelines, Volume 1: Soil and Land Resource Assessment* (Department of Environment and Science, 2021).

The physical and chemical properties of soils relevant to the potential for erosion has been determined for representative samples down the soil profile based on field and laboratory assessment of dispersive attributes including but not limited to texture, R1 dispersion and emerson aggregate test results.

Interpretation of the field and analytical results were undertaken with review against *Interpreting Soil Analysis for agricultural use in Queensland* (Baker, D.E. and Eldershaw, V.J. 1993), *Analytical Methods and interpretations used by the Agricultural Chemical Branch, QDPI, for soil and land use surveys*. (Bruce, R.C. and Rayment, G.F. 1982), *Soil Testing and Some Test Interpretations used by the QDPI*. (Bruce, R.C. and Rayment, G.F. 1984), *Soil Salinity and Sodicity. In, Fergus IF (ed.), Understanding Soils and Soil Data* (Shaw, R.J. 1988); Soil Analysis, an Interpretation Manual (Peveril, K.I., Sparrow, L.A. and Reuter, 1999) and *Interpreting Soil Test Results* (Hazelton, P.A. and Murphy, B.W. 2007).

Determination of land suitability for the soil study area has been conducted based on the *Guidelines for Agricultural Land Evaluation in Queensland* (GALE) (DSITI & DNRM, 2015), *Regional Land Suitability Frameworks for Queensland* (DSITI & DNRM, 2013), *Queensland Soil and Land Resource Survey Information Guideline* (Department of Resources, 2021) and *Queensland Land Resource Assessment Guidelines, Volume 1: Soil and Land Resource Assessment* (Department of Environment and Science, 2021).

The suitability of soils for rehabilitation have been assessed using the field and laboratory assessment of texture, fertility, dispersive and structural attributes.

Groupings of soils with similar attributes are described as soil types in *Land—EIS information guideline* (Department of Environment and Science, 2022). Soil types are defined either as the Australian Soil Classification (ASC) suborder or Soil Profile Class (SPC) within *Queensland Soil and Land Resource Survey Information Guideline* (Department of Resources, 2021). For the purpose of this assessment and in order to adhere to the more relevant *Queensland Land Resource Assessment Guidelines, Volume 1: Soil and Land Resource Assessment* (Department of Environment and Science, 2021), SPC terminology and assessment will be used.

The following sections provide a detailed description of the desktop study and field work methodology.

3.2 Desktop Study

GTE reviewed the available soils and land resources information for the soil study area to develop preliminary soil types and to inform the development of the field survey program.

3.2.1 Regional Soil Reports and Documentation

The following soils reports and publicly available information were reviewed to identify previous soils and land suitability fieldwork and recommendations relevant to the soil study area, and to determine potential field sampling locations:

- Queensland Globe.

  The database shows that there is 1:2,000,000 regional scale soil mapping (*Atlas of Australian Soils* (Northcote et al., 1960-1968)) for the soil study area. The following four soil landscapes are mapped within the soil study area:

  - Fa26 – Earthy loams on strongly undulating lands with short steep slopes.
  - JJ11 – Pale sands on low hilly/hilly dissected sandstone plateaus, often with steep sided gorges and ravines.
  - AB35 – Earthy soils on gently undulating plains.
  - Ms18 – Yellow massive earths on gently undulating plains.

- Perry et al. (1964), *General Report on Lands of the Leichhardt-Gilbert Area, 1953-54*

  This report describes a total of 61 land systems across the Leichhardt-Gilbert area in north Queensland and comprises of 117,000 square miles. It provides land use

limitation information for each soil type, including climate, moisture supply, fertility, wetness, flooding frequency, rockiness, topography, soil physical condition, vegetation, erodibility, landscape complexity and salinity. The information on land use limitations is useful in assisting in the development of recommendations for the stripping and reuse of soils in the soil study area. This report is also referenced within Queensland Globe under the database, Land Resource Mapping 1:1,000,000.

Queensland globe indicated the following four land systems mapped within and adjacent the soil study area:

- Strathpark – Gently sloping timbered plains near the centre of the area.
- Torwood – Broken sandstone tablelands generally timbered with lancewood.
- Strathmore – Timbered plains near the centre of the area.
- Hampstead – Gently sloping timbered plateau somewhat south-east of the centre of the area

Further review of the report indicates that Cockatoo, Currajong, Norman, Elliot and Skeletal soil types could potentially be present within the soil study area and its surrounds.

3.2.2 Satellite Imagery

Satellite Imagery from Google Earth (accessed on 1 October 2020) was reviewed as part of the desktop study. Preliminary soil type mapping boundaries were identified using this imagery.

3.3 Field Work

3.3.1 Survey Timing

The field survey was undertaken between 24 and 31 October 2020.

3.3.2 Survey Team

The fieldwork was led by associate environmental consultant Reece McCann and assisted by field technician Brett Larkin.

3.3.3 Survey Techniques

Preliminary survey sites were derived from the desktop review of background information, existing available soils information and an examination of aerial photography patterns. The specific locations of the survey sites were further refined in the field based on available site access, and the location being a sound representation of the soil types within the soil study area.

Free survey and transect techniques (Gunn et al., 1988; McKenzie et al., 2008) were used to verify, sample and assign boundaries to each SPC. Free survey is a commonly used method in land assessment as it enables flexibility in site selection (over grid mapping techniques), to

achieve a more accurate and time effective result. It is well suited to detailed-scale surveys and is commonly used in soil surveys for resource projects in Queensland. Transect techniques were utilised where free survey was unable to be conducted and included sampling at regular intervals along a gradient to reveal the pattern of soil variation. This information was then extrapolated to adjacent areas.

The soil types within the project site were generally accessible. However, for safety it was occasionally necessary to collect additional supplementary information on these soil types from more accessible locations outside the project site boundary. The data collected from these supplementary sites was reviewed to ensure it is representative of the project site conditions and has been incorporated into the findings of the soil survey where relevant.

Two types of soil survey site were undertaken – detailed sites and observation sites, and these are described below.

Detailed Sites

Detailed surveys were undertaken at 22 sites (Figure 3). The detailed sites were used to describe the range of soil profile morphological attributes as per the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009) including landforms, slope, surface conditions, rock cover, major vegetation and soil colour (as per Munsell Color [2009] Soil Colour Charts). At each detailed site, an assessment was also made of the quality, depth and quantities of reusable soil.

The soil profile at each detailed site was typically excavated using a 50 mm hand auger. The hand auger method is a technically suitable method for characterising the soil profile. Soil profiles were undertaken in accordance with the *Guidelines for Surveying Soil and Land Resources* (McKenzie et al., 2008).

The information recorded from the 22 detailed sites included:

- Location (GDA2020) and type of soil observation (e.g. erosion exposed cutting or hand auger);
- Major vegetation types;
- 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 (as per Munsell Color [2009] Soil Colour Charts) and mottling of each horizon;
- Observations of field texture, pH, presence and abundance of segregations, coarse fragments, structure, consistence and pedality and moisture content for each horizon;
- Presence of organic matter, roots and prevalence of biological activity;

- Presence of gleyed horizons, iron staining, jarosite presence and field pH; and
- Photographs of the soil profile and surrounding landscape.

The data collected from the detailed sites is presented in Appendix A.

Observation Sites

Observation surveys were undertaken at 53 sites (Figure 3). These sites were used to confirm the SPC and refine mapped soil boundaries.

Basic soil attributes were recorded at each observation site to confirm the SPC, and surface conditions including rock, slope percentage, landform type and position, major vegetation and land condition were also noted. The data collected from the observation sites is presented in Appendix B.

3.3.4 Laboratory Analysis

Soil samples were collected from each SPC present in the soil study area. For each of the sampled SPC (i.e. Nine units in total), the soil samples were collected from the detailed site that was considered to be most representative of that SPC.

A total of 46 soil samples were collected and submitted for laboratory analysis. Soil sampling of profiles was conducted as per McKenzie et al. (2008), with samples taken at standard depths incorporating the surface and every horizon change in the soil profile (typically at depths of 0.0-0.10 m, 0.30-0.40 m, 0.60-0.70 m, 0.90-1.00 m and 1.40-1.50 m). These depths were modified for sites in which field observations revealed soil horizons intersecting at these nominated depths, to ensure samples were collected in each separate horizon, and not across multiple horizons or in sub-horizon boundaries.

Laboratory analysis was undertaken to assist in determining the overall characterisation of the soils and to establish the physical and chemical limitations of soils. Laboratory testing was also used to identify soils that may require specific management measures.

Samples were analysed at Environmental Analysis Laboratory (EAL) who are accredited by the National Association of Testing Authority (NATA) and additionally certified by the Australasian Soil and Plant Analysis Council (ASPAC).

The laboratory analysis for surface soil horizons included the following parameters.

- pH (1:5);
- Electrical Conductivity (EC [1:5]);
- Chloride;
- Bicarbonate extractable P;
- Exchangeable Cations (Ca, Mg, Na, K);
- Cation Exchange Capacity (CEC);
- Calcium/Magnesium (Ca/Mg) Ratio;

- Exchangeable Sodium Percentage (ESP);
- Total N, Nitrates, Ammonia;
- Organic matter content;
- Particle Size Analysis (PSA) – Hydrometer Method (Coarse Sand [CS], Fine Sand [FS], Silt, Clay);
- R1 Dispersion;
- Emmerson Aggregate Test (EAT);
- Sulfate-Sulfur, Total Sulfur; and
- Metals - Total (Mn, B, Cu, Fe, Zn).

Samples lower in the soil profile were also analysed for a suite of parameters (pH, EC, chloride, exchangeable ions, CEC, Ca/Mg Ratio, ESP, PSA, EAT and R1 dispersion) that enabled GTE to determine soil reuse potential for rehabilitation of disturbed areas. The rationale for the selection of individual analyses is presented in Table 3-1.

The laboratory analytical results were used in conjunction with the field assessment results to determine the soil material that is suitable for stripping and reuse during rehabilitation. The laboratory results are summarised in Section 4 and detailed in Appendix C.

Table 3-1: Analytical Program and Number of Samples

Laboratory Analysis	Number of Samples Analsyed[1]	Justification
In situ measurements	Field pH 94	Used for 'on the spot' estimates of pH and to confirm the effective soil depth.
pH	27	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).
Electrical Conductivity	27	The measure of electrical conductivity 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	27	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 soil salinity.
Bicarbonate Extractable Phosphorus (Colwell)	9	Bicarbonate extractable P (Bicarb. extr. P) is routinely measured 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 and is more useful than alternatives (e.g. acid extr. P).
CEC, Exchangeable Cations, Ca/MG ratio, ESP	27	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 would 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 Nitrogen, Ammonia (total N, nitrate)	27	Testing provides an indication of the general fertility of soils and thus their suitability as a topdressing agent.
Organic Matter	9	Testing for soil organic 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)	27	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 SPC and water holding capacity.

Laboratory Analysis	Number of Samples Analsyed[1]	Justification
R1 Dispersion	27	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	27	The measure of Emerson Aggregate Test (EAT) is useful when determining soil physical behaviour.
Micronutrients	9	The analysis of aluminum, copper, zinc, manganese, and iron will assess potential natural concentrations of these heavy metals in the soil as well as any phytotoxicity issues that may exist.
Sulfate-Sulfur, Total Sulfur	27	Total levels of sulfur help identify whether organic matter or gypsum are present in a soil profile.

1. Total number of samples with laboratory analysis. Includes samples outside the scope of the soil study area.

4 SOIL TYPES AND MAPPING

A total of nine SPCs were identified within the soil study area (as shown in Figure 3).

Table 4-1 lists the SPCs in the soil study area and provides a description of the SPC concept (i.e. A group of similar soil profiles with a defined central concept and range of values including basic soil morphology, position in the landscape, and parent material).

Individual SPCs have been classified in accordance with the *Australian Soil Classification* (Isbell, 2002). Comparable land systems, as described by Perry et al (1964), are also provided in Table 4-1.

The detailed sites and representative sites for soil sampling and laboratory analysis are also listed in Table 4-1. Detailed descriptions of each SPC are provided in the following sections (Sections 4.1 to 4.1).

Table 4-1: Summary of the SPCs in the Soil Study Area

SPC	SPC Concept Description	Australian Soil Classification (Major Order/Sub-order)	Land System (Perry et al., 1964)	Area (ha)	Unique Mapping Areas (UMAs)	Detailed Sites (*Representative Sites)
1	Moderately deep, slightly acidic, black loam and brown sandy loam subsoil	Brown Kandosol	Strathpark	499	1, 6, 18, 21, 25	1*, 8, 10, 12, 30
2	Moderately deep, moderately acidic, black firm sandy loam with brown sandy loam to strongly alkaline, extremely sodic, sandy clay loam subsoil	Red Kandosol	Strathpark	80	3, 23	2*
3	Very shallow, rocky, strongly acidic, black sandy loam on steep hills on sedimentary rock	Leptic Rudosol	Strathpark	189	9, 13, 17, 22	3*
4	Moderately deep, moderately acidic, brown loamy sand on red, moderately alkaline, sandy clay loam subsoil	Red Kandosol	Strathpark	132	11, 15	5*
5	Shallow, hard-setting, slightly acidic, brown sands on brown sandy clay loam on sedimentary rock	Brown Kandosol	Strathpark	208	8, 16, 21	6*, 9
6	Moderately deep, firm, moderately alkaline, grey clay loam on strongly alkaline, extreme salinity and sodic, brown clay loam subsoil	Brown Kandosol	Strathpark	23	4, 7, 14	7*

SPC	SPC Concept Description	Australian Soil Classification (Major Order/Sub-order)	Land System (Perry et al., 1964)	Area (ha)	Unique Mapping Areas (UMAs)	Detailed Sites (*Representative Sites)
7	Deep, soft, moderately acidic, reddish brown sandy loam on red sandy clay loam subsoil	Red Kandosol	Strathpark, Hampstead, Strathmore	961	24	11, 13, 14, 15, 16, 18*, 27, 28
8	Shallow, hard setting, neutral, brown sandy loam with red sandy loam subsoil on metamorphic rock	Red Tenosol	Torwood	80	2, 19	29*
9	Very shallow, hard setting, strongly acidic, yellowish-brown sandy clay loam on sedimentary rock	Leptic Rudosol	Torwood	93	10, 12, 20	31*

4.1 Soil Profile Class 1: Moderately deep, slightly acidic, black loam and brown sandy loam subsoil

Overview

SPC 1 is a moderately deep, slightly acidic, black loam and brown sandy loam subsoils. The basic ASC is a brown Kandosol and is associated with lower slopes, plains and creeks.

SPC 1 has moderate limitations that make it suitable for mangoes and eggplant cropping, severe limitations for bananas and extreme limitations for peanut, rice and sorghum cropping. SPC 1 is suitable as limited cropping land and sown pastures.

Soil characteristics and chemistry

Laboratory data indicate the following attributes for this SPC:

- Gradational texture of sands to sandy loam;
- pH (laboratory analysis) ranges from neutral to moderately acidic;
- Electrical conductivity is moderate to very low;
- Chloride is very low;
- Cation exchange capacity (CEC) ranges are low to very low;
- In the topsoil, the CEC is 6.5 meq/100 and the exchangeable sodium percentage (ESP) is 1. For soils with a CEC of greater than 3 meq/100, ESP results are considered a reliable indicator of sodicity. If the ESP is less than 6% of the cation exchange capacity the soils are classed as non-sodic. Soils with an ESP of 6% or greater are classed as sodic. Hence, the topsoil of this soil type is non-sodic.
- In the subsoil, the ESP results are low (1-2%). However, the CEC is less than 3 meq/100 so the ESP results are not a reliable indicator of sodicity.
- Calcium to magnesium (Ca:Mg) ratios are very high;
- Nitrogen levels in topsoil are very low;
- Micronutrients indicate moderate levels for copper, manganese and zinc;
- Emerson aggregate test (EAT) results indicate slaking in topsoil. Subsoil results show slight dispersion above 0.75 mbgl. However, the particle size analysis indicates subsoils are sandy loam to loamy sand and therefore the EAT results are likely to overestimate dispersion.
- R1 dispersion testing confirms that these materials have low potential for dispersion;
- The level of bicarbonate extractable phosphorus present is high in topsoil; and
- Organic carbon levels in topsoil are low.

Representative site

Site 1 was selected as a representative site of this SPC.

A site description and soil profile morphology summary are presented in Table 4-2. The soil chemistry results for this SPC are presented in Table 4-3.

Table 4-2: Land Summary SPC 1

Item	Description
Representative Site	1
Representative Site photograph	
Location GDA2020 ZONE 54	741485 7810185
Current Use	Native woodland
Site survey type	Detailed, 50 mm hand auger
Vegetation	Tall to mid height woodland including Eucalyptus crebra (Narrow-leaved Ironback), as well as Eucalyptus leptophleba (Molloy red box) and Eucalyptus camaldulensis (Red gum)
Disturbance	No effective disturbance;
Landform element / pattern	Gently undulating plain
Microrelief	No microrelief
Drainage	Moderate well drained (Class 4)
Permeability (LRA, 2021)	Moderate Permeability (Class 3)
Erosion Observed	No erosion observed
Slope (%)	1.0 / 1.0
Surface coarse fragments	No coarse fragments
Surface condition	Hard setting
SPC ASC Order/Suborder	Brown Kandosol
Site ASC Order (s)	Haplic Eutrophic Brown Kandosol; moderately thick, non-gravelly, loamy, loamy, deep (Confidence level 1) ASC Coded Classification (Isbell, 2021): 1KAABAHCDAELLW
Land System / Soils Concept (Perry et al., 1964)	Strathpark / Cockatoo

Item	Description
K-Factor (Rosewell, 1993)	0.040
Land suitability summary	Land Suitability, Regional Frameworks: . Moderate (3) limitations for mangoes and eggplant. Severe (4) limitations for bananas. Extreme (5) limitations for soybean, mungbean and sorghum. Agricultural Suitability Class: B
Soil quality for mine rehabilitation	Stripped topsoils to 0.30 mbgl may be reused in rehabilitation activities with no amelioration required. Subsoils to a depth of 1.00 mbgl are suitable for stripping and reuse as subsoil in rehabilitation activities.
Total area (ha)	499

Soil Profile Morphology Summary



Horizon Depth (m), Boundary	Field Texture	Grade of Pedality Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Depth (m) / Field pH	Notes
A11 0.00-0.16 Abrupt 5-20mm	Loam fine sand	Massive Loose	Nil inclusions or segregations	10YR3/2 very dark greyish brown Nil mottles or bleaching	Dry Moderately well drained	Medium 2-5mm Few	0.10 / 6.0	Nil
A12 0.16-0.49 Abrupt 5-20mm	Loam fine sand	Massive Loose	Nil inclusions or segregations	10YR3/3 dark brown Nil mottles or bleaching	Dry Moderately well drained	Fine 1-2 mm Few	0.30 / 6.0	
B21 0.48-0.74 Clear 20-50mm	Sandy loam	Massive Loose	Nil inclusions or segregations	10YR3/4 dark yellowish brown Nil mottles or bleaching	Dry Moderately well drained	Very fine <1mm Few	0.65 / 6.5	
B22 0.74-1.00 End of borehole (EOBH)	Loamy sand	Massive Loose	<2% coarse fragments <2mm	10YR3/4 dark yellowish brown Nil mottles or bleaching	Dry Moderately well drained	Nil roots	0.90 / 6.5	

Table 4-3: Soil Chemistry Results for SPC 1, Representative Site 1

Analysis (Unit)	Sample Depth (mbgl)				
	0.00-0.10	0.20-0.30	0.50-0.60	0.75-0.85	0.90-1.00
	A11 horizon	A12 horizon	B21 horizon	B22 horizon	B22 horizon
Soil pH (H20)	6.62	5.95	6.27	6.45	6.41
Soil pH (CaCl2 / 0.01M)	5.4	-[1]	-	-	-
Soil EC (dS/m)	0.024	0.190	0.057	0.041	0.026
Soil Cl (milligrams per kilogram [mg/kg])	31	32	50	14	33
Exch. Ca (milli-equivalent per 100 grams [meq/100g])	4.3	5.3	2.0	1.5	1.5
Exch. Mg (meq/100g)	1.14	1.24	0.44	0.38	0.40
Exch. K (meq/100g)	1.01	0.23	<0.12	<0.12	<0.12
Exch. Na (meq/100g)	<0.065	0.09	<0.065	<0.065	<0.065
CEC (meq/100g)	6.5	6.8	2.6	2.0	2.0
Ca/Mg (ratio)	3.7	4.3	4.5	4.0	3.7
ESP (%Na/CEC)	1	1	2	2	2
Nitrate (mg/kg)	2.1	-	-	-	-
Ammonia (mg/kg)	4.2	-	-	-	-
Total Nitrogen (mg/kg)	0.04	-	-	-	-
Sulfate-S (mg/kg)	1.4	-	-	-	-
Total S (%)	<50	-	-	-	-
Zinc (mg/kg)	2.4	-	-	-	-
Mn (mg/kg)	42	-	-	-	-
Iron (mg/kg)	29	-	-	-	-
Copper (mg/kg)	0.40	-	-	-	-
Boron (mg/kg)	0.21	-	-	-	-
Silicon (mg/kg)	40	-	-	-	-
Tot Organic Carbon (%)	1.3	-	-	-	-
Organic Matter (%)	1.3	-	-	-	-
P (mg/kg)	27	-	-	-	-
Disp Ratio (R1)	0.53	0.58	0.39	0.37	0.32
EAT (No.)	5	5	5	8	8

Analysis (Unit)	Sample Depth (mbgl)				
	0.00-0.10	0.20-0.30	0.50-0.60	0.75-0.85	0.90-1.00
	A11 horizon	A12 horizon	B21 horizon	B22 horizon	B22 horizon
Gravel >2mm (%)	0	0	0	0	0
CS >50µm (%)	60	65	81	85	85
CS >20µm (%)	71	71	86	87	87
2-50µm-Silt (%)	25	20	9	7	8
2-20µm-Silt (%)	14	14	4	4	5
Clay <2µm (%)	15	15	11	9	7
Texture	Loam	Loam	Sandy Loam	Sandy Loam	Loamy Sand
PAWC Assessment					
Horizon Depth (m)	0.16	0.33	0.25	0.16	0.10
PAWC per horizon (mm)	9.60	19.80	12.50	8.00	4.00
PAWC Total	53.90				

1. '-' indicates laboratory analysis was not conducted for this sample.

4.2 Soil Profile Class 2: Moderately deep, moderately acidic, black firm sandy loam with brown sandy loam to strongly alkaline, extremely sodic, sandy clay loam subsoil

Overview

SPC 2 is a moderately deep, moderately acidic, black firm sandy loam with brown sandy loam to strongly alkaline, extremely sodic, sandy clay loam subsoil. The basic ASC is a red Kandosol and is associated with levels plains. Vegetation includes tall woodlands of narrow leaved ironbark and other eucalyptus species including Eucalyptus Microneural (Gilbert River Box).

SPC 2 has moderate limitations that make it suitable for mangoes and eggplant cropping, severe limitations for bananas and extreme limitations for peanut, rice and sorghum cropping. SPC 2 is suitable as limited cropping land and sown pastures.

Soil characteristics and chemistry

Laboratory data indicate the following attributes for this SPC:

- Textures included sandy loams varying to sandy clay loam at 0.90 mbgl;
- pH (laboratory analysis) is slightly acidic in topsoils and very strongly alkaline in subsoils;
- Chloride is very low in topsoil and varies between very low and low in subsoil;
- Very low electrical conductivity in the topsoils, increases to high in subsoils;
- CEC ranges are low in topsoils, increasing to high in subsoils;
- ESP is non-sodic in topsoil increasing to strongly and extremely sodic in subsoils. CEC results are above 3 cmol(+)=kg-1 for topsoil and generally within 3 cmol(+)=kg-1. The texture is sandy, this would indicate that ESP results may not be relied upon as an indicator of sodicity;
- Ca:Mg ratios are very high in topsoil decreasing to high in subsoils;
- Nitrogen levels in topsoil are low;
- Micronutrients indicate moderate levels of manganese and zinc, and low levels for copper;
- EAT reports no dispersion in topsoil with complete dispersion in subsoils;
- The level of bicarbonate extractable phosphorus present is high in topsoil; and
- Organic carbon levels in topsoil are moderate.

Representative site

Site 2 was selected as a representative site of this SPC.

A site description and soil profile morphology summary are presented in Table 4-4. The soil chemistry results for this SPC are presented in Table 4-5.

Table 4-4: Land Summary SPC 2

Item	Description
Representative Site	2
Representative Site photograph	
Location GDA2020 ZONE 54	740040 7809628
Current Use	Native woodland
Site survey type	Detailed, 50 mm hand auger
Vegetation	Tall woodland forest including narrow leaved ironbark with occasional Gilbert river box
Disturbance	Nil disturbance
Landform element /pattern	Level plain
Microrelief	No microrelief
Drainage	Moderately - well drained (Class 4)
Permeability (LRA, 2021)	Moderate Permeable (Class 3)
Erosion Observed	No erosion observed
Slope (%)	<1.0 / <1.0
Surface coarse fragments	No coarse fragments
Surface condition	Firm
SPC ASC Order/Suborder	Red Kandosol
Site ASC Order (s)	Haplic Eutrophic Red Kandosol; moderately thick, non-gravelly, sandy, loamy, deep (Confidence level 1) ASC Coded Classification (Isbell, 2021): 1KAAAAHCDBEKLW
Land System / Soils Concept (Perry et al., 1964)	Strathpark / Cockatoo
K-Factor (Rosewell, 1993)	0.030
Land suitability summary	Land Suitability, Regional Frameworks: Moderate (3) limitations for mangoes and eggplant. Severe (4) limitations for bananas. Extreme (5) limitations for soybean, mungbean and sorghum.

Item	Description
	Agricultural Suitability: B
Soil quality for mine rehabilitation	Stripped topsoils to 0.35 mbgl may be reused in rehabilitation activities with no amelioration required. Subsoils to a depth of 1.00 mbgl may be stripped and reused as subsoil in rehabilitation activities if other allocation volumes of subsoils have been used. Subsoil placement may require the use of gypsum and visual inspection of soils prior to placement.
Total area (ha)	80
Soil Profile Morphology Summary	



Horizon Depth (m), Boundary	Field Texture	Grade of Pedality Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Depth (m) / Field pH	Notes
A11 0.00-0.13 Clear 20-50mm	Sandy loam	Massive Loose	Nil inclusions or segregations	10YR3/2 very dark greyish brown Nil mottles or bleaching	Dry Moderately well drained	Fine 1-2mm Common	0.05 / 6.0	Nil
A12 0.13-0.38 Clear 20-50mm	Loamy sand	Massive Loose	Nil inclusions or segregations	10YR3/3 dark brown Nil mottles or bleaching	Dry Well drained	Nil roots	0.20 / 7.5	
B2 0.38-1.00 EOBH	Sandy loam	Massive Loose	2-10% coarse fragments 2-6mm	2.5Y4/3 dark brown Nil mottles or bleaching	Dry Moderately well drained	Nil roots	0.60 / 8.5 0.90 / 8.5	

Table 4-5: Soil Chemistry Results for SPC 2, Representative Site 2

Analysis (Unit)	Sample Depth (mbgl)				
	0.00-0.10	0.20-0.30	0.50-0.60	0.70-0.80	0.90-1.00
	A11 horizon	A12 horizon	B2 horizon	B2 horizon	B2 horizon
Soil pH (H20)	6.35	8.52	10.19	10.12	10.08
Soil pH (CaCl2 / 0.01M)	5.5	-[1]	-	-	-
Soil EC (dS/m)	0.043	0.099	0.509	0.393	0.378
Soil Cl (mg/kg)	71	102	79	101	132
Exch. Ca (meq/100g)	3.6	1.0	0.5	0.3	0.2
Exch. Mg	0.63	0.51	0.24	0.17	0.14

Analysis (Unit)	Sample Depth (mbgl)				
	0.00-0.10	0.20-0.30	0.50-0.60	0.70-0.80	0.90-1.00
	A11 horizon	A12 horizon	B2 horizon	B2 horizon	B2 horizon
(meq/100g)					
Exch. K (meq/100g)	0.43	0.16	0.04	0.04	0.06
Exch. Na (meq/100g)	0.08	0.44	2.50	2.39	2.62
CEC (meq/100g)	4.8	2.1	3.2	2.9	3.0
Ca/Mg (ratio)	5.8	2.0	1.9	1.6	1.1
ESP (%Na/CEC)	2	20	77	83	88
Nitrate (mg/kg)	7.8	-	-	-	-
Ammonia (mg/kg)	4.0	-	-	-	-
Total Nitrogen (mg/kg)	0.14	-	-	-	-
Sulfate-S (mg/kg)	2.6	-	-	-	-
Total S (%)	103	-	-	-	-
Zinc (mg/kg)	2.4	-	-	-	-
Mn (mg/kg)	20	-	-	-	-
Iron (mg/kg)	93	-	-	-	-
Copper (mg/kg)	0.3	-	-	-	-
Boron (mg/kg)	0.33	-	-	-	-
Silicon (mg/kg)	37	-	-	-	-
Tot Organic Carbon (%)	2.21	-	-	-	-
Organic Matter (%)	2.21	-	-	-	-
P (mg/kg)	16	-	-	-	-
Disp Ratio (R1)	0.32	0.40	0.62	0.60	0.62
EAT (No.)	8	1	1	1	1
Gravel >2mm (%)	0	0	0	0	0
CS >50µm (%)	84	82	69	71	73
CS >20µm (%)	87	87	76	76	77
2-50µm-Silt (%)	7	11	12	10	8
2-20µm-Silt (%)	4	6	5	5	3
Clay <2µm (%)	9	7	19	19	20
Texture	Sandy Loam	Loamy Sand	Sandy Loam	Sandy Loam	Sandy Clay Loam
PAWC Assessment					
Horizon Depth (m)	0.13	0.25	0.22	0.30	0.10
PAWC per	6.50	10.00	11.00	15.00	6.00

Analysis (Unit)	Sample Depth (mbgl)				
	0.00-0.10	0.20-0.30	0.50-0.60	0.70-0.80	0.90-1.00
	A11 horizon	A12 horizon	B2 horizon	B2 horizon	B2 horizon
horizon (mm)					
PAWC Total	48.50				

1. '-' indicates laboratory analysis was not conducted for this sample.

4.3 Soil Profile Class 3: Very shallow, rocky, strongly acidic, black sandy loam on steep hills on sedimentary rock

Overview

SPC 3 is a very shallow, rocky, strongly acidic, black sandy loam on steep hills on sedimentary rock. The basic ASC is a leptic Rudosol and is associated with steep hill country. Vegetation includes sparse shrublands and Acacia Shirleyi (Lancewood) woodlands with bedrock exposed on the surface.

SPC 3 has extreme limitations due to the location on steep hills and minimal soil. It is unsuitable for cropping and only suitable for light grazing.

Soil characteristics and chemistry

Laboratory data indicate the following attributes for this SPC:

- Very shallow loamy sand on bedrock outcrops;
- pH (laboratory analysis) is strongly acidic;
- Very low electrical conductivity;
- Chloride is very low;
- CEC ranges are very low;
- ESP is non-sodic. The CEC results are below 3 cmol(+)=kg-1 as well as a sandy loam texture indicates that ESP results may not be relied upon as an indicator of sodicity;
- Ca:Mg ratios are high;
- Nitrogen levels in topsoil are very low;
- Micronutrients indicate moderate levels of manganese and low levels for copper and zinc;
- EAT reports no dispersion or slaking;
- The level of bicarbonate extractable phosphorus present is high in topsoil; and
- Organic carbon levels in topsoil are low.

Representative site

Site 3 was selected as a representative site of this SPC.

A site description and soil profile morphology summary are presented in Table 4-6. The soil chemistry results for this SPC are presented in Table 4-7.

Table 4-6: Land Summary SPC 3

Item	Description
Representative Site	3
Representative Site photograph	
Location GDA2020 ZONE 54	740686 7808732
Current Use	Sparse tall woodlands consisting of lancewood
Site survey type	Detailed, 50 mm hand auger
Vegetation	Sparse vegetation
Disturbance	Nil disturbance
Landform element /pattern	Steep hill, crest
Microrelief	Nil microrelief
Drainage	Well drained (Class 5)
Permeability (LRA, 2021)	Highly Permeable (Class 4)
Erosion Observed	Nil erosion
Slope (%)	30+ over crest edge
Surface coarse fragments	2-10% coarse fragments, 20-60mm, 80% Bedrock
Surface condition	Firm
SPC ASC Order/Suborder	Leptic Rudosol
Site ASC Order (s)	Acidic Lithic Leptic Rudosol; slightly gravelly, sandy, very shallow (Confidence level 1) ASC Coded Classification (Isbell, 2021): 1TECYCZAIFKT
Land System / Soils Concept (Perry et al., 1964)	Strathpark / Skeletal sand and rock outcrop
K-Factor (Rosewell, 1993)	0.030
Land suitability summary	Land Suitability, Regional Frameworks: Extreme (5) limitations for cane, cucurbits, tomatoes, soybean, mungbean and sorghum. Agricultural Suitability Class: C3
Soil quality for mine rehabilitation	Not suitable for reuse in rehabilitation activities
Total area (ha)	189

Item	Description
Soil Profile Morphology Summary	



Horizon Depth (m), Boundary	Field Texture	Grade of Pedality Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Depth (m) / Field pH	Notes
A1 0.00-0.17 EOBH	Loamy sand	Single grain Loose	2-10% coarse fragments 2-6mm	10YR3/2 very dark greyish brown Nil mottles or bleaching	Dry Rapidly drained	Medium 2-5mm Few	0.10 / 5.5	0.00-0.10

Table 4-7: Soil Chemistry Results for SPC 3, Representative Site 3

Analysis (Unit)	Sample Depth (mbgl)
	0.00-0.10
	A1 horizon
Soil pH (H20)	5.20
Soil pH (CaCl2 / 0.01M)	4.6
Soil EC (dS/m)	0.047
Soil Cl (mg/kg)	20
Exch. Ca (meq/100g)	0.5
Exch. Mg (meq/100g)	0.24
Exch. K (meq/100g)	0.14
Exch. Na (meq/100g)	<0.065
CEC (meq/100g)	1.3
Ca/Mg (ratio)	1.9
ESP (%Na/CEC)	1
Nitrate (mg/kg)	15.2
Ammonia (mg/kg)	10.4
Total Nitrogen (mg/kg)	0.04
Sulfate-S (mg/kg)	3.0

Analysis (Unit)	Sample Depth (mbgl)
	0.00-0.10
	A1 horizon
Total S (%)	<50
Zinc (mg/kg)	<0.5
Mn (mg/kg)	6
Iron (mg/kg)	75
Copper (mg/kg)	0.1
Boron (mg/kg)	0.11
Silicon (mg/kg)	6
Tot Organic Carbon (%)	1.11
Organic Matter (%)	1.11
P (mg/kg)	17
Disp Ratio (R1)	0.04
EAT (No.)	8
Gravel >2mm (%)	0
CS >50µm (%)	92
CS >20µm (%)	92
2-50µm-Silt (%)	0
2-20µm-Silt (%)	0
Clay <2µm (%)	8
Texture	Sandy Loam
PAWC Assessment	
Horizon Depth (m)	0.17
PAWC per horizon (mm)	8.50
PAWC Total	8.50

4.4 Soil Profile Class 4: Moderately deep, moderately acidic, brown loamy sand on red, moderately alkaline, sandy clay loam subsoil

Overview

SPC 4 is a moderately deep, moderately acidic, brown loamy sand on red, moderately alkaline, sandy clay loam subsoil. The basic ASC is a red Kandosol and is associated with lower slopes and flat plains of gently undulating plains. Vegetation includes tall woodlands of Narrow Leaved Ironbark, Red Gum and Melaleuca Fluviatilis (River Tea Tree).

SPC 4 has moderate limitations that make it suitable for mangoes and eggplant cropping, severe limitations for bananas and extreme limitations for peanut, rice and sorghum cropping. SPC 4 is suitable as limited cropping land and sown pastures.

Soil characteristics and chemistry

Laboratory data indicate the following attributes for this SPC:

- Uniform to gradational textures of loamy sands to clayey sands with sandy clay loam at 0.90 mbgl;
- pH (laboratory analysis) is slightly acidic in topsoil to moderately alkaline in subsoils;
- Electrical conductivity is low in topsoil to very low in subsoils;
- Chloride is very low;
- CEC ranges are very low;
- ESP is non-sodic. CEC results are below 3 cmol(+)=kg-1 as well as the sandy texture indicates that ESP results may not be relied upon as an indicator of sodicity;
- Ca:Mg ratios are very high;
- Nitrogen levels in topsoil are very low;
- Micronutrients indicate moderate levels of manganese and zinc, and low levels for copper;
- EAT reports no dispersion or slaking;
- The level of bicarabonate extractable phosphorus present is high in topsoil; and
- Organic carbon in topsoil is low.

Representative site

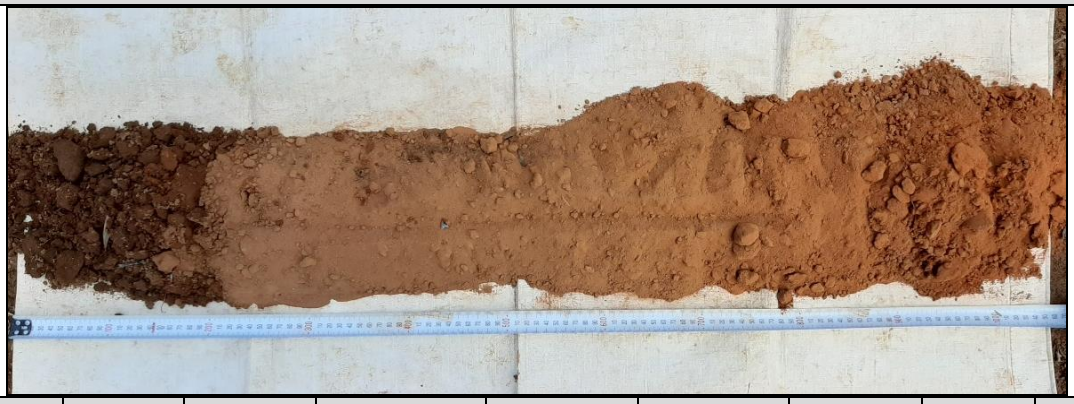
Site 5 was selected as a representative site of this SPC.

A site description and soil profile morphology summary are presented in Table 4-8. The soil chemistry results for this SPC are presented in Table 4-9.

Table 4-8: Land Summary SPC 4

Item	Description
Representative Site	5
Representative Site photograph	
Location GDA2020 ZONE 54	738544 7808620
Current Use	Native woodland
Site survey type	Detailed, 50 mm hand auger
Vegetation	Native tall woodland forests of Narrow leaved ironbark, Red gums and River tea trees
Disturbance	No disturbance observed
Landform element /pattern	Flat plain
Microrelief	No microrelief observed
Drainage	Moderate well drained (Class 4)
Permeability (LRA, 2021)	Moderately Permeable (Class 3)
Erosion Observed	No erosion observed
Slope (%)	<1.0 / <1.0
Surface coarse fragments	No coarse fragments
Surface condition	Soft
SPC ASC Order/Suborder	Red Kandosol
Site ASC Order (s)	Haplic Eutrophic Red Kandosol, moderately thick, non-gravelly, sandy, loamy, deep (Confidence level 1) ASC Coded Classification (Isbell, 2021): 1KAAAAHCDBEKLW
Land System / Soils Concept (Perry et al., 1964)	Strathpark / Cockatoo
K-Factor (Rosewell, 1993)	0.020
Land suitability summary	Land Suitability, Regional Frameworks: Moderate (3) limitations for mangoes and eggplant. Severe (4) limitations for bananas. Extreme (5) limitations for soybean, mungbean and sorghum. Agricultural Suitability Class: B
Soil quality for mine rehabilitation	Stripped topsoils to 0.20 mbgl may be reused in rehabilitation activities with no amelioration required. Subsoils to a depth of 1.00 mbgl are suitable for stripping and reuse as subsoil in rehabilitation

Item	Description
	activities.
Total area (ha)	132
Soil Profile Morphology Summary	



Horizon Depth (m), Boundary (Bdy)	Field Texture	Grade of Pedality Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Depth (m) / Field pH	Notes
A1 0.00–0.20 Abrupt 5-20mm	Loamy sand	Weak Very weak	Nil inclusions or segregations	7.5YR3/3 dark brown Nil mottles or bleaching	Moderately moist Rapidly drained	Fine 1-2mm Common	0.10 / 6.0	0.00-0.10 0.25-0.30 0.50-0.60 0.70-0.80 0.90-1.00
A2 0.20-0.80 Clear 20-50mm	Loamy sand	Massive Loose	Nil inclusions or segregations	5YR5/6 yellowish red Nil mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.30 / 6.0 0.60 / 6.0	
B2 0.80-1.00 EOBH	Clayey sand	Massive Weak / loose	Nil inclusions or segregations	5YR4/6 yellowish red Nil mottles or bleaching	Dry Moderately well drained	Very fine <1mm Few	0.90 / 7.0	

Table 4-9: Soil Chemistry Results for SPC 4, Representative Site 5

Analysis (Unit)	Sample Depth (mbgl)				
	0.00-0.10	0.25-0.30	0.50-0.60	0.70-0.80	0.90-1.00
	A1 horizon	A2 horizon	A2 horizon	A2 horizon	B2 horizon
Soil pH (H20)	6.26	7.82	8.11	8.06	7.99
Soil pH (CaCl2 / 0.01M)	5.6	-[1]	-	-	-
Soil EC (dS/m)	0.067	0.013	0.015	0.017	0.021
Soil Cl (mg/kg)	11	22	42	13	11
Exch. Ca (meq/100g)	2.6	1.3	1.2	1.5	2.0
Exch. Mg (meq/100g)	0.32	0.24	0.31	0.47	0.63
Exch. K (meq/100g)	0.19	0.17	0.13	0.23	0.33
Exch. Na (meq/100g)	<0.065	0.05	0.01	0.02	0.02
CEC (meq/100g)	3.1	1.8	1.6	2.2	2.9

Analysis (Unit)	Sample Depth (mbgl)				
	0.00-0.10	0.25-0.30	0.50-0.60	0.70-0.80	0.90-1.00
	A1 horizon	A2 horizon	A2 horizon	A2 horizon	B2 horizon
Ca/Mg (ratio)	8.1	5.4	3.8	3.3	3.1
ESP (%Na/CEC)	0	3	1	1	1
Nitrate (mg/kg)	28.2	-	-	-	-
Ammonia (mg/kg)	6.3	-	-	-	-
Total Nitrogen (mg/kg)	0.04	-	-	-	-
Sulfate-S (mg/kg)	1.1	-	-	-	-
Total S (%)	<50	-	-	-	-
Zinc (mg/kg)	1.1	-	-	-	-
Mn (mg/kg)	12	-	-	-	-
Iron (mg/kg)	14	-	-	-	-
Copper (mg/kg)	0.3	-	-	-	-
Boron (mg/kg)	0.23	-	-	-	-
Silicon (mg/kg)	19	-	-	-	-
Tot Organic Carbon (%)	0.59	-	-	-	-
Organic Matter (%)	0.70	-	-	-	-
P (mg/kg)	17	-	-	-	-
Disp Ratio (R1)	0.34	0.36	0.49	0.50	0.52
EAT (No.)	8	8	8	8	8
Gravel >2mm (%)	0	0	0	0	0
CS >50µm (%)	83	85	86	79	71
CS >20µm (%)	89	93	91	84	77
2-50µm-Silt (%)	11	9	6	8	9
2-20µm-Silt (%)	5	0	1	2	3
Clay <2µm (%)	6	7	8	13	20
Texture	Loamy Sand	Sand	Sand	Sandy Loam	Sandy Clay Loam
PAWC Assessment					
Horizon Depth (m)	0.20	0.30	0.20	0.10	0.20
PAWC per horizon (mm)	8.00	12.00	8.00	5.00	12.00
PAWC Total	45.00				

1. '-' indicates laboratory analysis was not conducted for this sample.

4.5 Soil Profile Class 5: Shallow, hard-setting, slightly acidic, brown sands on brown sandy clay loam on sedimentary rock

Overview

SPC 5 is a shallow, hard-setting, slightly acidic, brown sands on brown sandy clay loam on sedimentary rock. The basic ASC is a brown Kandosol and is associated with undulating rises. Vegetation includes sparse tall woodlands of Narrow leaved Ironbark.

SPC 5 has severe limitations for mangoes, bananas and eggplant cropping and extreme limitations for peanut, rice and sorghum cropping.

Soil characteristics and chemistry

Laboratory data indicate the following attributes for this SPC, excluding subsoils for the very shallow phase:

- Texture varies from sand to sandy clay loam textures;
- pH (laboratory analysis) is slightly acidic in topsoil to neutral and slightly acidic in subsoils;
- Electrical conductivity is moderate;
- Chloride is very low;
- CEC ranges are very low;
- ESP is non-sodic for topsoil but sodic in subsoils. CEC results are close to 3 cmol(+)=kg-1 which indicates that ESP results may be relied upon as an indicator of sodicity for A12 horizon;
- Ca:Mg ratios are very high in topsoil decreasing to moderate in subsoils;
- Nitrogen levels in topsoil are very low;
- Micronutrients indicate moderate levels of manganese and zinc, and low levels for copper;
- EAT reports no dispersion in topsoil, some dispersion in subsoils to 0.30 mbgl and non-dispersive from 0.30 mbgl;
- R1 dispersion is low;
- The level of bicarbonate extractable phosphorus present is moderate in topsoil; and
- Organic carbon in topsoil is low.

Representative site

Site 6 was selected as a representative site of this SPC.

A site description and soil profile morphology summary are presented in Table 4-10. The soil chemistry results for this SPC are presented in Table 4-11.

Table 4-10: Land Summary SPC 5

Item	Description
Representative Site	6
Representative Site photograph	
Location GDA2020 ZONE 54	739594 7808320
Current Use	Native woodland
Site survey type	Detailed, 50 mm hand auger
Vegetation	Tall, sparse woodlands including narrow leaved ironbark
Disturbance	No effective disturbance; hoofed animals
Landform element /pattern	Undulating rises, mid slope
Microrelief	No microrelief observed
Drainage	Moderately well drainage (Class 4)
Permeability (LRA, 2021)	Moderately Permeable (Class 3)
Erosion Observed	No erosion observed
Slope (%)	5
Surface coarse fragments	20-50% 6-20mm, 5-10% 20-60mm
Surface condition	Hard setting
SPC ASC Order/Suborder	Brown Kandosol
Site ASC Order (s)	Sodic Leptic Brown Kandosol; thin, moderately gravelly, sandy, loamy, shallow (Confidence level 1) ASC Coded Classification (Isbell, 2021): 1KABACYEOAHKLU
Land System / Soils Concept (Perry et al., 1964)	Strathpark / Cockatoo
K-Factor (Rosewell, 1993)	0.015
Land suitability summary	Land Suitability, Regional Frameworks: Severe (4) limitations for mangoes, bananas and eggplant. Extreme (5) limitations for peanut, rice and sorghum. Agricultural Suitability Class: C2

Item	Description
Soil quality for mine rehabilitation	Stripped topsoils to 0.15 mbgl may be reused in rehabilitation activities with no amelioration required. Subsoils to a depth of 0.45 mbgl may be suitable as subsoil for reuse in rehabilitation activities with recommendations.
Total area (ha)	208
Soil Profile Morphology Summary	



Horizon Depth (m), Boundary (Bdy)	Field Texture	Grade of Pedality Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Depth (m) / Field pH	Notes
A11 0.00-0.10 Sharp <5mm	Clayey sand	Massive Loose	20-50% coarse fragments 6-20mm	10YR3/3 dark brown Nil mottles or bleaching	Dry Well drained	Fine 1-2mm Few	0.05 / 6.0	0.00-0.07 0.10-0.20 0.30-0.40
B21 0.10-0.24 Clear 5-20mm	Clayey sand	Weak Loose	20-50% coarse fragments 6-20mm 2-10% coarse fragments 20-60mm	2.5Y5/6 light olive brown Nil mottles or bleaching	Dry Moderately well drained	Very fine <1mm Few	0.20 / 6.5	
B22 0.24-0.45 EOBH - Refusal on hard pan / rock	Clayey sand	Massive Loose	10-20% coarse fragments 6-20mm	2.5Y5/4 light olive brown Nil mottles or bleaching	Dry Moderately well drained	Nil roots	0.40 / 6.5	

Table 4-11: Soil Chemistry Results for SPC 5, Representative Site 6

Analysis (Unit)	Sample Depth (mbgl)		
	0.00-0.10	0.10-0.20	0.30-0.40
	A1 horizon	A12 horizon	A22 horizon
Soil pH (H20)	6.64	6.77	6.18
Soil pH (CaCl2 / 0.01M)	5.8	-[1]	-
Soil EC (dS/m)	0.014	0.015	0.010
Soil Cl (mg/kg)	17	8	11
Exch. Ca (meq/100g)	2.1	1.1	0.7

Analysis (Unit)	Sample Depth (mbgl)		
	0.00-0.10	0.10-0.20	0.30-0.40
	A1 horizon	A12 horizon	A22 horizon
Exch. Mg (meq/100g)	0.56	1.34	0.81
Exch. K (meq/100g)	0.27	0.16	0.19
Exch. Na (meq/100g)	<0.065	0.31	0.09
CEC (meq/100g)	2.9	2.9	1.8
Ca/Mg (ratio)	3.8	0.8	0.9
ESP (%Na/CEC)	0	11	5
Nitrate (mg/kg)	0.8	-	-
Ammonia (mg/kg)	1.2	-	-
Total Nitrogen (mg/kg)	0.06	-	-
Sulfate-S (mg/kg)	1.1	-	-
Total S (%)	<50	-	-
Zinc (mg/kg)	0.8	-	-
Mn (mg/kg)	11	-	-
Iron (mg/kg)	22	-	-
Copper (mg/kg)	0.2	-	-
Boron (mg/kg)	0.25	-	-
Silicon (mg/kg)	13	-	-
Tot Organic Carbon (%)	0.97	-	-
Organic Matter (%)	0.97	-	-
P (mg/kg)	14	-	-
Disp Ratio (R1)	0.36	0.53	0.53
EAT (No.)	8	2	8
Gravel >2mm (%)	0	0	0
CS >50µm (%)	87	66	76
CS >20µm (%)	91	73	81
2-50µm-Silt (%)	6	14	12
2-20µm-Silt (%)	2	7	7
Clay <2µm (%)	7	20	12
Texture	Sand	Sandy Clay Loam	Sandy Loam
PAWC Assessment			
Horizon Depth (m)	0.10	0.14	0.21
PAWC per horizon (mm)	4.00	8.40	10.50
PAWC Total	22.90		

1. '-' indicates laboratory analysis was not conducted for this sample.

4.6 Soil Profile Class 6: Moderately deep, firm, moderately alkaline, grey clay loam on strongly alkaline, extreme salinity and sodic, brown clay loam subsoil

Overview

SPC 6 is a moderately deep, firm, moderately alkaline, grey clay loam on strongly alkaline, extreme salinity and sodic, brown clay loam subsoil. The basic ASC is a brown Kandosol and is associated with flat plains. Vegetation is near non-existent on cracking clay surface.

SPC 6 has severe limitations that make it suitable for mangoes, bananas and eggplant cropping and extreme limitations for peanut, rice and sorghum cropping. SPC 6 is suitable for grazing on native pastures.

Soil characteristics and chemistry

Laboratory data indicate the following attributes for this SPC:

- Gradational textures of light clays and clay loams;
- pH (laboratory analysis) is moderately alkaline in topsoils increasing slightly to strongly alkaline in subsoils;
- Electrical conductivity is low in topsoils and extreme in subsoils from 0.20 mbgl;
- Chloride is very low in topsoils increasing to extreme levels in subsoil;
- CEC ranges are low in topsoil varying between low and moderate in subsoils;
- ESP is sodic in topsoil and extremely sodic in subsoils form 0.20 mbgl. CEC results are above to 3 cmol(+)=kg-1 which indicates that ESP results may be relied upon as an indicator of sodicity;
- Ca:Mg ratios are high in topsoil decreasing slightly to moderate in subsoils;
- Nitrogen levels in topsoil are very low;
- Micronutrients indicate moderate levels for copper, manganese and zinc;
- EAT reports some dispersion in topsoil, increasing to complete dispersion in subsoils from 0.20 mbgl;
- R1 dispersion overall is low;
- The level of bicarbonate extractable phosphorus present is high in topsoil; and
- Organic carbon in topsoil is very low.

Representative site

Site 7 was selected as a representative site of this SPC.

A site description and soil profile morphology summary are presented in Table 4-12. The soil chemistry results for this SPC are presented in Table 4-13.

Table 4-12: Land Summary SPC 6

Item	Description
Representative Site	7
Representative Site photograph	
Location GDA2020 ZONE 54	738636 7808181
Current Use	Sparse, near desolate area with fringe vegetation consisting of Ironbark
Site survey type	Detailed, 50 mm hand auger
Vegetation	Very sparse vegetation
Disturbance	Limited clearing observed
Landform element /pattern	Gently undulating plain, alluvial flat
Microrelief	No microrelief observed
Drainage	Moderately well drained (Class 4)
Permeability (LRA, 2021)	Moderately Permeable (Class 3)
Erosion Observed	Sheet and gully erosion observed
Slope (%)	1.0 / 1.0
Surface coarse fragments	<2% coarse fragments, 2-6mm
Surface condition	Firm
SPC ASC Order/Suborder	Brown Kandosol
Site ASC Order (s)	Sodic Eutrophic Brown Kandosol; moderately thick, non-gravelly, clay loamy, clayey, deep (Confidence level 1) ASC Coded Classification (Isbell, 2021): 1KAABAHEOBMOW
Land System / Soils Concept (Perry et al., 1964)	Strathpark / Vanrook
K-Factor (Rosewell, 1993)	0.030
Land suitability summary	Land Suitability, Regional Frameworks: Severe (4) limitations for mangoes, bananas and eggplant. Extreme (5) limitations for peanut, rice and sorghum. Agricultural Suitability Class: C2

Item	Description
Soil quality for mine rehabilitation	Not suitable for reuse in rehabilitation activities.
Total area (ha)	23
Soil Profile Morphology Summary	



Horizon Depth (m), Boundary (Bdy)	Field Texture	Grade of Pedality Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Depth (m) / Field pH	Notes
A11 00.0-0.18 Clear 20-50mm	Light clay	Weak Firm	Nil inclusions or segregations	10YR4/2 dark greyish brown Nil mottles or bleaching	Dry Moderately well drained	Nil roots	0.10 / 8.0	Nil
A12 0.18-0.30 Abrupt 5-20mm	Light clay	Weak Firm	Nil inclusions or segregations	10YR4/3 brown Nil mottles or bleaching	Dry Moderately well drained	Nil roots	0.25 / 8.0	
B21 0.30-0.80 Clear 20-50mm	Silty clay loam	Weak Firm	Nil inclusions or segregations	10YR5/4 yellowish brown Nil mottles or bleaching	Dry Moderately well drained	Nil roots	0.60 / 8.5	
B21 0.80-1.00 EOBH	Clayey sand	Weak Weak	Nil inclusions or segregations	10YR5/4 yellowish brown Nil mottles or bleaching	Dry Well drained	Nil roots	0.90 / 8.5	

Table 4-13: Soil Chemistry Results for SPC 6, Representative Site 7

Analysis (Unit)	Sample Depth (mbgl)				
	0.00-0.10	0.20-0.30	0.50-0.60	0.70-0.80	0.90-1.00
	A1 horizon	A2 horizon	A2 horizon	A2 horizon	B2 horizon
Soil pH (H20)	8.14	7.88	8.16	8.51	8.74
Soil pH (CaCl2 / 0.01M)	7.0	-[1]	-	-	-
Soil EC (dS/m)	0.084	4.092	4.843	2.980	1.464
Soil Cl (mg/kg)	94	3793	3222	2160	1211
Exch. Ca (meq/100g)	6.9	7.4	5.9	3.9	1.8

Analysis (Unit)	Sample Depth (mbgl)				
	0.00-0.10	0.20-0.30	0.50-0.60	0.70-0.80	0.90-1.00
	A1 horizon	A2 horizon	A2 horizon	A2 horizon	B2 horizon
Exch. Mg (meq/100g)	4.36	5.65	4.90	3.47	2.20
Exch. K (meq/100g)	0.48	0.24	0.21	0.16	0.14
Exch. Na (meq/100g)	1.24	3.98	4.89	3.67	2.68
CEC (meq/100g)	13.0	17.3	15.9	11.2	6.8
Ca/Mg (ratio)	1.6	1.3	1.2	1.1	0.8
ESP (%Na/CEC)	10	23	31	33	39
Nitrate (mg/kg)	2.2	-	-	-	-
Ammonia (mg/kg)	0.2	-	-	-	-
Total Nitrogen (mg/kg)	0.03	-	-	-	-
Sulfate-S (mg/kg)	10.8	-	-	-	-
Total S (%)	<50	-	-	-	-
Zinc (mg/kg)	0.6	-	-	-	-
Mn (mg/kg)	8	-	-	-	-
Iron (mg/kg)	9	-	-	-	-
Copper (mg/kg)	1.3	-	-	-	-
Boron (mg/kg)	0.42	-	-	-	-
Silicon (mg/kg)	63	-	-	-	-
Tot Organic Carbon (%)	0.44	-	-	-	-
Organic Matter (%)	0.44	-	-	-	-
P (mg/kg)	17	-	-	-	-
Disp Ratio (R1)	0.52	0.34	0.43	0.63	0.54
EAT (No.)	2	1	1	1	1
Gravel >2mm (%)	0	0	0	0	0
CS >50µm (%)	42	23	17	30	57
CS >20µm (%)	51	33	29	42	66
2-50µm-Silt (%)	28	40	41	37	17
2-20µm-Silt (%)	20	29	29	25	8
Clay <2µm (%)	29	38	42	33	26
Texture	Clay Loam	Sandy Clay Loam	Silty Clay	Clay Loam	Clay Loam
PAWC Assessment					
Horizon Depth (m)	0.18	0.12	0.40	0.10	0.20

Analysis (Unit)	Sample Depth (mbgl)				
	0.00-0.10	0.20-0.30	0.50-0.60	0.70-0.80	0.90-1.00
	A1 horizon	A2 horizon	A2 horizon	A2 horizon	B2 horizon
PAWC per horizon (mm)	14.40	7.20	40.00	8.00	16.00
PAWC Total	85.60				

1. '-' indicates laboratory analysis was not conducted for this sample.

4.7 Soil Profile Class 7: Deep, soft, moderately acidic, reddish brown sandy loam on red sandy clay loam subsoil

Overview

SPC 7 is a deep, soft, moderately acidic, reddish brown sandy loam on red sandy clay loam subsoil. The basic ASC is a red Kandosol and is associated with undulating plains and rises and is the dominant SPC to the south, south west of the soil study area. Vegetation includes tall woodlands of mixed vegetation including Corymbia Setosa (Bloodwoods) and Erythrophleum Chlorostachys (Ironwood).

SPC 7 has moderate limitations that make it suitable for mangoes and eggplant cropping, severe limitations for bananas and extreme limitations for peanut, rice and sorghum cropping. SPC 7 is suitable as limited cropping land and sown pastures.

Soil characteristics and chemistry

Laboratory data indicate the following attributes for this SPC:

- Gradational texture of sands to sandy clay loam;
- pH (laboratory analysis) is moderately acidic in topsoil varying from slightly acidic to moderately acidic in subsoils;
- Electrical conductivity is very low;
- Chloride is very low;
- CEC ranges are very low;
- ESP is non-sodic in topsoil and varies from being sodic to 0.50 mbgl to non-sodic 0.50 mbgl and below. Review of CEC results below to 3 cmol(+)=kg-1 indicates that ESP results may not be relied upon as an indicator of sodicity;
- Ca:Mg ratios are high in topsoil and decreases to low in subsoils at 1.40 mbgl;
- Nitrogen levels in topsoil is very low;
- Micronutrient levels indicate moderate levels of manganese and low levels for copper and zinc;
- EAT reports no dispersion or slaking;
- R1 dispersion is low in topsoil, increases slightly to moderate at 0.20 to 0.30 mbgl and then decreases with depth to low levels;
- The level of bicarbonate extractable phosphorus present is moderate in topsoil; and
- Organic carbon in topsoil is low.

Representative site

Site 18 was selected as a representative site of this SPC.

A site description and soil profile morphology summary are presented in Table 4-14. The soil chemistry results for this SPC are presented in Table 4-15.

Table 4-14: Land Summary SPC 7

Item	Description
Representative Site	18
Representative Site photograph	
Location GDA2020 ZONE 54	744760 7804883
Current Use	Native woodland
Site survey type	Detailed, 50 mm hand auger
Vegetation	Mixed vegetation including bloodwood and ironwood
Disturbance	No disturbance observed
Landform element /pattern	Undulating rises, mid slope
Microrelief	No microrelief observed
Drainage	Moderately well drained (Class 4)
Permeability (LRA, 2021)	Moderately Permeable (Class 3)
Erosion Observed	No erosion observed
Slope (%)	<5
Surface coarse fragments	No coarse fragments
Surface condition	Soft
SPC ASC Order/Suborder	Red Kandosol
Site ASC Order (s)	Haplic Mesotrophic Red Kandosol; moderately thick, non-gravelly, sandy, clay loamy, very deep (Confidence level 1) ASC Coded Classification (Isbell, 2021): 1KAAAAGCDBEKMX
Land System / Soils Concept (Perry et al., 1964)	Strathpark, Hampstead, Strathmore / Cockatoo
K-Factor (Rosewell, 1993)	0.030
Land suitability summary	Land Suitability, Regional Frameworks: Moderate (3) limitations for mangoes and eggplant. Severe (4) limitations for bananas. Extreme (5) limitations for soybean, mungbean and sorghum. Agricultural Suitability Class: B

Item	Description
Soil quality for mine rehabilitation	Topsoils between 0.00 m and 0.30 mbgl may be stripped and reused for topdressing in rehabilitation activities. Subsoils are not suitable for reuse in rehabilitation activities. Stripped topsoils to 0.30 mbgl may be reused in rehabilitation activities with no amelioration required. Subsoils to a depth up to 1.50 mbgl are suitable for stripping and reuse as subsoil in rehabilitation activities.
Total area (ha)	961
Soil Profile Morphology Summary	



Horizon Depth (m), Boundary (Bdy)	Field Texture	Grade of Pedality Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Depth (m) / Field pH	Notes
A11 0.00-0.20 Sharp <5mm	Loamy sand	Massive Loose	Nil inclusions or segregations	7.5YR3/4 dark reddish brown Nil mottles or bleaching	Moderately moist Rapidly drained	Medium 2-5mm Few	0.10 / 6.0	Road nearby
A12 0.20-0.41 Abrupt 5-20mm	Loamy sand	Massive Loose	Nil inclusions or segregations	2.5YR4/6 yellowish red Nil mottles or bleaching	Moderately moist Rapidly drained	Very fine <1mm Few	0.30 / 6.0	
B21 0.41-0.96 Gradual 50-100mm	Sandy loam	Massive Loose	Nil inclusions or segregations	2.5YR4/6 yellowish red Nil mottles or bleaching	Dry Rapidly drained	Very fine <1mm Few	0.60 / 6.0	
B22 0.96-1.50 EOBH	Sandy loam	Massive Loose	Nil inclusions or segregations	2.5YR4/8 red Nil mottles or bleaching	Dry Well drained	Nil roots	1.10 / 6.0	

Table 4-15: Soil Chemistry Results for SPC 7, Representative Site 18

Analysis (Unit)	Sample Depth (mbgl)					
	0.00-0.10	0.20-0.30	0.50-0.60	0.80-0.90	1.10-1.20	1.40-1.50
	A11 horizon	A12 horizon	B21 horizon	B21 horizon	B21 horizon	B22 horizon
Soil pH (H20)	5.97	6.37	5.89	5.84	5.83	5.80
Soil pH (CaCl2 / 0.01M)	5.1	-[1]	-	-	-	-
Soil EC (dS/m)	0.024	0.009	0.004	0.003	0.002	0.002
Soil Cl (mg/kg)	25	29	27	23	22	10
Exch. Ca (meq/100g)	1.3	0.6	0.2	0.3	0.2	0.1
Exch. Mg (meq/100g)	0.23	0.26	0.20	0.26	0.49	0.69
Exch. K (meq/100g)	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
Exch. Na (meq/100g)	<0.065	0.12	<0.065	<0.065	<0.065	<0.065
CEC (meq/100g)	1.6	1.0	0.5	0.6	0.8	0.9
Ca/Mg (ratio)	5.5	2.3	1.2	1.0	0.5	0.2
ESP (%Na/CEC)	0	11	3	2	1	1
Nitrate (mg/kg)	5.8	-	-	-	-	-
Ammonia (mg/kg)	2.0	-	-	-	-	-
Total Nitrogen (mg/kg)	0.02	-	-	-	-	-
Sulfate-S (mg/kg)	3.8	-	-	-	-	-
Total S (%)	<50	-	-	-	-	-
Zinc (mg/kg)	<0.5	-	-	-	-	-
Mn (mg/kg)	12	-	-	-	-	-
Iron (mg/kg)	36	-	-	-	-	-
Copper (mg/kg)	0.2	-	-	-	-	-
Boron (mg/kg)	<0.1	-	-	-	-	-
Silicon (mg/kg)	12	-	-	-	-	-
Tot Organic Carbon (%)	0.69	-	-	-	-	-
Organic Matter (%)	0.77	-	-	-	-	-
P (mg/kg)	12	-	-	-	-	-
Disp Ratio (R1)	0.26	0.68	0.36	0.37	0.19	0.14
EAT (No.)	8	8	8	8	8	8
Gravel >2mm (%)	0	0	0	0	0	0
CS >50µm (%)	91	87	83	81	79	75
CS >20µm (%)	90	89	87	82	80	77
2-50µm-Silt (%)	0	2	5	2	2	2
2-20µm-Silt (%)	1	1	1	1	1	1
Clay <2µm (%)	9	10	12	17	19	22

Analysis (Unit)	Sample Depth (mbgl)					
	0.00-0.10	**0.20-0.30**	**0.50-0.60**	**0.80-0.90**	**1.10-1.20**	**1.40-1.50**
	A11 horizon	**A12 horizon**	**B21 horizon**	**B21 horizon**	**B21 horizon**	**B22 horizon**
Texture	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Clay Loam	Sandy Clay Loam
PAWC Assessment						
Horizon Depth (m)	0.20	0.21	0.39	0.16	0.24	0.30
PAWC per horizon (mm)	10.00	10.50	19.50	8.00	14.40	18.00
PAWC Total	80.40					

1. '-' indicates laboratory analysis was not conducted for this sample.

4.8 Soil Profile Class 8: Shallow, hard setting, neutral, brown sandy loam with red sandy loam subsoil on metamorphic rock

Overview

SPC 8 is a shallow, hard setting, neutral, brown sandy loam with red sandy loam subsoil on metamorphic rock. The basic ASC is a red Tenosol and is associated with rolling low hills. Vegetation includes mid-dense to sparse tall woodlands of Narrow Leaved Ironbark and medium shrubbery.

SPC 8 has severe limitations for mangoes and bananas and extreme limitations for eggplant, peanut, rice and sorghum land uses that make it unsuitable for cropping activities. SPC 6 is suitable as grazing on native pastures.

Soil characteristics and chemistry

Laboratory data indicate the following attributes for this SPC, excluding subsoils for the very shallow phase:

- Uniform sandy loam textures;
- pH (laboratory analysis) is neutral;
- Electrical conductivity is low;
- Chloride is very low;
- CEC ranges are very low;
- ESP is non-sodic. CEC results are above to 3 cmol(+)=kg-1 and textures of sandy loam indicate that ESP results may be relied upon as an indicator of sodicity;
- Ca:Mg ratios are very high in topsoil decreasing to high in subsoils;
- EAT reports no dispersion or slaking;
- Nitrogen levels in topsoil is very low;
- Micronutrient levels indicate moderate levels of manganese, low levels for zinc and very low levels of copper;
- EAT reports is non dispersive;
- R1 dispersion is low;
- The level of bicarbonate extractable phosphorus present is very low in topsoil; and
- Organic carbon in topsoil is very high.

Representative site

Site 29 was selected as a representative site of this SPC.

A site description and soil profile morphology summary are presented in Table 4-16. The soil chemistry results for this SPC are presented in Table 4-17.

Table 4-16: Land Summary SPC 8

Item	Description
Representative Site	29
Representative Site photograph	
Location GDA2020 ZONE 54	741326 7810064
Current Use	Native woodland
Site survey type	Detailed, 50 mm hand auger
Vegetation	Tall, mid dense forest of ironbark
Disturbance	No effective disturbance
Landform element /pattern	Rolling low hills, simple slope
Microrelief	No microrelief observed
Drainage	Well drained (Class 5)
Permeability (LRA, 2021)	Highly permeable (Class 4)
Erosion Observed	No erosion observed
Slope (%)	15
Surface coarse fragments	20-50% coarse fragments 20-60mm
Surface condition	Hard setting
SPC ASC Order/Suborder	Red Tenosol
Site ASC Order (s)	Basic Lithic Red Tenosol; moderately thick, gravelly, sandy, loamy, shallow (Confidence level 2) ASC Coded Classification (Isbell, 2021): 2TEAAARBGKLU
Land System / Soils Concept (Perry et al., 1964)	Torwood / n/a
K-Factor (Rosewell, 1993)	0.030
Land suitability summary	Land Suitability, Regional Frameworks: Severe (4) limitations for mangoes and bananas. Extreme (5) limitations for eggplant, peanut, rice and sorghum. Agricultural Suitability Class: C2

Item	Description
Soil quality for mine rehabilitation	Topsoils between 0.00 and 0.35 mbgl may be reused in rehabilitation activities with no amelioration required. Subsoil is not available for reuse in rehabilitation activities.
Total area (ha)	80
Soil Profile Morphology Summary	



Horizon Depth (m), Boundary (Bdy)	Field Texture	Grade of Pedality Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Depth (m) / Field pH	Notes
A1 0.00-0.11 Abrupt 5-20mm	Loamy sand	Massive to weak Loose	10-20% coarse fragments 2-6mm	7.5YR5/6 yellowish red Nil mottles or bleaching	Dry Well drained	Fine 1-2mm Few	0.05 / 6.5	-
A2 0.11-0.37 EOBH Hard pan / Rock	Loamy sand	Massive to weak Loose	10-20% coarse fragments 2-6mm	5YR5/8 yellowish red Nil mottles or bleaching	Dry Well drained	Very fine <1mm Few	0.25 / 6.5	

Table 4-17: Soil Chemistry Results for SPC 8, Representative Site 29

Analysis (Unit)	Sample Depth (mbgl)	
	0.00-0.10	0.20-0.30
	A1 horizon	A2 horizon
Soil pH (H20)	6.76	6.67
Soil pH (CaCl2 / 0.01M)	5.6	-[1]
Soil EC (dS/m)	0.011	0.011
Soil Cl (mg/kg)	11	9
Exch. Ca (meq/100g)	2.7	3.5
Exch. Mg (meq/100g)	0.95	1.93
Exch. K (meq/100g)	0.25	0.19
Exch. Na (meq/100g)	<0.065	<0.065
CEC (meq/100g)	3.9	5.6

Analysis (Unit)	Sample Depth (mbgl)	
	0.00-0.10	0.20-0.30
	A1 horizon	A2 horizon
Ca/Mg (ratio)	2.9	1.8
ESP (%Na/CEC)	0	1
Nitrate (mg/kg)	0.6	-
Ammonia (mg/kg)	2.6	-
Total Nitrogen (mg/kg)	0.03	-
Sulfate-S (mg/kg)	3.1	-
Total S (%)	<50	-
Zinc (mg/kg)	<0.5	-
Mn (mg/kg)	11	-
Iron (mg/kg)	5	-
Copper (mg/kg)	<0.1	-
Boron (mg/kg)	<0.1	-
Silicon (mg/kg)	17	-
Tot Organic Carbon (%)	0.43	-
Organic Matter (%)	11 (Organic Carbon)	-
P (mg/kg)	4.5	-
Disp Ratio (R1)	0.39	0.46
EAT (No.)	8	8
Gravel >2mm (%)	0	0
CS >50µm (%)	81	72
CS >20µm (%)	86	79
2-50µm-Silt (%)	10	11
2-20µm-Silt (%)	5	4
Clay <2µm (%)	9	17
Texture	Sandy Loam	Sandy Loam
PAWC Assessment		
Horizon Depth (m)	0.11	0.26
PAWC per horizon (mm)	5.50	13.00
PAWC Total	18.50	

1. '-' indicates laboratory analysis was not conducted for this sample.

4.9 Soil Profile Class 9: Very shallow, hard setting, strongly acidic, yellowish-brown sandy clay loam on sedimentary rock

Overview

SPC 9 is a very shallow, hard setting, strongly acidic, yellowish-brown sandy clay loam on sedimentary rock. The basic ASC is a Leptic Rudusol and is associated with undulating rises. Vegetation includes very sparse tall woodlands of Lancewood on gravelly surface.

SPC 9 has severe limitations for mangoes and bananas and extreme limitations for eggplant, peanut, rice and sorghum land uses that make it unsuitable for cropping activities. It is only suitable for light grazing.

Soil characteristics and chemistry

Laboratory data indicate the following attributes for this SPC:

- Very shallow sandy clay loam on continuous gravel layers and bedrock;
- pH (laboratory analysis) is strongly acidic;
- Very low electrical conductivity;
- Chloride is very low;
- CEC ranges is very low;
- ESP is strongly sodic. Review of CEC results below 3 cmol(+)=kg-1 indicates that ESP results may not be relied upon as an indicator of sodicity.
- Ca:Mg ratios are low;
- Nitrogen levels in topsoil is very low;
- Micronutrient levels indicate moderate levels of manganese and low levels for copper and zinc;
- EAT reports no dispersion or slaking;
- R1 dispersion is low;
- The level of bicarobonate extractable phosphorus present is moderate; and
- Organic carbon in topsoil is low.

Representative site

Site 31 was selected as a representative site of this SPC.

A site description and soil profile morphology summary are presented in Table 4-18. The soil chemistry results for this SPC are presented in Table 4-19.

Table 4-18: Land Summary SPC 9

Item	Description
Representative Site	31
Representative Site photograph	
Location GDA2020 ZONE 54	747722 7809635
Current Use	Native woodland
Site survey type	Detailed, 50 mm hand auger
Vegetation	Very sparse woodland including lancewood
Disturbance	No disturbance observed
Landform element /pattern	Undulating Rise, simple slope
Microrelief	No microrelief observed
Drainage	Well drained (Class 5)
Permeability (LRA, 2021)	Moderately permeable (Class 3
Erosion Observed	Gully erosion
Slope (%)	15
Surface coarse fragments	>90% coarse fragments 20-60mm
Surface condition	Hard setting
SPC ASC Order/Suborder	Leptic Rudosol
Site ASC Order (s)	Acidic Lithic Leptic Rudosol; thin, slightly gravelly, clay loamy, very shallow (Confidence level 2) ASC Coded Classification (Isbell, 2021): 2RUCYCZAIAFMZT
Land System / Soils Concept (Perry et al., 1964)	Torwood / n/a
K-Factor (Rosewell, 1993)	0.025
Land suitability summary	Land Suitability, Regional Frameworks: Severe (4) limitations for mangoes and bananas. Extreme (5) limitations for eggplant, peanut, rice and sorghum. Agricultural Suitability Class: C3
Soil quality for mine rehabilitation	Topsoil stripping is not suitable for reuse in rehabilitation activities due to location, rockiness and dispersive limitations.
Total area (ha)	93

Item	Description
Soil Profile Morphology Summary	



Horizon Depth (m), Boundary	Field Texture	Grade of Pedality Strength	Inclusions Segregations	Colour, Mottle, Bleaching	Moisture Drainage	Roots	Depth (m) / Field pH	Notes
A1 0.00-0.10 Refusal on continuous gravel layer	Loam	Massive, loose	2-10% coarse fragments 2-6mm	10YR4/6 dark yellowish brown Nil mottles or bleaching	Dry Well drained	No	0.10 / 6.0	0.00-0.10

Table 4-19: Soil Chemistry Results for SPC 9, Representative Site 31

Analysis (Unit)	Sample Depth (mbgl)
	0.00-0.10
	A1 horizon
Soil pH (H20)	5.55
Soil pH (CaCl2 / 0.01M)	4.5
Soil EC (dS/m)	0.069
Soil Cl (mg/kg)	34
Exch. Ca (meq/100g)	0.1
Exch. Mg (meq/100g)	1.30
Exch. K (meq/100g)	<0.12
Exch. Na (meq/100g)	0.39
CEC (meq/100g)	2.5
Ca/Mg (ratio)	0.1
ESP (%Na/CEC)	16
Nitrate (mg/kg)	1.4
Ammonia (mg/kg)	4.2
Total Nitrogen (mg/kg)	<0.02

Analysis (Unit)	Sample Depth (mbgl)
	0.00-0.10
	A1 horizon
Sulfate-S (mg/kg)	2.6
Total S (%)	<50
Zinc (mg/kg)	<0.5
Mn (mg/kg)	6
Iron (mg/kg)	28
Copper (mg/kg)	0.2
Boron (mg/kg)	<0.1
Silicon (mg/kg)	14
Tot Organic Carbon (%)	0.39
Organic Matter (%)	0.39
P (mg/kg)	13
Disp Ratio (R1)	0.53
EAT (No.)	8
Gravel >2mm (%)	0
CS >50µm (%)	62
CS >20µm (%)	69
2-50µm-Silt (%)	15
2-20µm-Silt (%)	9
Clay <2µm (%)	22
Texture	Sandy Clay Loam
Horizon Depth (m)	0.10
PAWC per horizon (mm)	6.00
PAWC Total	6.00

5 LAND SUITABILITY ASSESSMENT

5.1 Introduction

A land suitability assessment has been undertaken to classify the soil types and mapping units (described in Section 4) according to their suitability for relevant land uses. The land suitability assessment has been undertaken in accordance with GALE (DSITI & DNRM, 2015), Regional Frameworks (DSITI and DNRM, 2013) with reference to Queensland Soil and Land Resource Survey Information Guideline (Department of Resources, 2021) and Queensland Land Resource Assessment Guidelines, Volume 1: Soil and Land Resource Assessment (Department of Environment and Science, 2021).

GALE (DSITI and DNRM, 2015) and the Regional Frameworks (DSITI and DNRM, 2013) give specific information for appropriate land uses and their associated limitations. The Regional Frameworks were reviewed in conjunction with GALE (DSITI and DNRM, 2015) to assist with assessing land suitability in the study area.

In general, the tasks undertaken with reference to GALE (DSITI and DNRM, 2015) and the Regional Frameworks (DSITI and DNRM, 2013) included:

- Identification of potentially relevant agricultural land uses. A land use is a combination of crop type/species and crop management system.
- Description of the land use requirements/limitations for the agricultural land uses.
- Identification of soil and land attributes that describe the limitations.
- Determining the limitation categories for each attribute.
- Assigning each limitation category to a land suitability subclass.
- Assigning an overall land suitability class to each SPC for each agricultural land use.

GALE defines five Land Suitability Classes for use in Queensland (Table 5-1) in which the land suitability for agriculture (i.e. cropping or grazing) decreases progressively from Land Suitability Class 1 to Class 5, based on the severity of the land use limitations.

Table 5-1: Land Suitability Classes

Land Suitability Class	Suitability	Limitations	Definition
1	Suitable	Negligible	Highly productive land requiring only simple management practices to maintain economic production.
2	Suitable	Minor	Land with limitations that either constrain production or require more than the simple management practices of class 1 land to maintain economic production.
3	Suitable	Moderate	Land with limitations that either further constrain production or require more than those management practices of class 2 land to maintain economic production.

Land Suitability Class	Suitability	Limitations	Definition
4	Unsuitable	Severe	Currently unsuitable land. The limitations are so severe that the sustainable use of the land in the proposed manner is precluded. In some circumstances, the limitations may be surmountable with changes to knowledge, economics or technology.
5	Unsuitable	Extreme	Land with extreme limitations that preclude any possibility of successful sustained use of the land in the proposed manner.

Land rated in Land Suitability Classes 1 to 3 is considered suitable for agricultural land use with negligible to moderate limitations. The long-term benefits obtained from using Land Suitability Classes 1 to 3 land for agriculture typically outweigh the inputs required to initiate and maintain agricultural production. It should be noted that with the use of soil improvement techniques (e.g. fertiliser), Class 3 land may be just as productive as Class 1 or 2 land.

Land rated as Land Suitability Class 4 is currently unsuitable for agricultural land use due to the severity of one or more limitations. However, in some circumstances it may be possible to upgrade Class 4 land to a more suitable class with the implementation of considerable soil improvement measures.

Land rated as Land Suitability Class 5 is considered entirely unsuitable for the specified land use as the limitation(s) are so severe that the inputs required to initiate and maintain the specified land use are not sustainable.

5.2 Agricultural Land Uses, Requirements and Limitations

The Regional Frameworks (DSITI and DNRM, 2013) provides the attributes, limitations and suitability subclass values for land suitability limitations assessment.

In reviewing the Regional Frameworks (DSITI and DNRM, 2013) suitability subclasses and attributes, the following assessments were undertaken:

- an assessment based on the cropping examples outlined in the suitability framework for the Gulf Plains area for cropping based on six subclasses (crops selected from the Regional Frameworks). The crops selected included mangoes, bananas, eggplant, peanuts, rice, and sorghum.
- These crops were identified from review of the Perry et al (1964), Wilson et al (1999) and Regional Frameworks (DSITI and DNRM, 2013) which reported that these crops are grown or may be grown in this part of the Gulf region. Different irrigation strategies for the same crop (e.g. spray, rainfed and furrow irrigation) have been assessed as one assessment per crop, in the favourable class (Lower class number). It states in GALE (DSITI & DNRM, 2015) that different irrigation strategies do not increase the number of crops.

These agricultural land uses were adopted for the land suitability assessment.

5.3 Land and Soil Attributes

The land suitability assessment for cropping is based on the following soil and land attributes:

- climate, precipitation (Cp);
- climate, heat stress (Cs);
- climate, frost (Cf);
- climate, temperature variation (Ct);
- wind erosion (A);
- moisture availability, irrigated crops (M);
- moisture availability, rainfed crops (M);
- nutrient balance, pH (Nr);
- physical restrictions (P);
- soil depth (Pd);
- water erosion (E);
- wetness (W);
- rockiness, all crops (R); and
- gilgai microrelief, all crops (Tm); and
- irrigation efficiency, all furrow irrigated crops (If).

5.4 SPC Assessment, Limitation Categories and Land Suitability Classification

Field and laboratory attributes collected from each of the SPC representative sites were reviewed against the Regional Frameworks (DSITI and DNRM, 2013) limitation (such as climate, precipitation) for each selected land use (i.e. Mangoes).

Table 5-2 presents the summary of Regional Frameworks (DSITI and DNRM, 2013) Land Suitability Classes for representative site SPCs. Table 5-3 presents the individual UMAs (SPC mapped areas where soil attributes such as rockiness or slope vary slightly) and the assessment of that specific limitation.

Sections 5.4.1 to 5.4.16 provide a detailed description of the SPC and individual limitations in the soil study area with their corresponding land suitability class results. Section 5.4.15 provides a summary of the limitations for each SPC. All limitations for each SPC were assessed with the most severe (highest suitability subclass) selected to represent that land use. The land suitability classes for cropping are presented in Figure 4.

Table 5-2: SPC, Land Uses and Regional Frameworks Suitability Subclass Assessment Summary

SPC	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
1	**3**	**4**	**3**	**5**	**5**	**5**
2	**3**	**4**	**3**	**5**	**5**	**5**
3	**5**	**5**	**5**	**5**	**5**	**5**
4	**3**	**4**	**3**	**5**	**5**	**5**
5	**4**	**4**	**4**	**5**	**5**	**5**
6	**4**	**4**	**4**	**5**	**5**	**5**
7	**3**	**4**	**3**	**5**	**5**	**5**
8	**4**	**4**	**5**	**5**	**5**	**5**
9	**4**	**4**	**5**	**5**	**5**	**5**

Individual UMAs of each SPC were assessed for land suitability classes against the rule set selected and representative SPC assessment in Table 5-2.

This review of detailed and check observation site field data included surface and profile attributes, slope, rockiness, and depth of soil profile. Table 5-3 includes UMAs where land suitability classes were amended. These amendments have been presented in Figure 5.

Table 5-3: Land Suitability Classes, Limitation and Regional Frameworks Assessment UMAs distinct from SPCs

SPC	UMA	Land Use Limitations and Assessment					
		Mangoes	Bananas	Eggplant	Peanut	Rice	Sorghum
1	-	No Limitations Amendments to UMAs					
2	-	No Limitations Amendments to UMAs					
3	-	No Limitations Amendments to UMAs					
4	-	No Limitations Amendments to UMAs					
5	-	No Limitations Amendments to UMAs					
6	-	No Limitations Amendments to UMAs					
7	-	No Limitations Amendments to UMAs					
8	19	**4**	**4**	**4 (Limitation updated based on slope of observation**	**5**	**5**	**5**

SPC	UMA	Land Use Limitations and Assessment					
		Mangoes	Bananas	Eggplant	Peanut	Rice	Sorghum
				site C81 and water erosion assessment.)			
9	-	No Limitations Amendments to UMAs					

5.4.1 Climate, precipitation (Cp) limitation

The precipitation limitation refers to the amount of rainfall during the growing season and is relevant for irrigated cropping.

A review of the annual rainfall for Richmond Post Office between 1889 and 2020 (Bureau of Meteorology, 2020), indicates that the soil study area a mean annual rainfall less than 500 mm (Level Cr5).

An assessment of the SPCs for this limitation is presented in Table 5-4. This indicates that climate is a severe limitation for sorghum land use in the soil study area. Remaining selected sub class were not assessed as per Regional Frameworks (DSITI and DNRM, 2013).

Table 5-4: Climate Land Suitability Subclass Level

SPC	Level	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
All SPCs	Cr5	-	-	-	-	-	4[1]

1. The limited nominated land uses including African mahogany, Spotted Gum, Maize and Soybean reported suitability subclass 5.

5.4.2 Climate, heat stress (Cs) limitation

The heat stress limitation refers to the solar radiation associated with high temperatures likely to cause damage to leaves and fruit of crops.

An assessment of the SPCs for this limitation is presented in Table 5-5 and is based on maximum daily temperatures for 2019 (Bureau of Meteorology, 2020) for the soil study area.

Results indicate severe limitations for land uses including banana land use, moderate limitations for mangoes and minor limitations across the remaining four land uses.

Table 5-5: Climate, Heat Stress Land Suitability Subclass Level

SPC	Level	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
All SPCs	Cs3	3	4	2	2	2	2

5.4.3 Climate, frost (Cf) limitation

The frost limitation refers to if it likely that frost would need to be considered in site selection and if a management regime is needed for certain frost sensitive crops i.e. less than 4 degrees Celsius.

An assessment of the SPCs for this limitation is presented in Table 5-6 and is based on minimum daily temperatures for 2019 (Bureau of Meteorology, 2020) for the soil study area.

Results indicate that frost is a moderate limitation for land uses including mangoes, bananas, and eggplant. Remaining selected land uses peanut, rice and sorghum indicated minor limitations.

Table 5-6: Climate, Frost Land Suitability Class Level

SPC	Level	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
All SPCs	Cf3	3	3	3	2	2	2

5.4.4 Climate, temperature variation (Ct) limitation

The temperature variation limitation refers to certain crops requiring cooler temperatures for efficient seed setting.

An assessment of the SPCs for this limitation is presented in Table 5-7. Mean monthly temperatures of Hughenden, located to the southeast of the soil study area was assessed (BOM, 2021).

Results indicate that temperature variation is a minor limitation for mangoes, bananas and eggplant. Remaining selected land uses of peanuts, rice and sorghum indicated negligible limitations.

Table 5-7: Climate, Temperature Variation Land Suitability Class Level

SPC	Level	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
All SPCs	Ct1	2	2	2	1	1	1

5.4.5 Wind erosion (A) limitation

Wind erosion refers to the vulnerability of sandy surfaced soils in arid areas to wind erosion.

An assessment of the SPCs for this limitation is presented in Table 5-8.

Results indicate that wind erosion is a severe limitation for SPC 5 for land use sorghum. All remaining SPCs presented negligible to moderate limitations, suitable for selected land uses.

Table 5-8: Wind Erosion Land Suitability Class Level

Land Attribute Level		Land suitability class for selected land uses					
SPC	Level	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
1	A1	1	1	1	1	1	1
2	A2	2	2	2	3	3	3
3	A2	2	2	2	3	3	3
4	A2	2	2	2	3	3	3
5	A2	2	2	2	3	3	4
6	A1	1	1	1	1	1	1
7	A2	2	2	2	3	3	3
8	A2	2	2	2	3	3	3
9	A2	2	2	2	3	3	3

5.4.6 Moisture Supply (M) Irrigated (Ir) and Rainfed (Rf) Crops limitation

Soil moisture supply (also referred to as 'storage') is determined by assessing plant available water capacity (PAWC) to the effective rooting depth (ERD).

For each SPC in the soil study area, the ERD is the depth of shallow impermeable layers in the soil profile or the depth of horizons with high salt concentrations. Where no impermeable or saline layers are present, an ERD of 1.0 m has been adopted in accordance with the Biggs and Philip (1995) method.

PAWC was calculated for each SPC using the methodology for assessing soil water storage in the *Regional Planning Interests Act 08/14: Guideline How to demonstrate that land in the strategic cropping area does not meet the criteria for strategic cropping land* (DSDMIP, 2019), field and chemical data for each SPC. The assigned PAWC values are presented in Table 5-9 and calculated based on laboratory texture, sample depth and horizon depths.

Table 5-9: Assigned PAWC for SPCs

SPC	PAWC (mm/100mm)
1	53.90
2	48.50
3	8.50
4	45.00
5	22.90
6	16.00
7	80.40
8	18.50
9	6.00

Each SPC has been assigned to one of the land attribute levels, based on the PAWC shown in Table 5-9. The SPC land attribute levels for irrigated crops and rainfed crops are presented in Tables 5-10 and 5-11.

Results indicates that in general, moisture supply for their applicable soils PAWC value is a negligible to moderate limitation for SPCs 1, 2, 4,and 7.

Moisture supply for SPCs assessed as having severe limitations including shallow soil profiles for SPCs 3, 5 8 and 9. and high chloride levels for SPC 6 at 0.20 mbgl.

Rainfed irrigation applied specifically to land uses soybean, mungbean and sorghum. All SPCs indicated extreme limitations, as presented in Table 5-12.

Table 5-10: Moisture Availability, Irrigated Crop Land Suitability Class Level

SPC	PAWC	Suitability subclass for Cane	Suitability subclass for Cucurbits	Suitability subclass for Tomatoes	Suitability subclass for Soybean	Suitability subclass for Mungbean	Suitability subclass for Sorghum
1	53.90	3	3	3	3	3	3
2	48.50	3	3	3	3	3	3
3	8.50	4	4	4	4	4	4
4	45.00	3	3	3	3	3	3
5	22.90	4	4	4	4	4	4
6	16.00	4	4	4	4	4	4
7	80.40	2	2	1	1	2	2
8	18.50	4	4	4	4	4	4
9	6.00	4	4	4	4	4	4

1. SPC soil profile is assessed as sand texture (Laboratory PSA Review) throughout the top 1.00m, therefore reported the lowest PAWC value of a full 1.00m soil profile. The lowest class level of less than 40 PAWC has been selected to reflect the minimal PAWC the soil profile is able to be store.

Table 5-11: Moisture Availability, Rainfed Land Suitability Class Level

SPC	PAWC / Value/s	Suitability subclass for Soybean	Suitability subclass for Mungbean	Suitability subclass for Sorghum
1	53.90	5	5	5
2	48.50	5	5	5
3	8.50	5	5	5
4	45.00	5	5	5
5	22.90	5	5	5
6	16.00	5	5	5
7	80.40	5	5	5
8	18.50	5	5	5
9	6.00	5	5	5

5.4.7 Nutrition Balance, pH (Nr) limitation

The soil pH affects the availability of nutrients for plant use and growth. Table 5-12 lists the soil pH nutrition land attribute level of each SPC.

An assessment of the SPCs for this limitation is presented in Table 5-12.

Results indicate that SPC 3 reporting minor limitations across all land uses and all remaining SPCs indicated negligible limitations.

Table 5-12: Soil Nutrition Land Suitability Class Level

Land Attribute Level		Land suitability class for selected land uses					
SPCs	Level	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
1	Nr1	1	1	1	1	1	1
2	Nr2	1	1	1	1	1	1
3	Nr3	2	2	2	2	2	2
4	Nr1	1	1	1	1	1	1
5	Nr1	1	1	1	1	1	1
6	Nr2	1	1	1	1	1	1
7	Nr1	1	1	1	1	1	1
8	Nr1	1	1	1	1	1	1
9	Nr1	1	1	1	1	1	1

1- pH H2O laboratory results referenced. The surface to 0.30 mbgl results assessed.

5.4.8 Soil Physical Restrictions (P) limitation

The soil physical condition relates to the physical condition of soils which affects cropping activities such as the timing of cultivation and the harvesting of root crops. Conditions such as hard setting surfaces, large aggregates and sodicity can create adverse conditions that affect seed germination and seedling development.

An assessment of the SPCs based on this limitation are presented in Table 5-13.

Results indicate that soil physical condition was similar across most SPCs with respect to surface condition, soil texture and structure. SPCs 6 and 9 indicated severe and extreme limitations for peanuts and sorghum. All remaining land uses for all SPCs presented negligible to moderate limitations.

Table 5-13: Soil Physical Restrictions Land Suitability Class Level

Land Attribute Level		Land suitability class for selected land uses					
SPC	Level	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
1	Ps2	2	2	1	1	1	1
2	Ps2	2	2	1	1	1	1

Land Attribute Level		Land suitability class for selected land uses					
SPC	Level	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
3	Ps2	2	2	1	1	1	1
4	Ps2	2	2	1	1	1	1
5	Ps2	2	2	1	1	1	1
6	Ps6	3	3	3	4	3	4
7	Ps2	2	2	1	1	1	1
8	Ps2	2	2	1	1	1	1
9	Ps7	3	3	3	5	3	4

5.4.9 Soil Depth (Pd) limitation

The soil depth relates to the depth limitation relating to physical support for the plant. Land uses may require a deeper soil profile.

An assessment of the SPCs based on this limitation is presented in Table 5-14.

Results indicate that limitations were negligible to moderate for selected land uses for SPCs 1, 2, 4, 6, and 7. Severe to extreme limitations due to soil depth were observed for SPCs 3, 5, 8 and 9.

Table 5-14: Soil Depth Land Suitability Class Level

Land Attribute Level		Land suitability class for selected land uses					
SPCs	Level	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
1	Pd2	1	1	1	1	1	1
2	Pd2	1	1	1	1	1	1
3	Pd5	5	5	4	5	5	5
4	Pd2	1	1	1	1	1	1
5	Pd4	4	4	2	4	4	4
6	Pd2	1	1	1	1	1	1
7	Pd1	1	1	1	1	1	1
8	Pd4	4	4	2	4	4	4
9	Pd5	5	5	4	5	5	5

5.4.10 Water Erosion (E) limitation

Water erosion relates to the loss of soil during the water flow over the surface. Stable soils are preferred for cropping. The assessment of water erosion is based on the k-factor and slope gradient percentage of the landscape.

An assessment of the SPCs based on this limitation is presented in Table 5-15.

Results indicate that water erosion is a negligible to moderate limitation for most land uses for SPCs 1, 2, 4 and 6.

SPCs 5, 7, 8 and 9 reported minor to extreme limitations for the selected land uses. SPC 3 was assessed as having extreme limitations for all selected land uses.

Table 5-15: Water Erosion Land Suitability ClassLevel

Land Attribute Level		Land suitability class for selected land uses					
SPCs	Level	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
1	E13	1	1	2	2	3	3
2	E12	1	1	2	2	2	3
3	E20	5	5	5	5	5	5
4	E12	1	1	2	2	2	3
5	E15	2	2	3	4	4	4
6	E12	1	1	2	2	2	3
7	E15	2	2	3	4	4	4
8	E18	3	4	5	5	5	5
9	E18	3	4	5	5	5	5

5.4.11 Wetness (W) limitation

Wetness relates to the adequate aeration of soil required for plant growth.

An assessment of the SPCs based on this limitation is presented in Table 5-16.

Results indicate that wetness is a negligible to moderate limitation for all SPCs except for SPCs 3 and 8, assessed as negligible limitations for all land uses.

Table 5-16: Wetness Land Suitability Subclass Level

Land Attribute Level		Land suitability class for selected land uses					
SPCs	Level[1]	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
1	W7	3	3	2	3	2	2

Land Attribute Level		Land suitability class for selected land uses					
SPCs	Level[1]	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
2	W6	2	2	2	2	2	2
3	W2	1	1	1	1	1	1
4	W7	3	3	2	3	2	2
5	W7	3	3	2	3	2	2
6	W7	3	3	2	3	2	2
7	W7	3	3	2	3	2	2
8	W2	1	1	1	1	1	1
9	W3	1	1	2	2	2	2

1- The surface to 0.60 mbgl results assessed for plant growth.

5.4.12 Rockiness, all crops (R) limitation

Rockiness refers to the coarse fragments and rock size and percent coverage in the plough zone which would interfere with agricultural machinery located on the surface.

An assessment of the SPCs based on the limitation is presented in Table 5-17.

Results indicate SPCs 3, 8 and 9 presented severe limitations for all selected land uses. All remaining SPCs presented negligible limitations.

Table 5-17: Rockiness Land Suitability Subclass Level

Land Attribute Level		Land suitability class for selected land uses					
SPC	Level	Suitability subclass for Cane	Suitability subclass for Cucurbits	Suitability subclass for Tomatoes	Suitability subclass for Soybean	Suitability subclass for Mungbean	Suitability subclass for Sorghum
1	R1	1					
2	R1	1					
3	R2	4					
4	R1	1					
5	R1	1					
6	R1	1					
7	R1	1					
8	R1	4					
9	R2	4					

5.4.13 Gilgai microrelief, all crops (Tm) limitation

Microrelief can cause uneven and reduced plant productivity due to uneven water distribution, water ponding, and it can also inhibit machine operations.

An assessment of the SPCs based on the limitation is presented in Table 5-18.

Results indicate that microrelief is not present on the soil study site and is a negligible limitation for all SPCs.

Table 5-18: Microrelief Land Suitability Subclass Level

Land Attribute Level		Land suitability class for selected land uses					
SPC	Level	Suitability subclass for Cane	Suitability subclass for Cucurbits	Suitability subclass for Tomatoes	Suitability subclass for Soybean	Suitability subclass for Mungbean	Suitability subclass for Sorghum
1	Tm1	1					
2	Tm1	1					
3	Tm1	1					
4	Tm1	1					
5	Tm1	1					
6	Tm1	1					
7	Tm1	1					
8	Tm1	1					
9	Tm1	1					

5.4.14 Irrigation Efficiency, all furrow irrigated crops (If) limitation

Irrigation efficiency refers to the applied water matching the soil infiltration characteristics to minimise water loss, deep drainage, and waterlogging issues. As outlined in Section 5.2, different irrigation strategies for the same crop (e.g. spray, rainfed and furrow irrigation) have been assessed against the most favourable irrigation method (spray and rainfed) assessment per crop. Therefore, a specific assessment for furrow irrigated methods has been excluded for this assessment.

5.4.15 Regional Frameworks SPC Limitations Summary

The suitability assessments of each limitation in sections 5.4.1 to 5.4.14 are now summarised for each SPC. The overall class for each land use is based on the most extreme (i.e. highest limitation). They have been summarised in Tables 5-19 to 5-27 and presented in Figure 4.

Table 5-19: Summary of Land Suitability Classes, SPC 1

Land Attribute	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
Cp	-	-	-	-	-	4
Cs	3	4	2	2	2	2
Cf	3	3	3	2	2	2
Ct	2	2	2	1	1	1
A	1	1	1	1	1	1
m(Ir)	3	3	3	3	3	3
m(Rf)	-	-	-	5	5	5
Nr	1	1	1	1	1	1
P	2	2	1	1	1	1
Pd	1	1	1	1	1	1
E	1	1	2	2	3	3
W	3	3	2	3	2	2
R	1	1	1	1	1	1
Tm	1	1	1	1	1	1
Overall Class	**3**	**4**	**3**	**5**	**5**	**5**

Table 5-20: Summary of Land Suitability Classes, SPC 2

Land Attribute	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
Cp	-	-	-	-	-	4
Cs	3	4	2	2	2	2
Cf	3	3	3	2	2	2
Ct	2	2	2	1	1	1
A	2	2	2	3	3	3
m(Ir)	3	3	3	3	3	3
m(Rf)	-	-	-	5	5	5
Nr	1	1	1	1	1	1
P	2	2	1	1	1	1
Pd	1	1	1	1	1	1
E	1	1	2	2	2	3
W	2	2	2	2	2	2
R	1	1	1	1	1	1
Tm	1	1	1	1	1	1
Overall Class	**3**	**4**	**3**	**5**	**5**	**5**

Table 5-21: Summary of Land Suitability Classes, SPC 3

Land Attribute	Suitability subclass for Cane	Suitability subclass for Cucurbits	Suitability subclass for Tomatoes	Suitability subclass for Soybean	Suitability subclass for Mungbean	Suitability subclass for Sorghum
Cp	-	-	-	-	-	4
Cs	3	4	2	2	2	2
Cf	3	3	3	2	2	2
Ct	2	2	2	1	1	1
A	2	2	2	3	3	3
m(Ir)	4	4	4	4	4	4
m(Rf)	-	-	-	5	5	5
Nr	2	2	2	2	2	2
P	2	2	1	1	1	1
Pd	5	5	4	5	5	5
E	5	5	5	5	5	5
W	1	1	1	1	1	1
R	4	4	4	4	4	4
Tm	1	1	1	1	1	1
Overall Class	**5**	**5**	**5**	**5**	**5**	**5**

Table 5-22: Summary of Land Suitability Classes, SPC 4

Land Attribute	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
Cp	-	-	-	-	-	4
Cs	3	4	2	2	2	2
Cf	3	3	3	2	2	2
Ct	2	2	2	1	1	1
A	2	2	2	3	3	3
m(Ir)	3	3	3	3	3	3
m(Rf)	-	-	-	5	5	5
Nr	1	1	1	1	1	1
P	2	2	1	1	1	1
Pd	1	1	1	1	1	1
E	1	1	2	2	2	3
W	3	3	2	3	2	2
R	1	1	1	1	1	1
Tm	1	1	1	1	1	1
Overall Class	**3**	**4**	**3**	**5**	**5**	**5**

Table 5-23: Summary of Land Suitability Classes, SPC 5

Land Attribute	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
Cp	-	-	-	-	-	4
Cs	3	4	2	2	2	2
Cf	3	3	3	2	2	2
Ct	2	2	2	1	1	1
A	2	2	2	3	3	4
m(Ir)	4	4	4	4	4	4
m(Rf)	-	-	-	5	5	5
Nr	1	1	1	1	1	1
P	2	2	1	1	1	1
Pd	4	4	2	4	4	4
E	2	2	3	4	4	4
W	3	3	2	3	2	2
R	1	1	1	1	1	1
Tm	1	1	1	1	1	1
Overall Class	**4**	**4**	**4**	**5**	**5**	**5**

Table 5-24: Summary of Land Suitability Classes, SPC 6

Land Attribute	Suitability subclass for Cane	Suitability subclass for Cucurbits	Suitability subclass for Tomatoes	Suitability subclass for Soybean	Suitability subclass for Mungbean	Suitability subclass for Sorghum
Cp	-	-	-	-	-	4
Cs	3	4	2	2	2	2
Cf	3	3	3	2	2	2
Ct	2	2	2	1	1	1
A	1	1	1	1	1	1
m(Ir)	4	4	4	4	4	4
m(Rf)	-	-	-	5	5	5
Nr	1	1	1	1	1	1
P	3	3	3	4	3	4
Pd	1	1	1	1	1	1
E	1	1	2	2	2	3
W	3	3	2	3	2	2
R	1	1	1	1	1	1
Tm	1	1	1	1	1	1
Overall Class	**4**	**4**	**4**	**5**	**5**	**5**

Table 5-25: Summary of Land Suitability Classes, SPC 7

Land Attribute	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
Cp	-	-	-	-	-	4
Cs	3	4	2	2	2	2
Cf	3	3	3	2	2	2
Ct	2	2	2	1	1	1
A	2	2	2	3	3	3
m(Ir)	2	2	1	1	2	2
m(Rf)	-	-	-	5	5	5
Nr	1	1	1	1	1	1
P	2	2	1	1	1	1
Pd	1	1	1	1	1	1
E	2	2	3	4	4	4
W	3	3	2	3	2	2
R	1	1	1	1	1	1
Tm	1	1	1	1	1	1
Overall Class	**3**	**4**	**3**	**5**	**5**	**5**

Table 5-26: Summary of Land Suitability Classes, SPC 8

Land Attribute	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
Cp	-	-	-	-	-	4
Cs	3	4	2	2	2	2
Cf	3	3	3	2	2	2
Ct	2	2	2	1	1	1
A	2	2	2	3	3	3
m(Ir)	4	4	4	4	4	4
m(Rf)	-	-	-	5	5	5
Nr	1	1	1	1	1	1
P	2	2	1	1	1	1
Pd	4	4	2	4	4	4
E	3	4	5	5	5	5
W	1	1	1	1	1	1
R	4	4	4	4	4	4
Tm	1	1	1	1	1	1
Overall Class	**4**	**4**	**5**	**5**	**5**	**5**

Table 5-27: Summary of Land Suitability Classes, SPC 9

Land Attribute	Suitability subclass for Mangoes	Suitability subclass for Bananas	Suitability subclass for Eggplant	Suitability subclass for Peanut	Suitability subclass for Rice	Suitability subclass for Sorghum
Cp	-	-	-	-	-	4
Cs	3	4	2	2	2	2
Cf	3	3	3	2	2	2
Ct	2	2	2	1	1	1
A	2	2	2	3	3	3
m(Ir)	4	4	4	4	4	4
m(Rf)	-	-	-	5	5	5
Nr	1	1	1	1	1	1
P	3	3	3	5	3	4
Pd	5	5	4	5	5	5
E	3	4	5	5	5	5
W	1	1	2	2	2	2
R	4	4	4	4	4	4
Tm	1	1	1	1	1	1
Overall Class	**5**	**5**	**5**	**5**	**5**	**5**

5.4.16 Agricultural Land Classes

Agricultural land classes (ALCs) are based on a simple hierarchical scheme that is applicable across Queensland. It allows the interpreted land evaluation data to indicate the location and extent of agricultural land that can be used for a wide range of land uses with minimal land degradation.

This evaluation scheme has evolved through various guidelines and state planning policies and is currently referenced in the GALE (DSITI & DNRM, 2015).

Table 5-28 outlines the ALC ranging from crop land (A), to limited crop land (class B), Pasture land (Class C) to non-agricultural land (Class D). The overall suitability classes for each SPC (Section 5.4.15) are assessed against the number of land uses and their suitability class.

Table 5-28: Agricultural Land Classes

Agricultural Land Class	Land Suitability (Cropping)[1]	Description	Number of Crops	Land Use Suitability Class
Crop Land	A	Land that is suitable for a wide range[2] of current and potential crops with nil to moderate limitations to production.	>=4	1-3
	A1	Suitable for a wide range of current and potential broadacre and horticultural[3] crops.	>=4	1-3
	A2	Suitable for a wide range of current and potential horticultural crops only.	>=4	1-3
Limited Crop Land	**B**	Land that is suitable for a narrow range[4] of crops. The land is suitable for sown pastures and may be suitable for a wider range of crops with changes to knowledge, economics or technology.	<=3	1-3
Pasture Land	**C**	Land that is suitable only for improved or native pastures due to limitations that preclude continuous cultivation for crop production. Some areas may tolerate a short period of ground disturbance for pasture establishment.	n/a	4/5
	C1	Suitable for grazing sown pastures requiring ground disturbance for establishment; or native pastures on higher fertility soils.	n/a	4/5
	C2	Suitable for grazing native pastures, with or without the introduction of pasture species, and with lower fertility soils than C1.	n/a	4/5
	C3	Suitable for light grazing of native pastures in accessible areas and includes steep land more suited to forestry or catchment protection.	n/a	5
Non-Agricultural Land[5]	**D**	Land not suitable for agricultural use, including land alienated from agricultural use.	n/a	5
Complex Classes	**A/C** **A/D** **B/C** **C/D**	Land that is a complex of class A, B, C or D land where it is not possible to delineate the land class at the map scale. The dominant class is the first code in the sequence and is assumed to be >50% of the area, but <70%[6].	n/a	-

1. Land Suitability Classes are a guide to assess ALC. Section 5.1 of this report and Table 11 of GALE provide a description of Land Suitability Classes and their correlation to ALC,
2. A wide range of crops is four or more crop types of local commercial significance.
3. Horticulture includes intensively grown small crops (e.g. vegetables) as well as tree crops (e.g. grown for nuts, seeds or fruit). Silviculture (plantation forestry) is not included.
4. A narrow range of crops is three or fewer crop types (broadacre or horticulture) of local commercial significance. Silviculture (plantation forestry) may be included. Crops with similar agronomic requirements e.g. maize and grain sorghum, peaches and nectarines are not generally regarded as different crop types. Different management regimes (including irrigation strategies) for the same crop do not increase the number of crops.
5. Non-agricultural land includes land that cannot be placed in any of the other land classes and includes land such as urban areas and stream channels.
6. In cases where two or more land classes are equally dominant and none are greater than 50%, judgement is used to identify the most appropriate agricultural land class/es for the unit.

The outcome of the agricultural land assessment using the ALC evaluation scheme is shown in Table 5-29 of each SPC. The ALCs within the soil study area are shown in Figure 5.

Table 5-29: Agricultural Land Assessment

Agricultural Land Assessment		
Agricultural Land Class	**SPC**	**Area (ha)**
A1	-	-
A2	-	-
B	1, 2, 4, 7	1,672
C1	-	-
C2	5, 6, 8	311
C3	3, 9	282
D	-	-

SPCs 1, 2, 4, and 7 is land that is suitable for a narrow range of crops or pastures.

SPCs 5, 6 and 8 is land that is suitable for grazing of native pastures, with or without the introduction of pasture species.

SPCs 3 and 9 is land that is suitable for light grazing of native pastures in accessible areas.

6 SOIL RESOURCES ASSESSMENT

All SPCs in the soil study area have been assessed to determine their suitability for stripping and reuse for rehabilitation activities.

An assessment of soil resources has been undertaken based on GTE's experience in soil reuse for mine rehabilitation and with reference to the Elliot and Veness (1981) selection process, the suitability criteria for the use of soils as growth media (DME, 1995) and Mine Rehabilitation, Leading Practice Sustainable Development Program for the Mining Industry (Australian Government, 2016). This assessment considered relevant soil observations and laboratory data collected from each SPC.

Table 6-1 provides a summary of the topsoil and subsoil thicknesses within the project site and their suitability for reuse in rehabilitation activities. The required amelioration measures are also listed. Topsoil stripping depths are presented in Figure 6.

In summary:

- Topsoil from all 9 SPCs is suitable for reuse in rehabilitation activities. Topsoil should be reused in the following order of preference:
    - SPCs 2 and 8; then
    - SPCs 4, 5 and 7; then
    - SPC 1; then
    - SPCs 3 and 9; then
    - SPC 6.
- Topsoil from SPC 3, 6 and 9 require amelioration measures as described in the table below (including the application of gypsum and/or lime and blending of topsoils, as necessary). The application rates and blending ratios will be determined as part of detailed rehabilitation design. In addition, topsoil may benefit from the application of organic matter during reuse to improve soil structure, reduce runoff and improve vegetation re-establishment.
- Subsoil from 5 SPCs (SPC 1, 2, 4, 5 and 7) is suitable for reuse in rehabilitation activities. Subsoil from SPCs 1, 4, and 7 should be preferentially reused before using subsoil from SPC 2 and 5.
- Subsoil from SPC 6 is saline and sodic and is not amenable to amelioration. Hence, subsoil from this SPC is not suitable for reuse in rehabilitation activities.
- Subsoil is not present in SPC 3, 8 and 9.

Table 6-1: Soil Resources in the Soil Study Area

Topsoil			
SPC	**Topsoil Depth Interval (mbgl)**	**Suitable for Reuse in Rehabilitation Activities**	**Required Amelioration and Management Measures for Soil Reuse in Rehabilitation Activities**
1	0.00 to 0.30	Yes	None required
2	0.00 to 0.35	Yes	None required
3	0.00 to 0.15	Yes	In order to increase the pH level of this topsoil for use in rehabilitation activities, the application of agricultural lime is required or alternatively, blending of this topsoil with topsoil from SPC 1, 2, 4, 5 and/or 8.
4	0.00 to 0.20	Yes	None required
5	0.00 to 0.15	Yes	None required
6	0.00 to 0.15	Yes	The application of gypsum is required to reduce the sodicity/dispersive attributes of this topsoil.
7	0.00 to 0.30	Yes	None required
8	0.00 to 0.35	Yes	None required
9	0.00 to 0.10	Yes	The application of gypsum is required to reduce the sodicity/dispersive attributes of the topsoil.
Subsoil			
SPC	**Subsoil Depth Interval (mbgl)**	**Suitable for Reuse in Rehabilitation Activities**	**Required Amelioration and Management Measures for Soil Reuse in Rehabilitation Activities**
1	0.30 to 1.00	Yes	None required
2	0.35 to 1.00	Yes	Visual inspection required prior to reuse of subsoil to confirm that there are no signs of dispersion or erosion. If the visual inspection identifies dispersion and/or erosion, the application of gypsum is required to reduce the sodicity/dispersive attributes of this subsoil. Avoid placement on steeply sloping ground.
3	No subsoil present	Not applicable	
4	0.20 to 1.00	Yes	None required

5	0.15 to 0.45	Yes	Visual inspection required prior to reuse of subsoil to confirm that there are no signs of dispersion or erosion. If the visual inspection identifies dispersion and/or erosion, the application of gypsum is required to reduce the sodicity/dispersive attributes of this subsoil. Avoid placement on steeply sloping ground.
6	0.15 to 1.00	No	Not applicable
7	0.30-1.50	Yes	None required
8	No subsoil present	Not applicable	
9	No subsoil present	Not applicable	

7 CONCLUSION

The key conclusions of the soil assessment are as follows:

- Nine SPC soil types are present in the soil study area.
- The suitability of each SPC for a range of agricultural land uses has been assessed. In overview, the conclusions of the land suitability assessment are as follows:
    - SPCs 1, 2, 4, and 7 are assessed as class B, land that is suitable for a narrow range of crops or pastures;
    - SPCs 5, 6 and 8 are assessed as class C2, land that is suitable for grazing of native pastures, with or without the introduction of pasture species; and
    - SPCs 3 and 9 are assessed as class C3, land that is suitable for light grazing of native pastures in accessible areas.
- The suitability of soils for reuse in mine rehabilitation has been assessed. In summary, topsoil from all SPCs is suitable for reuse in rehabilitation activities. Topsoil from SPCs 3, 6 and 9 require additional amelioration measures.
- SPCs 1, 2, 4, 5 and 7 contain subsoil horizons that are suitable for reuse in mine rehabilitation, if required.

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9 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.

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.

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.

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. The depths of which vegetation roots may readily penetrate the soil profile and have access to water and nutrients.

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.

Emmerson Aggregate Test. The test classifies the behavior 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 and then travels 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. The measurement of the pH in the field by a Manutec Pty Ltd, Soil pH Test Kit. This kit consists of pH dye indicator, Barium Sulphate and reference colour chart.

Gleyed. Indicative of permanent or periodic intense reduction due to wetness and is characterised by greying, bluish or greenish colour, generally of low chroma. Mottling may be prominent as well as rusty root channel mottling.

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.

Hectare (ha). A metric unit of square measure, equal 10,000 square metres.

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

Jarosite. Iron sulfate mineral found in Acid Sulfate Soils. Form distinct butter or straw coloured mottles with a hue of 2.5Y or yellower and a value chroma of 6 or more.

Kandosol. Soils that have well-developed B2 horizons in which the major part if massive or has only a weak grade of structure (compare with tenic B horizon and cemented pans) and have a maximum clay content in some part of the B2 horizon which exceeds 15% (i.e. heavy sand loam, SL+).

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

LSAT. Land Suitability Assessment Techniques.

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.

Mbgl. Metres below ground level.

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

Microrelief. Refers to relief up to a few metres about the plane of the land surface with alternating mounds and depressions formed due to clay horizons shrinking and swelling with alternate drying and wetting cycles.

Millimetres (mm). Unit of measurement, one thousandth of a metre.

Metres (m). Unit of measurement, the SI base unit of length.

Mottles. 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.

Mtpa. Million tonnes per annum.

Mdtpa. Million dry tonnes per annum.

NATA. National Association of Testing Authority.

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.

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 SPC for which detailed characterisation is to be done.

ROM. Run of mine.

Soil Profile Class (SPC). 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.

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.

Tenosol. Soils with generally only weak pedologic organisation apart from the A horizons.

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.

Unique Mapping Area (UMA). When the unique set of soil and land attributes associated with an individual polygon are described and collected, the polygon is referred to as a unique mapping area. UMAs assist in identifying different land attributes such as degree of rockiness and slope which may either be part of the same soil type or not.

10 FIGURES

Figure 1 **Soil Study Area Location**

Figure 2 **Soil Study Area Layout**

Figure 3 **Soil Profile Classes**

Figure 4 **Cropping Suitability**

Figure 5 **Agricultural Land Classes**

Figure 6 **Topsoil Stripping Depth**

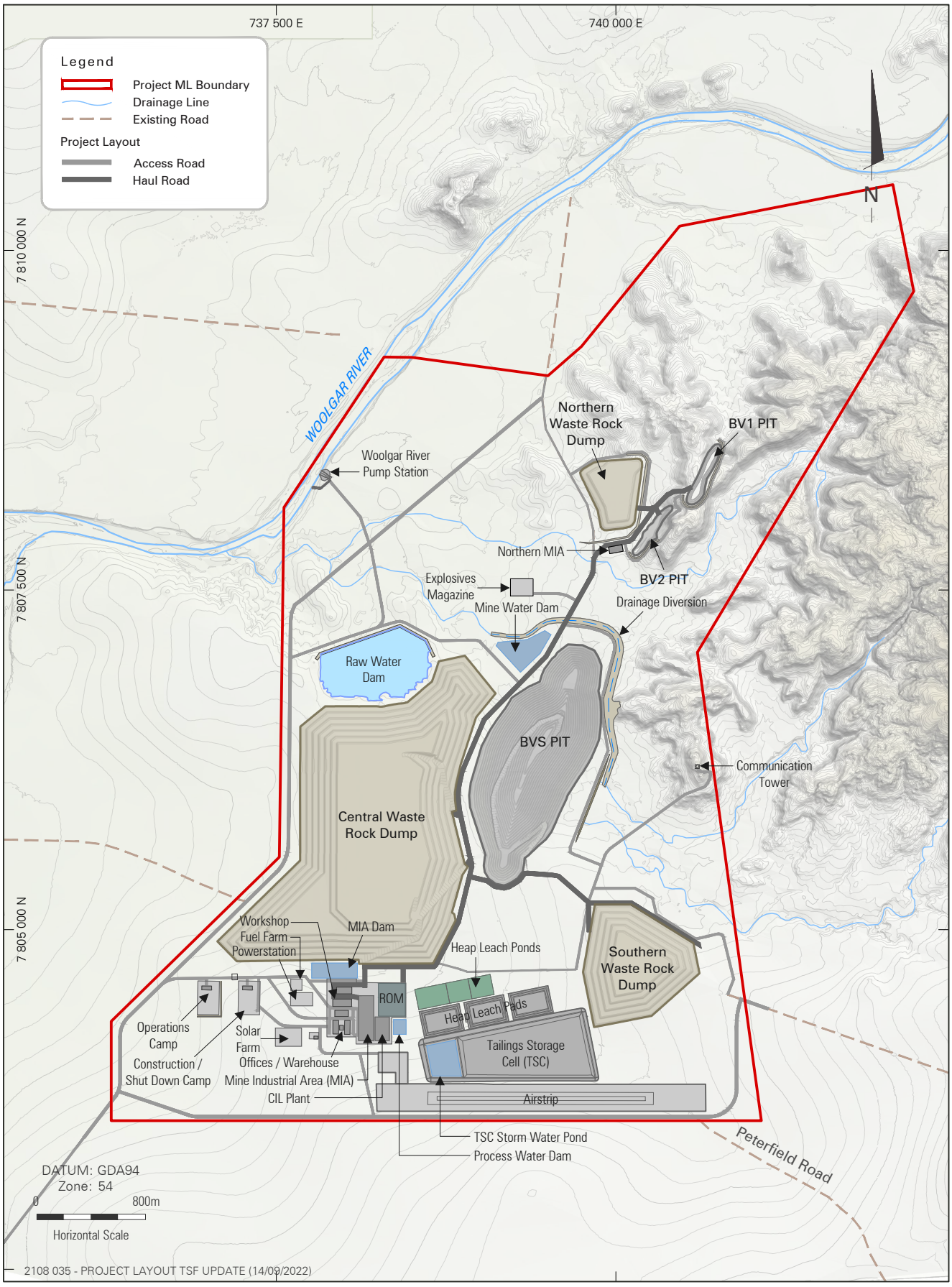


BIG VEIN SOUTH GOLD PROJECT

HANSEN ENVIRONMENTAL CONSULTING

Location Plan

FIGURE 1

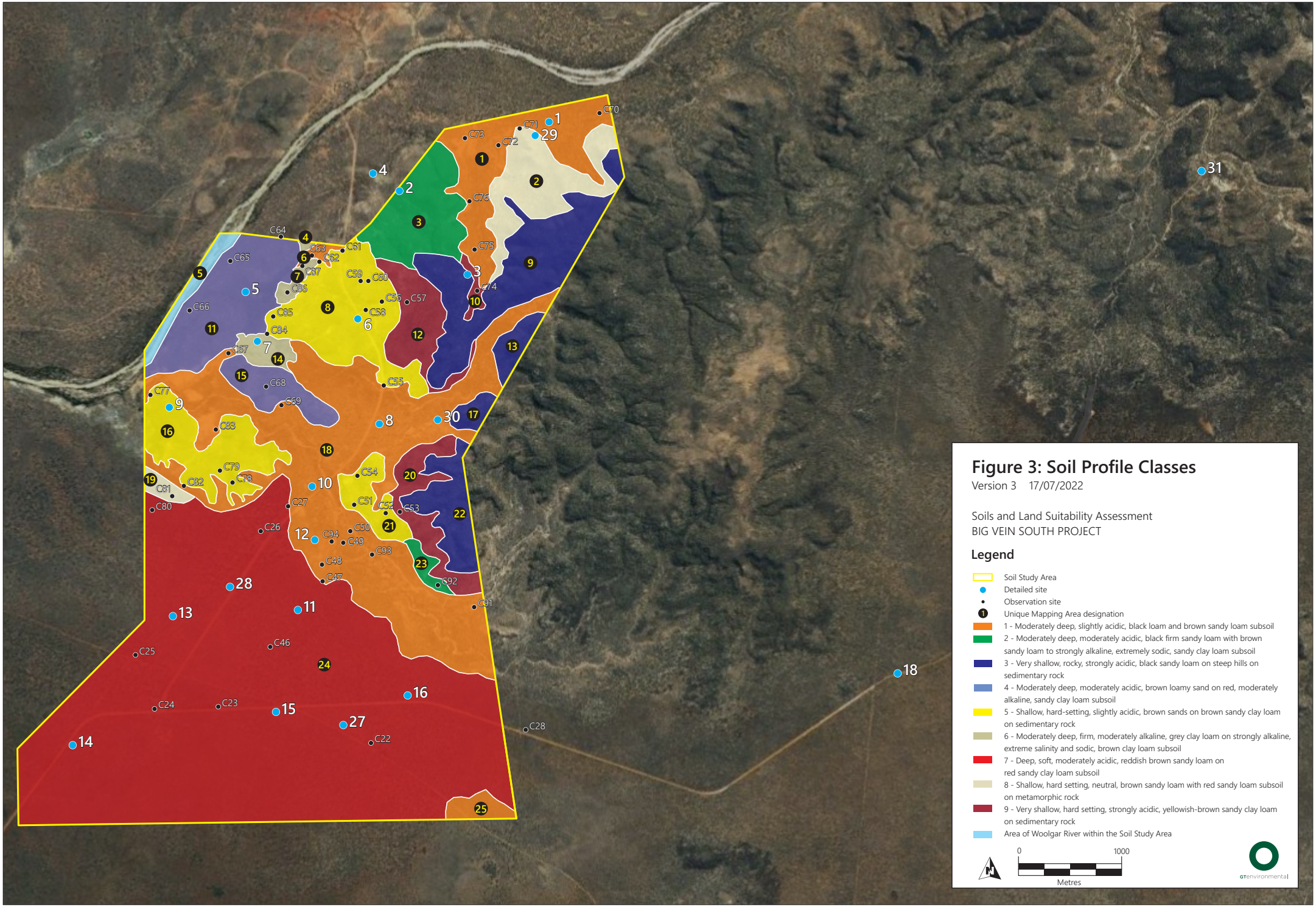


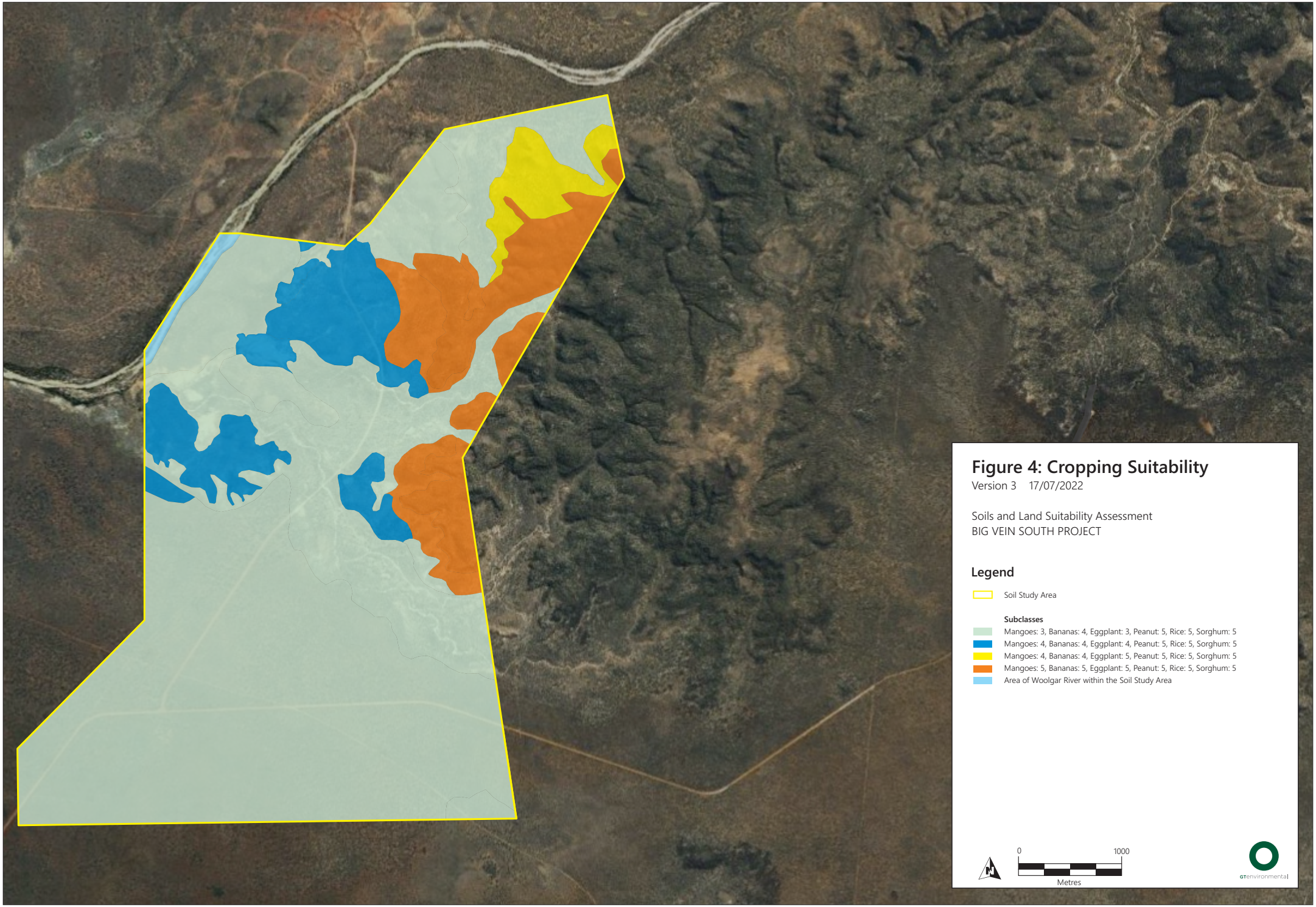
BIG VEIN SOUTH GOLD PROJECT

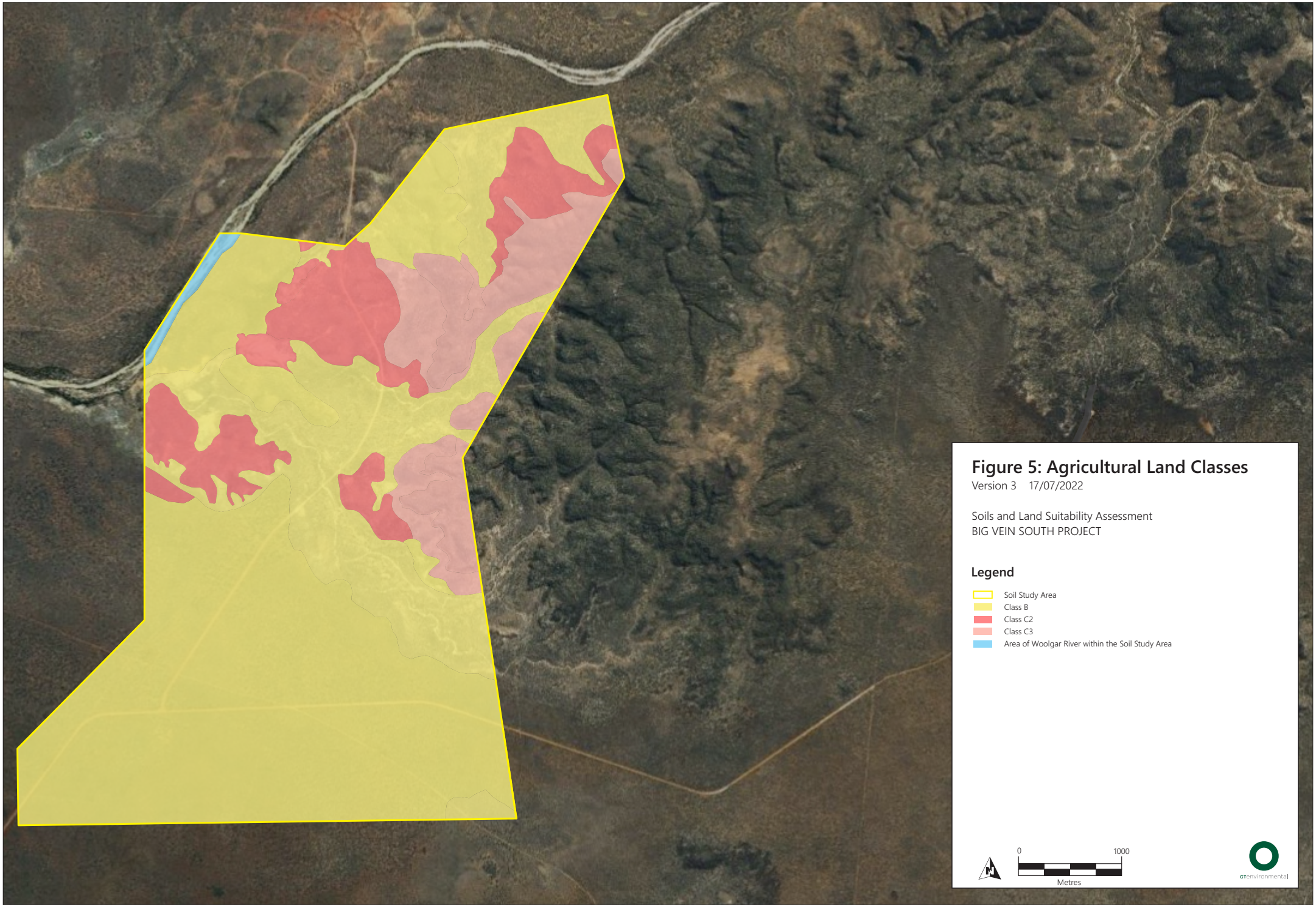
HANSEN ENVIRONMENTAL CONSULTING

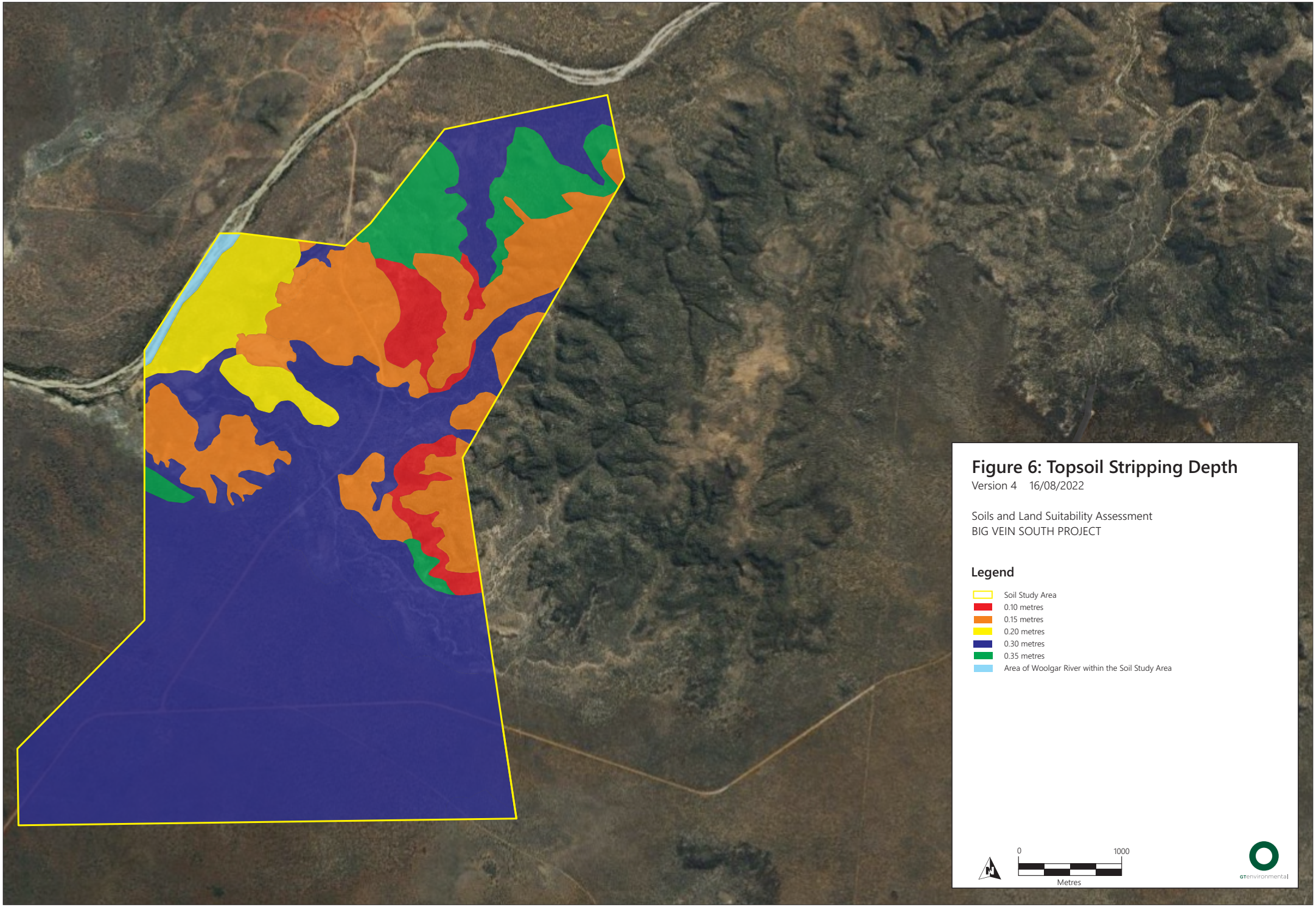
Project Layout

FIGURE 2


Figure 3: Soil Profile Classes
Version 3 17/07/2022
Soils and Land Suitability Assessment
BIG VEIN SOUTH PROJECT
Legend
Soil Study Area
Detailed site
Observation site
Unique Mapping Area designation
1 - Moderately deep, slightly acidic, black loam and brown sandy loam subsoil
2 - Moderately deep, moderately acidic, black firm sandy loam with brown sandy loam to strongly alkaline, extremely sodic, sandy clay loam subsoil
3 - Very shallow, rocky, strongly acidic, black sandy loam on steep hills on sedimentary rock
4 - Moderately deep, moderately acidic, brown loamy sand on red, moderately alkaline, sandy clay loam subsoil
5 - Shallow, hard-setting, slightly acidic, brown sands on brown sandy clay loam on sedimentary rock
6 - Moderately deep, firm, moderately alkaline, grey clay loam on strongly alkaline, extreme salinity and sodic, brown clay loam subsoil
7 - Deep, soft, moderately acidic, reddish brown sandy loam on red sandy clay loam subsoil
8 - Shallow, hard setting, neutral, brown sandy loam with red sandy loam subsoil on metamorphic rock
9 - Very shallow, hard setting, strongly acidic, yellowish-brown sandy clay loam on sedimentary rock
Area of Woolgar River within the Soil Study Area
0
1000
Metres
GTenvironmental


Figure 4: Cropping Suitability
Version 3 17/07/2022
Soils and Land Suitability Assessment
BIG VEIN SOUTH PROJECT
Legend
Soil Study Area
Subclasses
Mangoes: 3, Bananas: 4, Eggplant: 3, Peanut: 5, Rice: 5, Sorghum: 5
Mangoes: 4, Bananas: 4, Eggplant: 4, Peanut: 5, Rice: 5, Sorghum: 5
Mangoes: 4, Bananas: 4, Eggplant: 5, Peanut: 5, Rice: 5, Sorghum: 5
Mangoes: 5, Bananas: 5, Eggplant: 5, Peanut: 5, Rice: 5, Sorghum: 5
Area of Woolgar River within the Soil Study Area
N
0
1000
Metres
GTenvironmental


Figure 5: Agricultural Land Classes
Version 3 17/07/2022
Soils and Land Suitability Assessment
BIG VEIN SOUTH PROJECT
Legend
Soil Study Area
Class B
Class C2
Class C3
Area of Woolgar River within the Soil Study Area
0
1000
Metres
GTenvironmental


Figure 6: Topsoil Stripping Depth
Version 4 16/08/2022
Soils and Land Suitability Assessment
BIG VEIN SOUTH PROJECT
Legend
Soil Study Area
0.10 metres
0.15 metres
0.20 metres
0.30 metres
0.35 metres
Area of Woolgar River within the Soil Study Area
0
1000
Metres
GTenvironmental

11 APPENDICES

Appendix A Detailed Site Descriptions

Appendix B Observation Site Descriptions

Appendix C Laboratory Certificates

Site 1	Soil Profile Class: 1	Location (mE/mS GDA2020 ZONE 54): 741485 7810185	Australian Soil Class: Brown Kandosol / 1KAABAHCDAELLW	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 30/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Alluvial Plain Gently undulating plain 1 %	Narrow leaved Ironbark No microrelief No effective disturbance; hoofed animals	Hard setting No coarse fragments	A11 0.00-0.16 Abrupt 5-20mm	Loam fine sand	Massive Loose	No inclusions or segregations	10YR3/2 very dark greyish brown No mottles or bleaching	Dry Moderately well drained	Medium 2-5mm Few	0.10 / 6.0	0.00-0.10 0.20-0.30 0.50-0.60 0.75-0.85 0.90-1.00
			A12 0.16-0.49 Abrupt 5-20mm	Loam fine sand	Massive Loose	No inclusions or segregations	10YR3/3 dark brown No mottles or bleaching	Dry Moderately well drained	Fine 1-2 mm Few	0.30 / 6.0	
			B21 0.48-0.74 Clear 20-50mm	Sandy loam	Massive Loose	No inclusions or segregations	10YR3/4 dark yellowish brown No mottles or bleaching	Dry Moderately well drained	Very fine <1mm Few	0.65 / 6.5	
			B22 0.74-1.00 End of Borehole (EOBH)	Loamy sand	Massive Loose	<2% coarse fragments <2mm	10YR3/4 dark yellowish brown No mottles or bleaching	Dry Moderately well drained	No roots	0.90 / 6.5	

Landscape



Surface



Soil Profile



Site 2	Soil Profile Class: 2	Location (mE/mS GDA2020 ZONE 54): 740040 7809628	Australian Soil Class: Red Kandosol / 1KAAAAHCDBEKLW	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 30/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Level plain Flat <1%	Iron Bark No microrelief No effective disturbance; natural gully	Firm No coarse fragments	A11 0.00-0.13 Clear 20-50mm	Sandy loam	Massive Loose	No inclusions or segregations	10YR3/2 very dark greyish brown No mottles or bleaching	Dry Moderately well drained	Fine 1-2mm Common	0.05 / 6.0	0.00-0.10 0.20-0.30 0.50-0.60 0.70-0.80 0.90-1.00
			A12 0.13-0.38 Clear 20-50mm	Loamy sand	Massive Loose	No inclusions or segregations	10YR3/3 dark brown No mottles or bleaching	Dry Well drained	No roots	0.20 / 7.5	
			B2 0.38-1.00 EOBH	Sandy loam	Massive Loose	2-10% coarse fragments 2-6mm	2.5Y4/3 dark brown No mottles or bleaching	Dry Moderately well drained	No roots	0.60 / 8.5 0.90 / 8.5	

Landscape



Surface



Soil Profile



Site 3	Soil Profile Class: 3	Location (mE/mS GDA2020 ZONE 54): 740686 7808732	Australian Soil Class: Black Tenosol / 1TECYCZAIFKT	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 30/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Steep hills, crest 30+%	Lancewood No microrelief No effective disturbance; natural	Firm 2-10% coarse fragments 20-60mm 80% Bedrock	A1 0.00-0.17 EOBH Bedrock	Loamy sand	Single grain Loose	2-10% coarse fragments 2-6mm	10YR3/2 very dark greyish brown No mottles or bleaching	Dry Rapidly drained	Medium 2-5mm Few	0.10 / 5.5	0.00-0.10

Landscape



Surface



Soil Profile



Site 4	**Soil Profile Class:** Not applicable, as SMU polygon not included in project site	**Location (mE/mS GDA2020 ZONE 54):** 739554 7809819	**Australian Soil Class:** Red Kandosol	**Soil Survey Type:** Detailed 50 mm hand auger	**Survey Date:** 29/10/2020

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 / Pedality**	**Inclusions / Segregations**	**Colour / Mottle / Bleaching**	**Moisture / Drainage**	**Roots Size / Abundance**	**Depth (m) / Field pH**	**Sample (m) / Observations**
Native Woodland Gently undulating plain Flat Slope <1%	Ironbark No microrelief No effective disturbance; hoofed animals	Cracking No coarse fragments	A1 0.00-0.14 Abrupt 5-20mm	Silty loam	Massive Loose	No inclusions or segregations	10YR3/3 dark brown No mottles or bleaching	Dry Well drained	Fine 1-2mm Common	0.10 / 6.0	0.00-0.10 0.20-0.30 0.52-0.60 0.70-0.80 0.90-1.00
			A2 0.14-0.50 Clear 20-50mm	Silty loam	Massive Loose	No inclusions or segregations	7.5YR4/6 strong brown No mottles or bleaching	Dry Moderately well drained	Fine 1-2mm Few	0.30 / 6.0	
			B2 0.50-1.00 EOBH	Silty clay loam	Massive Loose	No inclusions or segregations	2.5YR4/4 reddish brown No mottles or bleaching	Dry Moderately well drained	Very fine <1mm Few	0.60 / 6.5 0.90 / 7.5	

Landscape



Surface



Soil Profile



Site 5	Soil Profile Class: 4	Location (mE/mS GDA2020 ZONE 54): 738544 7808620	Australian Soil Class: Red Kandosol / 1KAAAAHCDBEKLW	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 24/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Gently undulating plain Flat Slope <1%	Tall woodlands of eucalyptus species. No microrelief No disturbance No erosion	Soft, No coarse fragments No bedrock	A1 0.00–0.20 Abrupt 5-20mm	Loamy sand	Weak Very weak	No inclusions or segregations	7.5YR3/3 dark brown No mottles or bleaching	Moderately moist Rapidly drained	Fine 1-2mm Common	0.10 / 6.0	0.00-0.10 0.25-0.30 0.50-0.60 0.70-0.80 0.90-1.00
			A2 0.20-0.80 Clear 20-50mm	Loamy sand	Massive Loose	No inclusions or segregations	5YR5/6 yellowish red No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.30 / 6.0 0.60 / 6.0	
			B2 0.80-1.00 EOBH	Clayey sand	Massive Weak / loose	No inclusions or segregations	5YR4/6 yellowish red No mottles or bleaching	Dry Moderately well drained	Very fine <1mm Few	0.90 / 7.0	

Landscape



Surface



Soil Profile



Site 6	Soil Profile Class: 5	Location (mE/mS GDA2020 ZONE 54): 739594 7808320	Australian Soil Class: Brown Kandosol / 1KABACYEOAHKLU	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 29/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Undulating rises Mid-slope 5%	Sparse narrow leaved ironbark No microrelief No effective disturbance; hoofed animals	Hard setting Coarse fragments: 20-50% 6-20mm 5-10% 20-60mm	A1 0.00-0.10 Sharp <5mm	Clayey sand	Massive Loose	20-50% coarse fragments 6-20mm	10YR3/3 dark brown No mottles or bleaching	Dry Well drained	Fine 1-2mm Few	0.05 / 6.0	0.00-0.10 0.10-0.20 0.30-0.40 Skeletal soil on low rises
			B21 0.10-0.24 Clear 20-50mm	Clayey sand	Weak Loose	20-50% coarse fragments 6-20mm 2-10% coarse fragments 20-60mm	2.5Y5/6 light olive brown No mottles or bleaching	Dry Moderately well drained	Very fine <1mm Few	0.20 / 6.5	
			B22 0.24-0.45 EOBH - Refusal on hard pan / rock	Clayey sand	Massive Loose	10-20% coarse fragments 6-20mm	2.5Y5/4 light olive brown No mottles or bleaching	Dry Moderately well drained	No roots	0.40 / 6.5	

Landscape



Surface



Soil Profile



Site 7	Soil Profile Class: 6	Location (mE/mS GDA2020 ZONE 54): 738636 7808181	Australian Soil Class: Brown Dermosol / 1DEABAHEOBMOW	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 30/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native grasslands Gently undulating plain Alluvial flat 1%	Very sparse vegetation on the fringe of the SPC No microrelief Limited clearing Sheet and gully erosion observed	Cracking, minor <2mm <2% coarse fragments 2-6mm	A11 00.0-0.18 Clear 20-50mm	Light clay	Weak Firm	No inclusions or segregations	10YR4/2 dark greyish brown No mottles or bleaching	Dry Moderately well drained	No roots	0.10 / 8.0	0.00-0.10 0.20-0.30 0.50-0.60 0.70-0.80 0.90-1.00
			A12 0.18-0.30 Abrupt 5-20mm	Light clay	Weak Firm	No inclusions or segregations	10YR4/3 brown No mottles or bleaching	Dry Moderately well drained	No roots	0.25 / 8.0	
			B21 0.30-0.80 Clear 20-50mm	Silty clay loam	Weak Firm	No inclusions or segregations	10YR5/4 Yellowish brown No mottles or bleaching	Dry Moderately well drained	No roots	0.60 / 8.5	
			B21 0.80-1.00 EOBH	Clayey sand	Weak Weak	No inclusions or segregations	10YR5/4 Yellowish brown No mottles or bleaching	Dry Well drained	No roots	0.90 / 8.5	

Landscape



Surface



Soil Profile



Site 8	Soil Profile Class: 1	Location (mE/mS GDA2020 ZONE 54): 739810 7807317	Australian Soil Class: Brown Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 29/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Grazing Gently undulating rises Flat	Narrow leaved Ironbark No microrelief Limited clearing	Soft No coarse fragments	A11 0.00-0.13 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	10YR3/2 very dark greyish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Common	0.05 / 6.0	0.00-0.10 0.20-0.30 0.50-0.60 0.75-0.85 0.90-1.00
			A12 0.13-0.43 Clear 20-50mm	Loamy sand	Massive Loose	No inclusions or segregations	10YR3/3 dark brown No mottles or bleaching	Dry Rapidly drained	No roots	0.25 / 6.0	
			B21 0.43-0.74 Gradual 50-100mm	Sandy Loam	Massive Loose	<2% coarse fragments 2-6mm	10YR4/3 brown No mottles or bleaching	Dry Rapidly drained	No roots	0.60 / 6.0	
			B22 0.74-1.00 Gradual 50-100mm	Sandy Loam	Massive Loose	<2% coarse fragments 2-6mm	10YR4/4 Dark yellowish brown No mottles or bleaching	Dry Rapidly drained	No roots	0.90 / 6.0	
			B23 1.00-2.09 EOBH	Sandy Loam	Massive Loose	2-10% coarse fragments <2mm	10YR4/4 Dark yellowish brown No mottles or bleaching	Dry Rapidly drained	No roots	1.50 / 6.0	

Landscape



Surface



Soil Profile



Site 9	Soil Profile Class: 5	Location (mE/mS GDA2020 ZONE 54): 737800 7807490	Australian Soil Class: Shallow Red Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 30/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Rolling hills Crest Wide flat crest area	Sparse shrubbery with ironbark nearby No microrelief No effective disturbance; hoofed animals	Hard setting 2-10% coarse fragments 20-60mm	A11 0.00-0.17 EOBH Refusal on rock	Loamy sand	Massive Loose	10-20% coarse fragments 6-20mm	7.5YR5/4 brown No mottles or bleaching	Dry Well drained	Fine 1-2mm Few	0.10 / 6.5	Three attempts to verify; 0.17m, 0.15m, 0.15m

Landscape



Surface



Soil Profile



Site 10	Soil Profile Class: 1	Location (mE/mS GDA2020 ZONE 54): 739139 7806742	Australian Soil Class: Brown Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 28/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Gently undulating plain Flat Flat plain with minor undulations	Narrow leaved Ironbark No microrelief Limited clearing	Soft No coarse fragments	A11 0.00 -0.13 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	10YR3/3 dark brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.08 / 6.0	0.00-0.10 0.20-0.30 0.50-0.60 0.70-0.80 0.92-1.00
			A12 0.13-0.41 Clear 20-50mm	Loamy sand	Massive Loose	No inclusions or segregations	7.5YR4/4 reddish brown No mottles or bleaching	Moderately moist Rapidly drained	Fine 1-2mm Few	0.30 / 6.5	
			B21 0.41-0.92 Gradual 50-100mm	Sandy Loam	Massive Loose	<2% coarse fragments 2-6mm <2% quartz	10YR5/6 Yellowish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.60 / 6.5	
			B22 0.92-1.00 EOBH	Sandy Loam	Massive Loose	<2% coarse fragments 2-6mm <2% quartz	2.5Y4/6 olive brown No mottles or bleaching	Dry Rapidly drained	No roots	0.96 / 7.0	

Landscape



Surface



Soil Profile



Site 11	Soil Profile Class: 7	Location (mE/mS GDA2020 ZONE 54): 739072 7805574	Australian Soil Class: Deep Red Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 29/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Gently undulating plain 2%	Gums, River Reid Box, slim Eucalypt species. No microrelief No effective disturbance; natural	Soft No coarse fragments	A11 0.00-0.11 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	7.5YR3/3 dark brown No mottles or bleaching	Moderately moist Rapidly drained	Fine 1-2mm Few	0.05 / 6.5	No samples taken Drill pad nearby
			A12 0.11-0.33 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	2.5YR4/4 reddish brown No mottles or bleaching	Moderately moist Rapidly drained	Fine 1-2mm Few	0.25 / 6.5	
			A13 0.33-0.69 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	2.5YR4/6 red No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.60 / 6.5	
			B21 0.69-1.41 Gradual 50-100mm	Sandy loam	Massive Loose	No inclusions or segregations	2.5YR3/6 dark red No mottles or bleaching	Dry Well drained	Fine 1-2mm Few	0.90 / 6.5	
			B22 1.41-2.00 EOBH	Clayey sand	Massive Loose	No inclusions or segregations	2.5YR3/6 dark red No mottles or bleaching	Dry Well drained	No roots	1.60 / 6.5	

Landscape



Surface



Soil Profile



Site 12	Soil Profile Class: 1	Location (mE/mS GDA2020 ZONE 54): 739170 7806235	Australian Soil Class: Brown Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 29/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Gently undulating rise Mid-slope	Mixed Eucalypt species including Narrow leaved Ironbark No microrelief No effective disturbance; natural	Firm to soft No coarse fragments	A11 0.00-0.13 Sharp <5mm	Loamy sand	Massive Loose	No inclusions or segregations	10YR4/4 Dark yellowish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.05 / 6.5	0.00-0.10 0.20-0.30 0.50-0.60 0.70-0.80 0.90-100
			A12 0.13-0.46 Gradual 50-100mm	Loamy sand	Massive Loose	No inclusions or segregations	10YR4/6 Dark yellowish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.30 / 6.5	
			B2 0.46-1.15 Abrupt 5-20mm	Clayey sand	Single grain Loose	No inclusions or segregations	2.5Y5/6 light olive brown No mottles or bleaching	Dry Rapidly drained	Very fine <1mm Few	0.80 / 6.5	
			C 1.15-1.30 Sharp <5mm Weathered sandstone	Sandy loam	Single grain Loose	<2% coarse fragments 2-6mm	2.5Y5/4 light olive brown No mottles or bleaching	Dry Imperfectly drained	No roots	1.25 / 7.0	
			C 1.30-1.60 EOBH Weathered sandstone	Sandy loam	Single grain Loose	2-10% coarse fragments 2-6mm	2.5Y5/4 light olive brown Mottles: 10YR5/6 Yellowish brown	Dry Imperfectly drained	No roots	1.50 / 7.0	

Landscape



Surface



Soil Profile



Site 13	Soil Profile Class: 7	Location (mE/mS GDA2020 ZONE 54): 737871 7805580	Australian Soil Class: Deep Red Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 28/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Level plain Flat 0.5-1.0%	Eucalypt species No microrelief No effective disturbance; natural Vegetation not as dense as site 15	Firm to soft No coarse fragments	A11 0.00-0.16 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	7.5YR3/4 dark reddish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.10 / 7.5	0.00-0.10 0.20-0.30 0.50-0.60 0.70-0.80 0.90-1.00
			A12 0.16-0.49 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	5YR4/4 reddish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.30 / 7.5	
			A13 0.49-0.81 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	5YR4/6 yellowish red No mottles or bleaching	Dry Rapidly drained	Very fine <1mm Few	0.60 / 7.5	
			B2 0.81-1.00 EOBH	Sandy loam	Weak Very weak	No inclusions or segregations	5YR3/4 dark reddish brown No mottles or bleaching	Dry Well drained	No roots	0.90 / 7.5	

Landscape



Surface



Soil Profile



Site 14	Soil Profile Class: 7	Location (mE/mS GDA2020 ZONE 54): 736809 7804317	Australian Soil Class: Deep Red Kandosolxx	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 31/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Gently undulating rises Mid slope 2% slope	Mixed vegetation including eucalyptus species No microrelief No erosion	Soft No coarse fragments	A11 0.00-0.17 Clear 20-50mm	Loamy sand	Massive Loose	No inclusions or segregations	7.5YR3/3 dark brown No mottles or bleaching	Moderately moist Rapidly drained	Fine 1-2mm Few	0.10 / 6.5	No samples taken
			A12 0.17-0.42 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	5YR3/45YR3/4 dark reddish brown No mottles or bleaching	Moderately moist Rapidly drained	Medium 2-5mm Few	0.30 / 6.5	
			B21 0.42-0.80 Gradual 50-100mm	Loamy sand	Massive Loose	No inclusions or segregations	2.5YR4/6 yellowish red No mottles or bleaching	Dry Rapidly drained	Medium 2-5mm Few	0.60 / 6.5	
			B22 0.80-1.00 EOBH	Clayey sand	Massive Loose	No inclusions or segregations	2.5YR4/8 red No mottles or bleaching	Dry Well drained	Fine 1-2mm Few	0.90 / 6.5	

Landscape



Surface



Soil Profile



Site 15	Soil Profile Class: 7	Location (mE/mS GDA2020 ZONE 54): 738748 7804612	Australian Soil Class: Deep Red Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 28/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Gently undulating rises Flat 0.5-1% slope	Mixed vegetation including eucalyptus species No microrelief Minor limited clearing No erosion	Soft No coarse fragments	A11 0.00-0.17 Clear 20-50mm	Loamy sand	Massive Loose	No inclusions or segregations	7.5YR3/3 dark brown No mottles or bleaching	Moderately moist Rapidly drained	Fine 1-2mm Few	0.10 / 6.5	No samples taken
			A12 0.17-0.42 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	5YR3/4 dark reddish brown No mottles or bleaching	Moderately moist Rapidly drained	Medium 2-5mm Few	0.30 / 6.5	
			B21 0.42-0.80 Gradual 50-100mm	Loamy sand	Massive Loose	No inclusions or segregations	2.5YR4/6 yellowish red No mottles or bleaching	Dry Rapidly drained	Medium 2-5mm Few	0.60 / 6.5	
			B22 0.80-1.00 EOBH	Clayey sand	Massive Loose	No inclusions or segregations	2.5YR4/8 red No mottles or bleaching	Dry Well drained	Fine 1-2mm Few	0.90 / 6.5	

Landscape



Surface



Soil Profile



Site 16	Soil Profile Class: 7	Location (mE/mS GDA2020 ZONE 54): 739996 7804747	Australian Soil Class: Deep Red Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 28/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Gently undulating rises Flat 0.5-1% slope	Mixed vegetation including eucalyptus species No microrelief Limited clearing	Soft No coarse fragments	A11 0.00-0.21 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	7.5YR3/4 dark reddish brown No mottles or bleaching	Moderately moist Rapidly drained	Fine 1-2mm Few	0.10 / 6.0	No samples taken
			A12 0.21-0.71 Gradual 50-100mm	Loamy sand	Massive Loose	No inclusions or segregations	2.5YR4/6 yellowish red No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.40 / 6.0	
			B2 0.71-1.50 EOBH	Clayey sand	Massive-weak Loose	No inclusions or segregations	2.5YR4/8 red No mottles or bleaching	Dry Rapidly drained	Very fine <1mm Few	0.90 / 6.0 1.40 / 6.0	

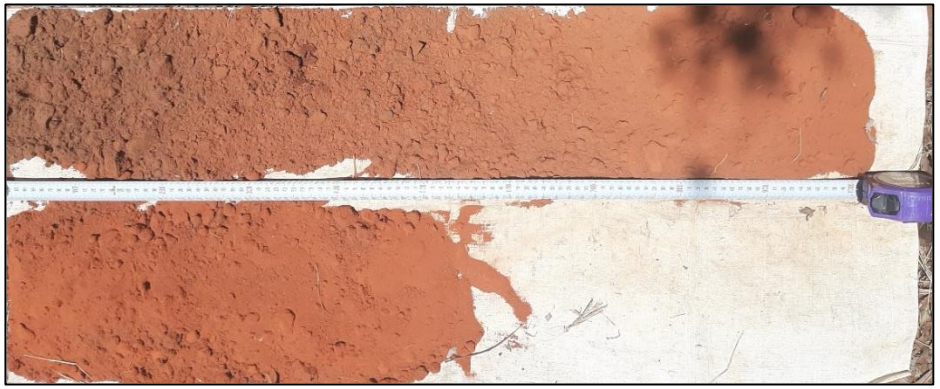
Landscape



Surface



Soil Profile



Site 18	Soil Profile Class: 7	Location (mE/mS GDA2020 ZONE 54): 744760 7804883	Australian Soil Class: Deep Red Kandosol / 1KAAAAGCDBEKMX	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 28/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Undulating rises Mid-slope <5%	Mixed vegetation including Bloodwood No microrelief No effective disturbance; natural No erosion	Soft No coarse fragment	A11 0.00-0.20 Sharp <5mm	Loamy sand	Massive Loose	No inclusions or segregations	7.5YR3/4 dark reddish brown No mottles or bleaching	Moderately moist Rapidly drained	Medium 2-5mm Few	0.10 / 6.0	0.00-0.10 0.20-0.30 0.50-0.60 0.80-0.90 1.10-1.20 1.40-1.50 Road nearby
			A12 0.20-0.41 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	2.5YR4/6 yellowish red No mottles or bleaching	Moderately moist Rapidly drained	Very fine <1mm Few	0.30 / 6.0	
			B21 0.41-0.96 Gradual 50-100mm	Sandy Loam	Massive Loose	No inclusions or segregations	2.5YR4/6 yellowish red No mottles or bleaching	Dry Rapidly drained	Very fine <1mm Few	0.60 / 6.0	
			B22 0.96-1.50 EOBH	Sandy loam	Massive Loose	No inclusions or segregations	2.5YR4/8 red No mottles or bleaching	Dry Well drained	No roots	1.10 / 6.0	

Landscape



Surface



Soil Profile



Site 27	Soil Profile Class: 7	Location (mE/mS GDA2020 ZONE 54): 739438 7804443	Australian Soil Class: Deep Red Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 28/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Gently undulating plain Mid-slope 2%	Mixed vegetation including Eucalyptus species No microrelief No effective disturbance; natural	Soft No coarse fragments	A11 0.00-0.11 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	7.5YR3/4 dark reddish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.05 / 6.0	No samples taken
			A12 0.11-0.54 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	5YR3/4 dark reddish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.30 / 6.0	
			A13 0.54-0.81 Clear 20-50mm	Loamy sand	Massive Loose	No inclusions or segregations	2.5YR4/4 reddish brown No mottles or bleaching	Dry Rapidly drained	Very fine <1mm Few	0.60 / 6.0	
			B21 0.81-1.23 Gradual 50-100mm	Loamy sand	Single grain Loose	No inclusions or segregations	2.5YR4/6 yellowish red No mottles or bleaching	Dry Rapidly drained	Few	0.95 / 6.0	
			B22 1.23-2.00 EOBH	Clayey sand	Massive Loose	No inclusions or segregations	2.5YR4/8 red No mottles or bleaching	Dry Well drained	No roots	1.50 / 6.0	

Landscape



Surface



Soil Profile



Site 28	Soil Profile Class: 7	Location (mE/mS GDA2020 ZONE 54): 738332 7805782	Australian Soil Class: Deep Red Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 28/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Gently undulating plain Mid-slope 2%	Slim Eucalypt species No microrelief No effective disturbance; natural	Soft No coarse fragments	A11 0.00-0.11 Abrupt 5-20mm	Loamy sand	Massive Loose	No inclusions or segregations	7.5YR3/4 dark reddish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.05 / 6.0	No samples taken
			A12 0.11-0.54 Clear 20-50mm	Loamy sand	Massive Loose	No inclusions or segregations	5YR3/4 dark reddish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.30 / 6.0	
			A13 0.54-0.81 Gradual 50-100mm	Loamy sand	Massive Loose	No inclusions or segregations	2.5YR4/4 reddish brown No mottles or bleaching	Dry Rapidly drained	Very fine <1mm Few	0.60 / 6.0	
			B21 0.81-1.23 Gradual 50-100mm	Clayey sand	Single grain Loose	No inclusions or segregations	2.5YR4/6 yellowish red No mottles or bleaching	Dry Rapidly drained	Few	0.95 / 6.0	
			B22 1.23-2.00 EOBH	Clayey sand	Massive Loose	No inclusions or segregations	2.5YR4/8 red No mottles or bleaching	Dry Well drained	No roots	1.50 / 6.0	

Landscape



Surface



Soil Profile



Site 29	Soil Profile Class: 8	Location (mE/mS GDA2020 ZONE 54): 741326 7810064	Australian Soil Class: Red Tenosol / 2TEAAARBGKLU	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 30/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Rolling low hills Simple slope 15%	Very sparse vegetation with short native grasses No microrelief No effective disturbance; natural	Hard setting 20-50% coarse fragments 20-60mm	A1 0.00-0.11 Abrupt 5-20mm	Loamy sand	Massive to weak Loose	10-20% coarse fragments 2-6mm	7.5YR5/6 yellowish red No mottles or bleaching	Dry Well drained	Fine 1-2mm Few	0.05 / 6.5	0.00-0.10 0.20-0.30
			A2 0.11-0.37 EOBH Hard pan / Rock	Loamy sand	Massive to weak Loose	10-20% coarse fragments 2-6mm	5YR5/8 yellowish red No mottles or bleaching	Dry Well drained	Very fine <1mm Few	0.25 / 6.5	

Landscape



Surface



Soil Profile



Site 30	Soil Profile Class: 1	Location (mE/mS GDA2020 ZONE 54): 740357 7807361	Australian Soil Class: Brown Kandosol	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 31/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Native Woodland Gently undulating plain Flat Near creek, partial bank	No microrelief Extensive clearing	Hard setting No coarse fragments	A11 0.00-0.17 Abrupt 5-20mm	Loamy sand	Weak Very weak	No inclusions or segregations	10YR3/4 Dark yellowish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	0.10 / 6.0	0.00-0.10 020-0.30 0.50-0.60 0.70-0.80 0.90-1.00
			A12 0.17-0.32 Clear 20-50mm	Loamy sand	Massive Firm	No inclusions or segregations	10YR4/4 Dark yellowish brown No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm	0.23 / 7.0	
			B21 0.32-0.87 Clear 20-50mm	Sandy loam	Massive Weak	No inclusions or segregations	10YR4/3 Brown No mottles or bleaching	Dry Well drained	No roots	0.50 / 7.5	
			B22 0.87-1.00 EOBH	Clayey sand	Weak Weak	No inclusions or segregations	10YR4/3 Brown No mottles or bleaching	Dry Well drained	No roots	0.95 / 8.0	

Landscape



Surface



Soil Profile



Site 31	Soil Profile Class: 9	Location (mE/mS GDA2020 ZONE 54): 747722 7809635	Australian Soil Class: Brown Tenosol / 2TEABGFAIAFMZT	Soil Survey Type: Detailed 50 mm hand auger	Survey Date: 31/10/2020

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 / Pedality	Inclusions / Segregations	Colour / Mottle / Bleaching	Moisture / Drainage	Roots Size / Abundance	Depth (m) / Field pH	Sample (m) / Observations
Natural Woodland Undulating rises Simple slope 15%	Very sparse woodland of lancewood No microrelief No effective disturbance; natural Gully Erosion	Hard setting >90% coarse fragments 20-60mm	A1 0.00-0.10 Refusal on continuous gravel layer	Loam	Massive, loose	2-10% coarse fragments 2-6mm	10YR4/6 Dark yellowish brown No mottles or bleaching	Dry Well drained	No	0.10 / 6.0	0.00-0.10

Landscape



Surface



Soil Profile



Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C22	739625 7804324	7	Date, 28/10/2020 Native woodland, gently undulating plain, mid slope 1-2% Mixed vegetation including eucalyptus species, No microrelief, No effective disturbance, natural, No erosion Surface soft with nil coarse fragments, loamy sand, massive/loose, No rock outcrop 7.5YR3/3 dark brown, Dry ASC Order, Kandosol	
C23	738185 7804660	7	Date, 28/10/2020 Native woodland, gently undulating plain, lower slope 1.5% Mixed vegetation including eucalyptus species, No microrelief, No effective disturbance, natural, No erosion, No rock outcrop Surface soft with nil coarse fragments, loamy sand, massive/loose 7.5YR3/4 dark brown, Dry, rapidly drained ASC Order, Kandosol	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C24	737622 7804646	7	Date, 28/10/2020 Native woodland, gently undulating plain, mid slope 1-2% Mixed vegetation including eucalyptus species No microrelief, No effective disturbance, natural, No erosion, No rock outcrop Surface soft with nil coarse fragments, loamy sand, massive/loose 7.5YR3/4 dark brown ASC Order, Kandosol	
C25	737427 7805178	7	Date, 28/10/2020 Native woodland, gently undulating plain, lower slope Limited clearing, No microrelief, No erosion Surface soft with nil coarse fragments, No rock outcrop ASC Order, Kandosol	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C26	738614 7806272	7	Date, 28/10/2020 Native woodland, gently undulating rises, upper slope 2% Slim Eucalypt species, No microrelief, No effective disturbance, natural, No erosion, No rock outcrop Surface soft with nil coarse fragments, loamy sand, massive/loose 10YR3/4 dark yellowish brown, Dry ASC Order, Kandosol	
C27	738928 7806579	7 / 1	Date, 28/10/2020 Native woodland, gently undulating plain, upper slope No effective disturbance, natural , No microrelief, No erosionSurface soft with nil coarse fragments, No rock outcrop Boundary between SPC MAP UNITs 7 and 1	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C28	741167 7804404	7	Date, 28/10/2020 Native woodland, gently undulating plain, lower slope 1-2% Slim Eucalypt species, No microrelief, No effective disturbance, natural, No erosion, No rock outcrop Surface soft with nil coarse fragments, loamy sand, massive/loose 7.5YR3/3 dark brown, Dry ASC Order, Kandosol	
C46	738790 7805303	7	Date, 29/10/2020 Native woodland, gently undulating plain, mid slope Mixed vegetation including eucalyptus species, no effective disturbance; natural, No microrelief, No erosion Surface soft with nil coarse fragments, No rock outcrop Loamy sand 7.5YR3/4 dark brown ASC Order, Kandosol	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C47	739247 7805862	1 / 7	Date, 29/10/2020 Native woodland, gently undulating plain, mid slope Eucalypt speciesincluding narrow leaved ironbarks , no effective disturbance; natural, No microrelief, No erosion Surface soft with nil coarse fragments, No rock outcrop Loamy sand 7.5YR3/4 dark brown Boundary between SPC 1 and 7	
C48	739239 7805983	1	Date, 29/10/2020 Native woodland, gently undulating plain, mid slope 1-2% Eucalypts species including Ironbarks, no effective disturbance; natural, No microrelief, No erosion Surface soft with nil coarse fragments, No rock outcrop	-
C49	739434 7806195	1	Date, 29/10/2020 Native woodland, gently undulating plain, open depression Eucalypt species including Ironbarks, limited clearing, No microrelief, No erosion Surface soft with nil coarse fragments, No rock outcrop Overbank of creek to the north	-

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C50	739561 7806340	1	Date, 29/10/2020 Native woodland, gently undulating plain, lower slope 1-2% No effective disturbance; natural, No microrelief, No erosion Surface soft with nil coarse fragments, No rock outcrop Loamy sand 10YR3/4 dark yellowish brown	-
C51	739563 7806558	1 / 5	Date, 29/10/2020 Native woodland, gently undulating rises, lower slope Ironbark located to the south, No effective disturbance; natural, No microrelief, No erosion Exposed bedrock observed Boundary between SPCs 1 and 5	-
C52	739864 7806522	5	Date, 29/10/2020 Native woodland, undulating rises, mid to upper slope No effective disturbance; natural, No microrelief, No erosion, No rock outcrop Surface soft with nil coarse fragments Loamy sand 10YR3/4 dark yellowish brown, nil inclusions	-
C53	739984 7806536	9	Date, 29/10/2020 Native woodland, undulating rises, upper slope 18% No effective disturbance; natural, No microrelief, No erosion Exposed bedrock observed 50-90% coverage	-

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C54	739582 7806869	5	Date, 29/10/2020 Native woodland, gently undulating rises, simple slope Ironbark No effective disturbance; natural, No microrelief, No erosion Surface soft with no coarse fragments, loamy sand, No rock outcrop Near to creek	-
C55	739848 7807747	1 / 5	Date, 29/10/2020 Native woodland, gently undulating rises, open depression, 2-5% coarse fragments 6-20mm No effective disturbance; natural, No microrelief, No erosion, No rock outcrop Boundary between SPCs 1 and 5	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C56	739841 7808524	5	Date, 29/10/2020 Native woodland, undulating low hills, lower slope Ironbark, No effective disturbance; natural, No microrelief, No erosion Surface soft with 2-5% coarse fragments 6-20 mm, No rock outcrop Termite mounds observed, brown/olive brown in colour	
C57	740121 7808489	9	Date, 29/10/2020 Tall, very sparse woodland, steep low rolling hills 13%, simple slope No effective disturbance; natural, No microrelief, No erosion Surface with 50-90% coarse fragments 0.6-2.0 m Exposed bedrock	-

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C58	739683 7808456	5	Date, 29/10/2020 Native woodland, undulating rises, lower slope No effective disturbance; natural, No microrelief , No erosion Small rise nearby wth rocky outcrop	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C59	739686 7808729	5	Date, 29/10/2020 Grazing, gently undulating rises, mid slope, gully Ironbark, No effective disturbance; natural, No microrelief, No erosion except cuting Surface with 20-50% coarse fragments, No rock outcrop Soil profile cutting observed	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C60	739740 7808715	5	Date, 29/10/2020 Gently undulating rises, crest Limited clearing, No microrelief, No erosion Surface hard setting with 10-20% coarse fragments 20-60 mm, No rock outcrop Top of crest with exposed bedrock observed approximately 50 m away	
C61	739470 7809017	1 / 5	Date, 29/10/2020 Native woodland, gently undulating plain Ironbark, No effective disturbance; natural, No microrelief, No erosion Surface loamy sand, 2-5% coarse fragments 6-20mm, No rock outcrop Boundary between SPC MAP UNITs 1 and 5	-

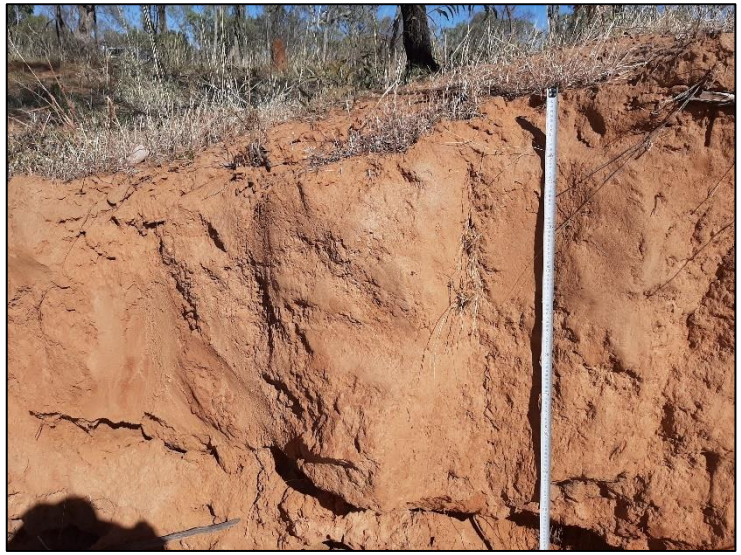
Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C62	739247 7808922	5	Date, 29/10/2020 Native sparse tall woodland consisting of Irongbark, gently undulating plain, open depression, drainage line No effective disturbance; natural, No microrelief, No erosion Surface loose sand, colour 7.5YR3/4 dark brown, <2% coarse fragments 6-20mm, No rock outcrop	
C63	739172 7808966	1	Date, 29/10/2020 Native woodland, gently undulating plain, lower slope Eucalypt species, Ironbark No effective disturbance; natural, No microrelief, No erosion, No rock outcrop Surface loamy sand, loose with nil coarse fragments, Colour 7.5YR 3/3 dark brown, dry Grey soils, near alluvial area	-

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C64	738861 7809162	4	Date, 29/10/2020 Native woodland, gently undulating plain, mid slope 1-2% No effective disturbance; natural, No microrelief, No erosion Surface soft, loamy sand with nil coarse fragments, No rock outcrop	
C65	738404 7808927	4	Date, 29/10/2020 Native woodland, gently undulating plain, upper slope No effective disturbance; natural, No microrelief, No erosion Surface form with nil coarse fragments, No rock outcrop	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C66	73799 7808478	4	Date, 29/10/2020 Native woodland, gently undulating plains, upper slope No effective disturbance; natural, No microrelief, No erosion Surface soft to firm, nil coarse fragments, No rock outcrop, loamy sand	
C67	738382 7808067	1	Date, 29/10/2020 Native woodland, gently undulating plain, open depression Ironbark, No microrelief, Limited clearing, No erosion Surface loose with nil coarse fragments, No rock outcrop, loamy sand to sand Drainage line	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C68	738694 7807733	4	Date, 29/10/2020 Grazing, gently undulating plain, flat Eucalypt species including Red Gum and minor Ironbark, Limited clearing, No microrelief, No erosion Surafce soft with nil coarse fragments, loamy sand, No rock outcrop 10YR4/4 dark yellowish brown	
C69	738877 7807538	1	Date, 29/10/2020 Native woodland, level alluvial plain, flat Pale grey eucalypt specie, no effective disturbance; natural, No microrelief, No erosion Surface soft with nil coarse fragments, loamy sand, No rock outcrop	-
C70	741932 7810308	1	Date, 30/10/2020 Native woodland, gently undulating plain, mid slope 1-2% No effective disturbance; natural, No microrelief , No erosionSurface soft Boundary with loamy sands to the north, minor cracking to the south, <2% coarse fragments 6-20mm, No rock outcrop	-

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C71	741176 7810182	8	Date, 30/10/2020 Native woodland with ironbark, rolling low hills, lower slope Nil microrelief, No effective disturbance; natural, No microrelief, No erosion Surface hard setting with 10-20% coarse fragments 20-60 mm, No rock outcrop	-
C72	741000 7809994	1	Date, 30/10/2020 Native woodland, rolling low hills, flat, gully Mixed vegetation, No effective disturbance; natural, No microrelief, No erosion Surface hard setting, nil coarse fragments, loamy sand, No rock outcrop	-

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C73	740685 7810080	1	Date, 30/10/2020 Native woodland, undulating plain, open depression No microrelief, No effective disturbance; natural, gully erosion Surface soft with nil coarse fragments, No rock outcrop Area appears light coloured in aerial imagery, minor red SCL at depth, unmappable, aggregated within surrounding SPC MAP UNIT • A11 / 0.00-0.20m / Abrupt boundary ○ Loam, massive, loose ○ Nil inclusions or segregations ○ 7.5YR3/3 dark brown, nil mottles ○ Dry, rapidly drained • A12 / 0.20-0.70m / Abrupt boundary ○ Loam, massive, loose ○ Nil inclusions or segregations ○ 7.5YR3/4 dark brown, nil mottles ○ Dry, rapidly drained, fine/few roots • B1 / 0.70-1.00m / EOBH ○ Sandy clay loam, massive, weak ○ Nil inclusions or segregations ○ 2.5YR4/8 red, nil mottles ○ Dry, well drained, nil roots	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C74	740767 7808634	9	Date, 30/10/2020 Native woodland, rolling rises Mixed vegetation, no effective disturbance; natural, No microrelief, No erosion Surface Hard setting with 50-90% coarse fragments 6-20 mm 13%, No rock outcrop Located near a despression between two hills (Site 29)	
C75	740731 7809020	1	Date, 30/10/2020 Native woodland, undulating rises, open depression Narrow leaved Ironbark, no effective disturbance; natural, No microrelief, No erosion, No rock outcrop Surface soft with nil coarse fragments, loamy sand 7.5YR3/4 dark brown	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C76	740700 7809464	1	Date, 30/10/2020 Native woodland, undulating rises, open dperession No effective disturbance; natural, No microrelief, No erosion, No rock outcrop Surface firm with >90% coarse fragments and rocks 0.6-2.0 m inlcuding exposed bedrock	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C77	737594 7807683	1	Date, 30/10/2020 Native woodland, undulating plain, open depression Ironbark, no effective disturbance; natural, No microrelief, No erosion, No rock outcrop Surface firm, cracking, loamy sand, nil coarse fragments 10YR4/3 brown Nil mottles or inclusions 	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C78	738368 7806826	5	Date, 30/10/2020 Native woodland, gently undulating plain, flat to lower slope Ironbark observed Linted clearing, No microrelief, No erosion, <2% coarse fragments 6-20mm, No rock outcrop Surface soft, loamy sand, massive, loose 10YR4/3 brown	
C79	738254 7806888	1 / 5	Date, 30/10/2020 Native woodland, undulating plain, upper slope Ironbark and mixed vegetation No effective disturbance; natural, No microrelief, No erosion Surface soft with 2-10% coarse fragments 6-20 mm, No rock outcrop Boundary between SPC MAP UNITs 1 and 5	-
C80	737629 7806565	7	Date, 30/10/2020 Native woodland, undulating rises, mid slope Mixed vegetation including eucalyptus species, no effective disturbance Surface soft with nil coarse fragments, No rock outcrop	-

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C81	737813 7806694	8	Native woodland, undulating rises, 8% No effective disturbance; natural, No microrelief, No erosion Surface soft with 20-50% coarse fragments 0.6-2.0 m Exposed bedrock on shallow red soils	
C82	737904 7806814	1	Date, 30/10/2020 Native woodland, undulating rises Mixed vegetation with Ironbark No effective disturbance; natural, No microrelief, No erosion Surface soft with nil coarse fragments, loamy sand, No rock outcrop 10YR3/4 dark yellowish brown	-

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C83	738254 7807330	1	Date, 30/10/2020 Grazing, level plain, flat Sparse vegetation No effective disturbance; natural, No microrelief, No erosion Surface cracking with nil coarse fragments, No rock outcrop Light clay 10YR4/2 dark greyish brown	
C84	738744 7808249	5 / 6	Date, 30/10/2020 Native woodland, level plain, flat No effective disturbance; natural, No microrelief, No erosion, No rock outcrop Boundary of clay soils to the north, SPCs 5 and 6	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C85	738804 7808422	5	Native woodland, undulating rises, crest No effective disturbance; natural, No microrelief, No erosion Surface hard setting woth 20-50% coarse fragments 60-200 mm, No rock outcrop Shallow red soils with bedrock exposed	
C86	738945 7808633	6	Date, 30/10/2020 Native woodland including ironbarks, level plain, flat Short grass, Limited clearing, No microrelief, No erosion Surface firm, silty clay loam, <2% coarse fragments 6-20mm, No rock outcrop 7.5YR5/4 brown, nil mottles	-
C87	739090 7808891	6 / 1	Date, 30/10/2020 Native woodland including ironbarks, gently undulating plain, flat Limited clearing, No microrelief, No erosion, No rock outcrop Surface firm with nil coarse fragments, sandy loam 7.5YR3/4 dark brown Near to boundary between surface soils with silty clay loam and sandy loam, SPC MAP UNITs 6 and 1	-

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C91	740728 7805614	1	Date, 31/10/2020 Native woodland, gently undulating rises, mid slope Slim Eucalypt species, No effective disturbance; natural, No microrelief, No erosion, No rock outcrop Surface soft loamy sand with nil coarse fragments 10YR3/4 dark yellowish brown	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C92	740363 7805820	2	Date, 31/10/2020 Native woodland, gently undulating rises No effective disturbance; natural, No microrelief, No erosion, No rock outcrop Narrow leaved ironbark and gilbert river box • A11 / 0.00-0.13m / Abrupt boundary • Loamy sand • 10YR3/2 very dark greyish brown • Nil inclusions • A12 / 0.13-0.30 + / Abrupt boundary • Loamy sand • 10YR3/4 dark yellowish brown • Nil inclusions	

Site No.	Location mE, mN (GDA2020 Zone 54)	Soil Profile Class Map Unit	Comments	Plates
C93	739702 7806139	1	Date, 31/10/2020 Native woodland, level plain, open depression, <2% coarse fragments 6-20mm Red-grey pale eucalypts species , No effective disturbance, natural, No microrelief, Gully erosion, No rock outcrop Surface loose, sand-sandy loam Creek bed No effective disturbance, natural	
C94	739338 7806207	1	Date, 31/10/2020 Native woodland, undulating rises, open depression, lower slope, <2% coarse fragments 6-20mm Limited clearing, No microrelief, Gully erosion, No rock outcrop Boundary of a small, aggregated area of red rocky shallow soils to the north west No effective disturbance, natural	

ESSA Pty Ltd / by EAL NATA (ASPAC certified)

For Info Refer ESSA Pty Ltd
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References: K0695 Sheet 1 of 4

Date Received: 17/11/2020
Date Completed: 08/01/2021

FINAL REPORT

Project:
Project -20WG

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: 40 Tested Report K0695

ESSA /EAL Pty Ltd **(NATA, ASPAC Approved)**

Soil Analysis Report
Batch Numbers:K0695

Client: GTE 20WG- Results Page 1 of 2

ESSA Ref	Field Ref	Soil pH	Soil EC	Soil Cl	Exch.Ca	Exch.Mg	Exch. K	Ech. 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
K0695/1	**1-0.00-0.10**	6.62	0.024	31	4.3	1.14	1.01	<0.065	6.5	1	3.7	15D3
K0695/2	**1-0.20-0.30**	5.95	0.190	32	5.3	1.24	0.23	0.09	6.8	1	4.3	15D3
K0695/3	**1-0.50-0.60**	6.27	0.057	50	2.0	0.44	<0.12	<0.065	2.6	2	4.5	15D3
K0695/4	**1-0.75-0.85**	6.45	0.041	14	1.5	0.38	<0.12	<0.065	2.0	2	4.0	15D3
K0695/5	**1-0.90-1.00**	6.41	0.026	33	1.5	0.40	<0.12	<0.065	2.0	2	3.7	15D3
K0695/6	**2-0.00-0.10**	6.35	0.043	71	3.6	0.63	0.43	0.08	4.8	2	5.8	15D3
K0695/7	**2-0.20-0.30**	8.52	0.099	102	1.0	0.51	0.16	0.44	2.1	20	2.0	15C1
K0695/8	**2-0.50-0.60**	10.19	0.509	79	0.5	0.24	0.04	2.50	3.2	77	1.9	15C1
K0695/9	**2-0.70-0.80**	10.12	0.393	101	0.3	0.17	0.04	2.39	2.9	83	1.6	15C1
K0695/10	**2-0.90-1.00**	10.08	0.378	132	0.2	0.14	0.06	2.62	3.0	88	1.1	15C1
K0695/11	**3-0.00-0.10**	5.20	0.047	20	0.5	0.24	0.14	<0.065	1.3	1	1.9	15D3
K0695/12	**5-0.00-0.10**	6.26	0.067	11	2.6	0.32	0.19	<0.065	3.1	0	8.1	15D3
K0695/13	**5-0.25-0.30**	7.82	0.013	22	1.3	0.24	0.17	0.05	1.8	3	5.4	15C1
K0695/14	**5-0.50-0.60**	8.11	0.015	42	1.2	0.31	0.13	0.01	1.6	1	3.8	15C1
K0695/15	**5-0.70-0.80**	8.06	0.017	13	1.5	0.47	0.23	0.02	2.2	1	3.3	15C1
K0695/16	**5-0.90-1.00**	7.99	0.021	11	2.0	0.63	0.33	0.02	2.9	1	3.1	15C1
K0695/17	**6-0.00-0.10**	6.64	0.014	17	2.1	0.56	0.27	<0.065	2.9	0	3.8	15D3
K0695/18	**6-0.10-0.20**	6.77	0.015	8	1.1	1.34	0.16	0.31	2.9	11	0.8	15D3
K0695/19	**6-0.30-0.40**	6.18	0.010	11	0.7	0.81	0.19	0.09	1.8	5	0.9	15D3
K0695/20	**7-0.00-0.10**	8.14	0.084	94	6.9	4.36	0.48	1.24	13.0	10	1.6	15C1
K0695/21	**7-0.20-0.30**	7.88	4.092	3793	7.4	5.65	0.24	3.98	17.3	23	1.3	15C1
K0695/22	**7-0.50-0.60**	8.16	4.843	3222	5.9	4.90	0.21	4.89	15.9	31	1.2	15C1
K0695/23	**7-0.70-0.80**	8.51	2.980	2160	3.9	3.47	0.16	3.67	11.2	33	1.1	15C1
K0695/24	**7-0.90-1.00**	8.74	1.464	1211	1.8	2.20	0.14	2.68	6.8	39	0.8	15C1
K0695/25	**18-0.00-0.10**	5.97	0.024	25	1.3	0.23	<0.12	<0.065	1.6	0	5.5	15D3
K0695/26	**18-0.20-0.30**	6.37	0.009	29	0.6	0.26	<0.12	0.12	1.0	11	2.3	15D3
K0695/27	**18-0.50-0.60**	5.89	0.004	27	0.2	0.20	<0.12	<0.065	0.5	3	1.2	15D3
K0695/28	**18-0.80-0.90**	5.84	0.003	23	0.3	0.26	<0.12	<0.065	0.6	2	1.0	15D3
K0695/29	**18-1.10-1.20**	5.83	0.002	22	0.2	0.49	<0.12	<0.065	0.8	1	0.5	15D3
K0695/30	**18-1.40-1.50**	5.80	0.002	10	0.1	0.69	<0.12	<0.065	0.9	1	0.2	15D3
K0695/31	**22-0.00-0.10**	5.04	0.014	70	0.3	0.14	<0.12	<0.065	1.2	0	2.3	15D3
K0695/32	**22-0.20-0.30**	4.58	0.015	8	<0.05	0.03	<0.12	<0.065	0.1	6	1.2	15D3
K0695/33	**22-0.50-0.60**	4.68	0.011	8	<0.05	0.05	<0.12	<0.065	0.1	5	0.9	15D3
K0695/34	**22-0.70-0.80**	4.99	0.005	9	<0.05	0.16	<0.12	<0.065	0.2	6	0.1	15D3
K0695/35	**24-0.00-0.10**	7.62	0.132	24	8.1	1.52	0.36	0.04	10.0	0	5.3	15C1
K0695/36	**24-0.20-0.30**	7.36	0.025	13	1.7	0.58	0.21	0.04	2.6	2	3.0	15C1
K0695/37	**24-0.40-0.50**	7.39	0.013	16	1.6	0.95	0.33	0.02	2.9	1	1.7	15C1
K0695/38	**29-0.00-0.10**	6.76	0.011	11	2.7	0.95	0.25	<0.065	3.9	0	2.9	15D3
K0695/39	**29-0.20-0.30**	6.67	0.011	9	3.5	1.93	0.19	<0.065	5.6	1	1.8	15D3
K0695/40	**31-0.00-0.10**	5.55	0.069	34	0.1	1.30	<0.12	0.39	2.5	16	0.1	15D3

ESSA Ref	field ref	Zinc	Mn	Iron	Copper	Boron	Si	Tot C	Org Matter	P Col.	NO3	NH4
	depth (m)	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%	mg/kg	mg/kg	mg/kg
K0695/1	**1-0.00-0.10**	2.4	42	29	0.40	0.21	40	1.3	1.3	27	2.1	4.2
K0695/6	**2-0.00-0.10**	2.4	20	93	0.3	0.33	37	2.21	2.21	16	7.8	4.0
K0695/11	**3-0.00-0.10**	<0.5	6	75	0.1	0.11	6	1.11	1.11	17	15.2	10.4
K0695/12	**5-0.00-0.10**	1.1	12	14	0.3	0.23	19	0.59	0.70	17	28.2	6.3
K0695/17	**6-0.00-0.10**	0.8	11	22	0.2	0.25	13	0.97	0.97	14	0.8	1.2
K0695/20	**7-0.00-0.10**	0.6	8	9	1.3	0.42	63	0.44	0.44	17	2.2	0.2
K0695/25	**18-0.00-0.10**	<0.5	12	36	0.2	<0.1	12	0.69	0.77	12	5.8	2.0
K0695/31	**22-0.00-0.10**	<0.5	2	82	<0.1	0.10	4	1.07	1.14	11	3.9	0.2
K0695/35	**24-0.00-0.10**	2.0	8	16	0.3	0.46	30	3.87	3.87	19	33.1	1.1
K0695/38	**29-0.00-0.10**	<0.5	11	5	<0.1	<0.1	17	0.43	11 (OC)	4.5	0.6	2.6
K0695/40	**31-0.00-0.10**	<0.5	6	28	0.2	<0.1	14	0.39	0.39	13	1.4	4.2

Cu = Copper, Si = Silicon, P Col. = P by Colwell, NO3 = Nitrate N , NH4 = Ammonium N

ESSA /EAL Pty Ltd **(NATA, ASPAC Approved)**

Soil Analysis Report
Batch Numbers:K0695

Client: GTE 20WG- Results Page 2 of 2

ESSA Ref	field ref	Tot Sulfur	Soil pH CaCl2	Soil pH H2O	Tot N	SO4S	C/N
	depth (m)	mg/kg	0.01M		%	mg/kg	Rat.
K0695/1	1-0.00-0.10	<50	5.4	6.6	0.04	1.4	29
K0695/6	2-0.00-0.10	103	5.5	6.4	0.14	2.6	16
K0695/11	3-0.00-0.10	<50	4.6	5.2	0.04	3.0	27
K0695/12	5-0.00-0.10	<50	5.6	6.3	0.04	1.1	18
K0695/17	6-0.00-0.10	<50	5.8	6.6	0.06	1.1	18
K0695/20	7-0.00-0.10	<50	7.0	8.1	0.03	10.8	16
K0695/25	18-0.00-0.10	<50	5.1	6.0	0.02	3.8	34
K0695/31	22-0.00-0.10	<50	4.4	5.0	0.04	1.3	28
K0695/35	24-0.00-0.10	154	7.1	7.6	0.23	4.8	17
K0695/38	29-0.00-0.10	3	5.6	6.76	0.03	3.1	14
K0695/40	31-0.00-0.10	<50	4.5	5.6	<0.02	2.6	21

Lab No	Sample No	Moisture	Gravel	Sand	Sand	Silt	Silt	Clay	Texture	R1	Emerson
	Depth (m)	Content	> 2 mm	> 50 µm	> 20 µm	2−50 µm	2−20 µm	< 2 µm	Class	Disp.	Class no.
		%		<2mm	<2mm	<2mm	<2mm	<2mm		Rat.	
K0695/1	1-0.00-0.10	1	0	60	71	25	14	15	Loam	0.53	5
K0695/2	1-0.20-0.30	1	0	65	71	20	14	15	Loam	0.58	5
K0695/3	1-0.50-0.60	0	0	81	86	9	4	11	S Loam	0.39	5
K0695/4	1-0.75-0.85	0	0	85	87	7	4	9	S Loam	0.37	8
K0695/5	1-0.90-1.00	0	0	85	87	8	5	7	LSand	0.32	8
K0695/6	2-0.00-0.10	0	0	84	87	7	4	9	S Loam	0.32	8
K0695/7	2-0.20-0.30	0	0	82	87	11	6	7	Loamy Sand	0.40	1
K0695/8	2-0.50-0.60	1	0	69	76	12	5	19	S Loam	0.62	1
K0695/9	2-0.70-0.80	0	0	71	76	10	5	19	S Loam	0.60	1
K0695/10	2-0.90-1.00	0	0	73	77	8	3	20	Sandy Clay Lo	0.62	1
K0695/11	3-0.00-0.10	0	0	92	92	0	0	8	S Loam	0.04	8
K0695/12	5-0.00-0.10	0	0	83	89	11	5	6	LSand	0.34	8
K0695/13	5-0.25-0.30	0	0	85	93	9	0	7	Sand	0.36	8
K0695/14	5-0.50-0.60	0	0	86	91	6	1	8	Sand	0.49	8
K0695/15	5-0.70-0.80	0	0	79	84	8	2	13	S Loam	0.50	8
K0695/16	5-0.90-1.00	0	0	71	77	9	3	20	SC Loam	0.52	8
K0695/17	6-0.00-0.10	0	0	87	91	6	2	7	Sand	0.36	8
K0695/18	6-0.10-0.20	1	0	66	73	14	7	20	SC Loam	0.53	2
K0695/19	6-0.30-0.40	0	0	76	81	12	7	12	S Loam	0.53	8
K0695/20	7-0.00-0.10	2	0	42	51	28	20	29	Clay Loam	0.52	2
K0695/21	7-0.20-0.30	2	0	23	33	40	29	38	SC Loam	0.34	1
K0695/22	7-0.50-0.60	2	0	17	29	41	29	42	Silty Clay	0.43	1
K0695/23	7-0.70-0.80	1	0	30	42	37	25	33	Clay Loam	0.63	1
K0695/24	7-0.90-1.00	1	0	57	66	17	8	26	Clay Loam	0.54	1
K0695/25	18-0.00-0.10	0	0	91	90	0	1	9	S Loam	0.26	8
K0695/26	18-0.20-0.30	0	0	87	89	2	1	10	S Loam	0.68	8
K0695/27	18-0.50-0.60	0	0	83	87	5	1	12	S Loam	0.36	8
K0695/28	18-0.80-0.90	0	0	81	82	2	1	17	S Loam	0.37	8
K0695/29	18-1.10-1.20	0	0	79	80	2	1	19	SC Loam	0.19	8
K0695/30	18-1.40-1.50	0	0	75	77	2	1	22	SC Loam	0.14	8
K0695/31	22-0.00-0.10	0	0	87	87	1	1	12	S Loam	0.41	8
K0695/32	22-0.20-0.30	0	0	74	73	4	4	23	SC Loam	0.47	8
K0695/33	22-0.50-0.60	0	0	65	67	5	4	29	SC Loam	0.39	8
K0695/34	22-0.70-0.80	0	0	64	67	11	8	25	Clay Loam	0.38	8
K0695/35	24-0.00-0.10	1	0	78	82	7	4	14	S Loam	0.23	5
K0695/36	24-0.20-0.30	0	0	83	89	7	0	10	S Loam	0.21	8
K0695/37	24-0.40-0.50	0	0	83	85	6	3	12	S Loam	0.26	8
K0695/38	29-0.00-0.10	1	0	81	86	10	5	9	S Loam	0.39	8
K0695/39	29-0.20-0.30	1	0	72	79	11	4	17	S Loam	0.46	8
K0695/40	31-0.00-0.10	0	0	62	69	15	9	22	SC Loam	0.53	8

Texture Codes S = Sandy, L= Loamy, C = Clay

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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

Reference: K0695

*** 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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