Soils of the Banana Area Central Queensland

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Queensland Government
Natural Resources and Water

Land Resources Bulletin

Soils of the Banana area, Central Queensland

P.G. Muller

Natural Resources and Water,
Queensland 2008

BAN_1
ISBN 978 1 7417 2914 6

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Department of Natural Resources and Water
Locked Bag 40
Coorparoo Qld 4151

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Acknowledgements

There are many people who greatly contributed to and supported the Banana land resource survey project.

My first and foremost thanks go to Jon Burgess who was never unstinting in his advice, and whose suggestions were always thoughtful and informative, and who, above all, helped me to understand the geomorphology of central Queensland. Our many fruitful discussions were inspirational and lead eventually to the format of this report.

Others who helped with the technical aspect of soils and landscapes were Alan Barton, Bernie Powell, Bruce Radford, Peter Wilson and Bruce Forster.

Geologists Clem Hill, John Dear and Mark Biggs were extremely helpful in the identification of the many rock specimens I sent them, particularly in the early days of the project and enabled me to come to grips with the many varying parent materials within the survey area.

My sincere gratitude also goes to my assistants who without complaint came out in the field with me day after day despite some hot and uncomfortable weather each summer. In order of appearance they are: Peter Pederson who, despite never making it to Biloela, purchased and gathered together equipment and resources for the project prior to my arrival ensuring the project got off to a good start; Steven Nurser, Sue-Ellen Dear, Susan McCarroll and Paul Duffy all helped with the field work, entered the data, dried the soil samples, and maintained the equipment. I thank you all.

Bob Clem, Col Esdale and Stuart Cannon all provided me with valuable advice on the beef cattle and cropping land uses of the Callide and Dawson Valley areas for the development of the land suitability assessments for the project.

Special mention must also be made of the Queensland Herbarium botanists who identified many plant specimens for me. QDPI pasture agronomists Bob Clem and Eric Anderson also identified many other plant specimens throughout the survey.

Alan McTaggart provided the office accommodation and many other resources at Biloela Research Station, while Doug Porter at the workshop carried out many repairs to the equipment, soil rig and vehicle. The administration staff, Sandra Ruthenberg, Karen Suhr, and Fiona Longhurst of Biloela, and Samantha Spence of Mackay, also provided invaluable assistance with the word processing of the many NSCP and NLP progress reports, interim reports, field notes and of course this soils report.

Finally, Alistair Coutts' unflagging energy and willingness to help enabled this report to get over the line to the publisher, as he was able to efficiently produce the profile diagrams, salt and sodocity graphs, representative Profile Descriptions and analytical data in the Appendices, as well as make many changes to the manuscript.

GIS and cartographic services were provided by Charlie Ellis, John Myers and Gary Finney for drafting and printing the soils map.

Bruce Forster and Scott Irvine reviewed and provided editorial imput for the final report, and final publication completed by Diane Bray.

Funding for this project was provided firstly by the National Soil Conservation Programme (NSCP), which became the National Landcare Programme (NLP) halfway through the project.

Summary

The land resources of approximately 278 480 ha of central Queensland was surveyed at a low intensity scale of 1:100 000. Soils were mapped using free survey techniques with an average overall intensity of 1 site per 110 ha. The soils have been grouped according to their parent material type.

The climate of the area is semi-arid with the majority of the high intensity rain falling through the summer months, with little if any winter rainfall. The highest annual average rainfall of 900 mm occurs in the north-eastern area of the Banana study area due to the influence of the Calliope Range. Rainfall decreases further to the west and south to 670 mm at the township of Banana.

The eastern part of the Banana study area comprises the Callide Tertiary basin, an undulating plain of largely unconsolidated colluvial and alluvial sediments interspersed with the many remnants of the former Tertiary land surface. The Callide basin is confined by the Calliope Range to the east, and by the steep hills to undulating low hills of the uplifted Palaeozoic volcanic rocks of the Banana Range to the west. Gently undulating to undulating plains and rises formed on the folded Permian sedimentary rocks of the Bowen basin unconformably overlie the volcanic rocks of the Banana Range in the western areas of the study area.

Over 2600 site descriptions were made identifying 69 different soil profile classes. At each site land, vegetation, geological and soil morphological data were recorded. All soils were sampled for chemical and physical analyses.

Soils in the study area have formed from ten parent materials – acid and intermediate volcanic rocks, acid intrusive rocks, basalt, granite, Permain sedimentary rocks, Jurassic sandstone, deeply weathered Tertiary sedimentary rocks, unconsolidated Cainozoic alluvial-colluvial sediments and Quaternary alluvial sediments. Soils developed on the unconsolidated Cainozoic (32 %) and Quaternary (17 %) sediments, intermediate volcanic (22 %) and Permian sedimentary rocks (18 %) are the most dominant, whilst soils of the Tertiary sandstones (5 %) and acid volcanic rocks (4 %) account for much smaller areas. The soils of the basalt (1 %), acid intrusive rocks (0.4 %), Jurassic sandstone (0.03 %) and granite (0.02 %) are only minor in area.

The plant available water capacity (PAWC) of the soil is the most limiting factor to rainfed crop production in cental Queensland. This is why many of the marginal soils that were bought into crop production during the more favourable seasons of the 1970's and early 1980's were unable to sustain yields in the drier seasons that followed. This study concludes that only soils with a PAWC of 120 mm or greater are viable for long term rainfed cropping. This means that rainfed cropping is largely confined to the better quality cracking clay soils.

Beef cattle fattening relies on the soils fertility to produce the necessary high quality pasture in order for cattle to reach weight for age market specifications. Beef cattle fattening enterprises in central Queensland are largely centred upon introduced grass pastures of buffel grass and green panic that have been sown onto the former brigalow and softwood scrub soils. The high fertility alluvial soils are also capable of fattening cattle on either the original native grass pastures or introduced sown grasses. In this study the levels of bicarbonate extractable phosphorous and total nitrogen have been used to assess a soils' fertility and make recommendations as to its suitability for cattle fattening.

1. Introduction

The Banana land resource survey describes the soils, landforms, vegetation, geology and agricultural land suitability of the soils of the Banana 1:100 000 study area. Located to the west of Biloela in central Queensland (Figure 1), the Banana village and district are named after a yellow bullock that was renowned for leading the wild bullocks into the yards in the late nineteenth century. The study area covers approximately 281 500 ha and is one of the priority areas for land resources mapping in central Queensland (Shields and Turner, 1985). Land use in the study area is predominantly beef cattle fattening and breeding enterprises on introduced and native pastures. There are also limited areas of rainfed cropping throughout the district, and irrigated cropping occurs on the Callide Valley floodplain due to the presence of underground water.

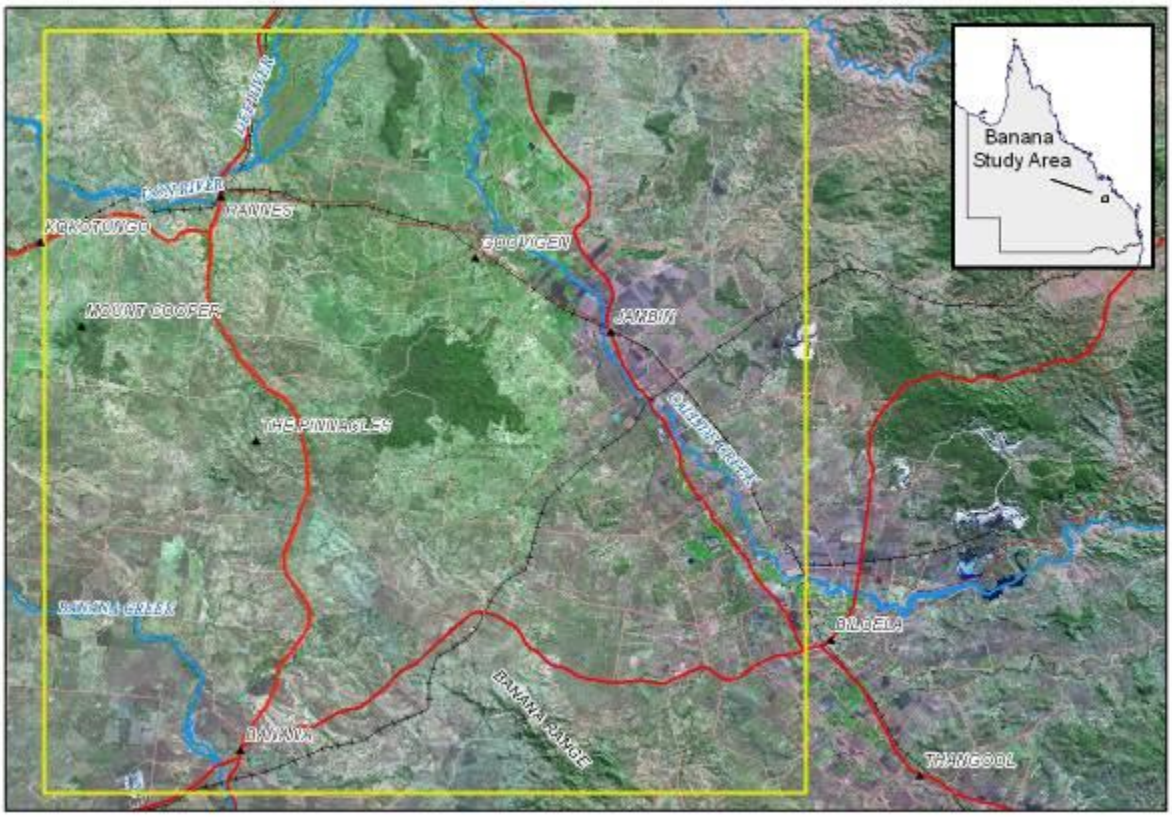

Figure 1. Location map of the Banana study area

Detailed land resources information was required in central Queensland when large areas of grazing lands were bought into cropping in the late 1970's and early 1980's. Cropping inappropriate soils resulted in poor yields and exacerbated land degradation in the area. With only broad-scale CSIRO land systems information available (Speck et al, 1968), more detailed soils information was required in order to provide sound advice to landholders on land use recommendations, cropping options and property management planning.

The objectives of the study were to:

- provide detailed information on the soils and land resources of the study area; and
- evaluate the suitability of the land resources for irrigated and dryland cropping and beef cattle production.

The land resources described in this report are not confined to the study area alone. This study area is representative of many of the land types within the Dawson and Callide Valley districts. The results of this study can therefore be extrapolated to this larger area with confidence (Shields and Williams, 1991). The land systems report and map for the Dawson-Fitzroy area (Speck et al, 1968) can be used to determine the extent to which this study applies.

1.1 Climate

The climate of central Queensland is classified as semi-arid with a highly erosive, summer dominant rainfall. Annual rainfall is between 670 mm to 730 mm across the study area with up to 70 % of the rain falling between October and March (Table 1). Winter rainfall is generally more reliable in the southern areas of central Queensland around Biloela and Moura, than to the north of Emerald. Summers are hot with at least one heat wave event each summer. Frosts occur on the low-lying country between May and September. The mean monthly maximum and minimum temperatures and daily pan evaporation for Biloela are shown in Table 2. For detailed climatic data refer to the Commonwealth Bureau of Meteorology and Shields and Gillespie (1991).

Table 1. Mean monthly and annual rainfall for Biloela and Banana

Station	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Biloela	101	101	63	38	41	34	30	21	23	54	76	98	683
Banana	99	95	71	35	37	39	32	22	30	54	68	92	674

Table 2. Mean temperature and evaporation data for Biloela

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Maximum (°C)	33.2	32.2	31.2	28.9	25.4	22.2	21.9	23.9	27.0	29.8	31.7	32.9	28.3
Minimum (°C)	19.8	19.5	17.7	13.7	10.1	6.5	5.2	5.6	8.6	13.2	16.4	18.4	12.9
Evaporation (mm/day)	7.2	6.8	6.0	4.8	3.4	2.9	2.9	3.7	5.2	6.4	7.2	7.6	5.3
Average days with -													
Max > 35	8.5	5.6	2.6	0.1						1.5	4.7	7.4	30.5
Min < 2					0.6	5.1	9.0	5.5	0.7				20.9

Source: Bureau of Meteorology

2. Methods

2.1 Soil mapping

The soils of the Banana study area were mapped at the 1:100 000 scale using free survey methods (Reid, 1988). For the reference making phase, the soils were initially investigated on short transects across the major geological formations. The soils and landforms were described at intervals of 300 to 500 m on the main landform elements along the transects. Some 422 soil profiles were described over 43 transects. This information was used to develop a preliminary soil reference.

For the soils mapping, the site intensity was varied according to the landscape complexity. Hills and mountains, with simple soil patterns, had the lowest intensity of field work of one site per 175 ha, compared to one site per 80 ha on the flood plains. A reliability diagram on the map shows the intensities used for the various landscapes. Overall, 2602 sites were described, along with several hundred other 'check sites,' where the site was not described, but where soil and land properties were observed to determine soil boundaries and soil complexity within a map unit, thus giving an overall site intensity of one observation per 95 ha.

Black and white aerial photographs at an approximate scale of 1:25 000 were used for the initial aerial photo interpretation to locate sites as well as for mapping soil boundaries. The soil profile was described in the field from an intact 50 mm core that was obtained from a vehicle mounted hydraulic rig that pushed a 50 mm thin-walled, steel tube into the ground. The soil profile was examined to a depth of 1.5 m or to hard, unweathered bedrock, which ever occurred first. Where it was not possible to use the steel push tubes on very stony soils and hilly landscapes, the soil profile was examined by digging a small pit to a depth of 0.5 m, with a crowbar and spade. If bedrock did not occur by 0.5 m, a 75 mm jarret hand auger was used to examine the lower subsoil.

The soil and land properties were described according to McDonald *et al* (1990) and the coded data was recorded onto Queensland Department of Primary Industries (QDPI) site description sheets. Additional data collected include 1:5, soil:water electrical conductivities ($EC_{1:5}$) that were measured in the field with a portable TPS conductivity meter. Soil profiles were classified to a principal profile form (Northcote, 1979) and by the second and third approximations of the Australian Soil Classification (ASC) system (Isbell, 1992; 1993). The ASC reported here is from Isbell (1996). Unknown vegetation species were sampled and identified by either the Queensland herbarium or QDPI pasture agronomists.

The parent material was determined in the field from the underlying geology and by interpreting the geomorphology at each site. The Monto 1:250 000 geological map and report (Dear *et al*, 1971) was used as the main guide to the rock types and structures found in the Banana study area. QDPI and private geologists also assisted with identification of rock samples.

These data were entered into a sequential ASCII file and analysed using the worldwide applicable resource inventory system (WARIS) computer programs (Rosenthal et al, 1986). These files have since converted to the Soil And Land Information (SALI) database.

Soil profile classes (SPC) or soil types are grouped according to the parent material on which they are formed, and are named after a locality or topographic feature near where they were first described. Some soil names from the Dawson-Callide Land Management Manual (Gillespie *et al*, 1991) have been used for similar soils in this study. Sixty-nine soil profile classes were identified during this study and are described in detail in Appendix 1.

2.2 Soil sampling and analysis

A representative profile of each soil profile class was sampled at least once for full profile laboratory analysis. Soil profile classes with gilgai microrelief had both the mound and depression components sampled as separate profiles. A total of 113 profiles were sampled and soil samples were analysed by the then QDPI agricultural chemistry laboratories (now the Analytical Centre of the Department of Natural Resources and Water). Each representative profile was sampled in 10 cm increments to either bedrock or a maximum depth of 1.5 m. Profile analyses at the surface and at 0.3 m intervals down the profile or at major soil horizon changes included 1:5,soil:water pH, electrical conductivity (EC) and chloride content (Cl^-); pH in calcium chloride ($CaCl_2$); particle size; cation exchange capacity (CEC), exchangeable cations, and exchangeable aluminium and acidity when the soil pH is less than 5.5; total phosphorous (P), potassium (K) and sulphur (S); moisture content at 1500 Kpa and R1 dispersion ratio (Baker and Eldershaw, 1993) Analyses at the intermediate 10 cm intervals consisted only of 1:5,soil:water pH, EC and Cl^-. The exchangeable cations were extracted with either ammonium chloride (NH_4Cl) at pH 7.0 (aqueous) or 8.5 (alcoholic) depending on the pH of the soil (Baker and Eldershaw, 1993).

A composite surface sample (0-10 cm), made up of nine (9) sub-samples, was also taken for each representative profile for soil fertility analyses. The analyses for soil fertility consist of organic carbon (C); total nitrogen (N); bicarbonate extractable P; extractable K; trace elements iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu); sulphate-S and nitrate-N. A further 345 composite topsoil samples were also taken from other sites during soil mapping in order to characterise the surface fertility of each soil profile class. However, only organic C, total N, bicarbonate P, extractable K and sulfate S were measured on these samples. The fertility data are only reported on an air dry basis, while all other results are presented as oven dry.

The original data reported by the laboratory are shown in the analytical data tables for a representative profile for each soil profile class in Appendix 2. However, in the results section, interpretated data has been presented, to assist the reader, for the following conditions –

- exchangeable sodium, measured by the aqueous method, has been adjusted to account for soluble salts (Rayment and Higginson, 1992);
- when gypsum is present the electrical conductivity has been estimated from the chloride content; and
- where there is significant difference between the CEC and sum of the cations, the latter has been used to estimate the cation exchange capacity.

These adjustments are indicated in the tables when applied.

2.3 Plant available water capacity

The plant available water capacity (PAWC) for each soil was calculated using the PAWCER model of Littleboy (1995). The particle size and 1500 Kpa data from the laboratory data, along with an average stone content, are input into the model to calculate the PAWC to a defined rooting depth for each soil. The rooting depth is limited by high subsoil soluble salt content of EC 1.0 dS/m or greater, very high exchangeable sodium percent (ESP) of 20 or greater, and a strongly acid pH of 5.5 or less. Where none of these conditions apply, a maximum rooting depth of 1.5 m is used.

2.4 UMA data

Each polygon shown on the map is termed a unique map area (UMA), which is identified by a number. The map code for the dominant soil type for each UMA is shown on the map. Where a soil complex occurs, the two main soil types are indicated. A range of soil and land information such as soils, slope and landform has been recorded for each UMA, and entered into the SALI UMA database. This information will form the basis for future assessments of cropping suitability and grazing productivity to be presented in a separate report and maps.

3. Geology

The Banana study area has four distinct geological areas that have differing rocks, landforms and geomorphic history (Figure 2). The first is an almost continuous ridge of hills and mountains, up to ten kilometres wide, that runs in a NNW direction from near the south-east corner through the centre of thestudy area. These hills which are composed mainly of acid and intermediate volcanic rocks, separate the deeply weathered sedimentary rocks and unconsolidated, Cainozoic and Quaternary alluvial sediments of the Callide Tertiary Basin in the east from the folded, Permian sedimentary rocks of the Bowen Basin in the west. A small area of rises and hills formed from sedimentary and volcanic rocks deposited in the Yarrol Basin occurs in the north-east corner of the study area. Other minor rocks that outcrop in the study area include small areas of Tertiary basalt, an outcrop of the Jurassic Precipice sandstone, and two low hills formed from Cretaceous acid intrusive rocks.

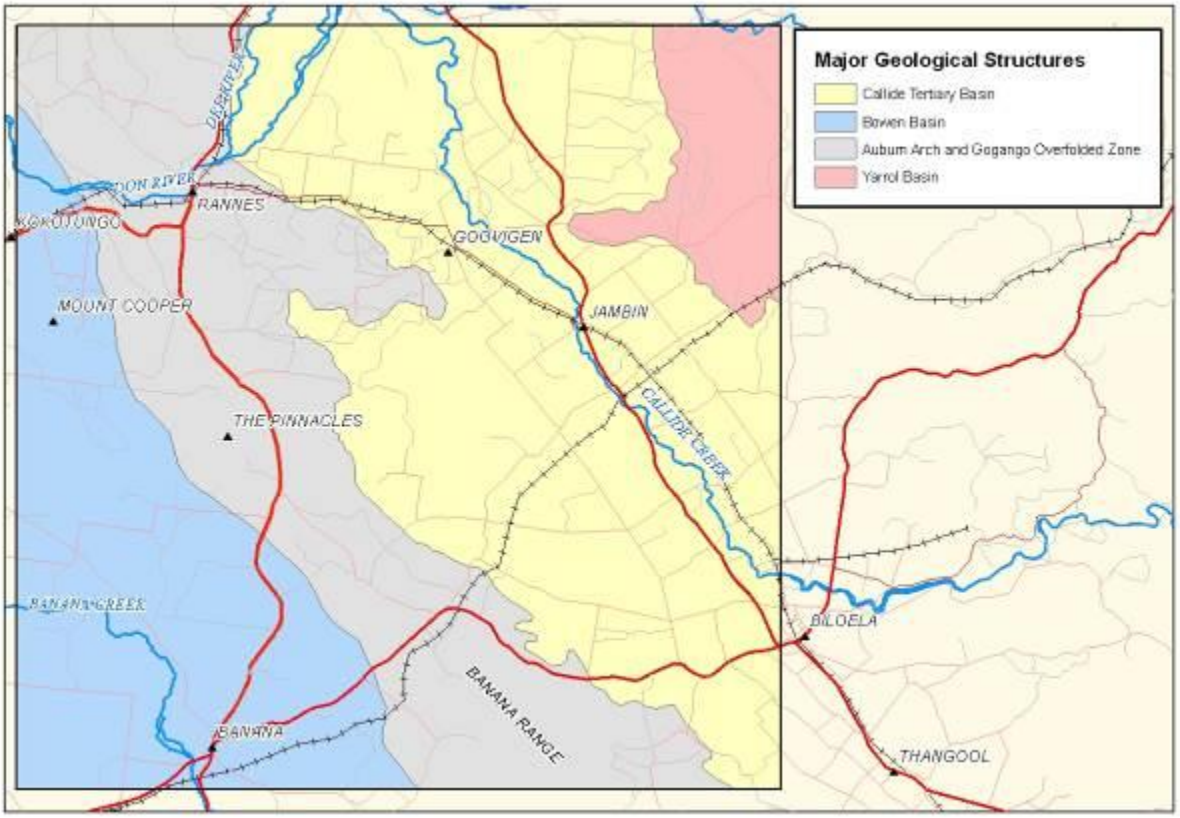

Figure 2. Major geological formations of the Banana study area

The central ridge of hills is made up of two major geological structures, the Auburn Arch and the Gogango Overfolded Zone. The northern part of the Auburn Arch just enters into the southern part of the Banana study area and forms the highlands of the Banana Range. Mount Benn is the highest peak with an altitude of 520 m. The Auburn Arch is made up of acid and intermediate volcanic rocks of the Torsdale beds and the Camboon andesties which have been intruded by granites of the Glandore granodiorites. It is a broad, uplifted anticline trending NNW and plunges to the north. The age of uplift is uncertain, and parts of the uplift may have occurred at separate times during the late Carboniferous, late Permian-early Triassic and again during the late Triassic (Dear *et al*, 1971).

The unsheared rocks of the Torsdale beds and igneous intrusives of the Auburn Arch pass north-westwards into the sheared volcanics of the Gogango Overfolded Zone. The Auburn Arch ends abruptly at the Neville Creek fault on the Banana-Biloela road. The Gogango Overfolded Zone is made up of volcanics and sediments of an early Permian trough represented by the Camboon andesites, Rannes and Torsdale beds, and the Rookwood volcanics. The Camboon andesites interfinger with the Rannes beds just to the north and south of Rannes. These rocks were uplifted, cleaved, sheared, folded and in places overfolded several times during the late Permian or early

Triassic and form a belt of low-grade, regionally metamorphised sediments and volcanics (Dear *et al*, 1971).

The eastern limb of the Bowen Basin with mid to late Permian sedimentary rocks is a major geological structure occurring to the west of these hills. The marine Back Creek group is the major formation of the Bowen Basin represented in the Banana study area and is made up of sandstones, siltstones and mudstones. There is also a smaller area of Back Creek group sediments present on the eastern flank of the Auburn Arch in the south-east corner of the study area. It is believed that these sediments were once continuous with those to the west and were thus laid down prior to the late Permian-early Triassic uplift of the Auburn Arch (Dear *et al*, 1971).

In the south-west corner of the study area the predominantly freshwater sediments of the Gyranda formation conformably overlie the upper members of the Back Creek group. The Gyranda formation is composed of mainly siltstone and sandstone. Deposition ceased in the Bowen Basin in the early Triassic and the sediments were uplifted, gently folded and eroded. Further down warping formed a major syncline which has its axis 50 km to the west of Banana (Dear *et al*, 1971).

Two hills, six kilometres to the south of Kokotungo, represent two Cretaceous intrusive stocks that were intruded into the surrounding Permian sedimentary rocks. The larger of the two hills is the domed shaped Mt. Cooper. They are composed of rhyolite, syenite and quartz porphyry and are possibly related to the trachyte stock of Mt Ramsay some ten kilometres to the west (Olgers, 1966).

To the east of the central belt of hills lies the Callide Tertiary Basin, which is confined on its eastern side by the Devonian to Permian sedimentary, intrusive and volcanic rocks of the uplifted Yarrol Basin. These rocks, which make up the Calliope Range, form a small area of rises and steep hills in the north-east corner of the study area. The major rock types present here are the Devonian undifferentiated acid and intermediate volcanic rocks, the Permian Owl Gully volcanics (andesitic lavas), the Youlambie conglomerates and the Mt. Gerard intrusive complex (granodiorite). A small area of the Jurassic Precipice sandstone, which is a flat-lying quartzose sandstone, outcrops on the foothills of the Calliope Range on the eastern edge of the study area, at the Boundary Hill coal mine lease area.

The Callide Tertiary Basin was formed mainly from fluvial and lacustrine deposits of quartz sandstone, grey clay shale and pebble conglomerates (Dear *et al*, 1971). These sediments filled the Callide, and other basins in central Queensland, and formed a gently undulating to level land surface surrounded by low hills formed from the previously mentioned resistant, uplifted Palaeozoic rocks (Galloway, 1967). This land surface was deeply weathered during the Tertiary period and has been extensively eroded, so that now only scattered, remnant plateaus are all that remain of this former Tertiary land surface in the Callide and Dawson Valleys.

The outwash from the erosion of the Tertiary land surface was laid down as thick, unconsolidated clay sheets forming extensive level to gently undulating plains in both the Callide and Dawson valleys. The thickness of these clay sheets varies from 60 to 120 m (Malone, 1966). Along the western margin of the study area, this material forms a thin surface cover over the Permian sedimentary rocks, while, in the Callide, this material has in-filled almost the entire valley, covering the older Palaeozoic rocks.

The last major geological activity of the Tertiary period was the outpouring of olivine basalt from volcanoes and vents in the upper (southern) reaches of the Callide Valley. These basalt flows originally covered large areas, but extensive weathering has left only remnant, level to undulating basalt plateaus throughout the district, five of which occur in the south-east corner of the study area. To the west and north-east of Goovigen, small areas of black and red clay soils are formed on what appears to be remnants of valley lava flows of basalt. Outcrops of basalt on these remnants are rare, but vesicular basalt surface stone are common in places.

During the Quaternary, alluvial deposits of gravel, sand, silt and clay were laid down to form the major floodplain of the Callide Creek, and valley flats of minor creeks such as Banana Creek. The

Callide floodplain alluvium has an average thickness of 17 m (Dear *et al*, 1971) and the underlying gravel aquifers yield groundwater of variable quality and quantity. Groundwater to the north of Goovigen and under the floodplain between the Don and Dee rivers, to the west of the Callide, is mostly too saline for irrigation purposes. Significant water-bearing aquifers are also not present on the valley flats of the minor creeks in the study area. Reid (1940) and Isbell (1954) provide detailed information on the groundwater of the Callide Valley.

4. Soils

The main morphological and chemical properties of each soil profile class along with the characteristic landform, vegetation and parent material are described in this section. These soil descriptions are supported by Appendix 1 which contain the detailed interpreted data for each soil profile class. The land and profile morphology descriptions and analytical data for the sampled representative profiles of each soil profile class are contained in Appendix 2.

4.1 Soil parent material

The soils of the Banana study area have been grouped according to the parent materials on which the soils have formed. Ten parent material types were identified, based upon lithology. These parent materials, their structural features and stratigraphic units and dominant lithologies are outlined in Table 3. The geological details have been taken from the Monto 1:250,000 geology map sheet (Dear *et al*. 1971).

Table 3. Stratigraphic unit, structural feature and dominant lithologies for each parent material group

Parent material group	Stratigraphic unit	Structural feature	Dominant lithologies
1. Devonian, Carboniferous and Permian acid volcanic rocks	Torsdale Beds (Ct)	Auburn Arch and Gogango Overfolded Zone	Acid and intermediate lavas and tuff
	Undifferentiated (Du)	Yarrol Basin	Andesitic lava, tuff and siltstone
	Glandore Granodiorite (Cul)	Auburn Arch	Granodiorite, tonalite, adamellite, diorite
2. Cretaceous acid intrusive rocks	Unnamed (Ki)	Igneous intrusions into the sedimentary rocks of the Bowen Basin	Quartz porphyry, rhyolite, aplite, syenite
3. Permian granite	Unmapped outlier of the Mt Gerard Complex (PRf) (M. Biggs pers. comm.)	Yarrol Basin	Diorite, gabbro, granodiorite, granite
4. Permian and Devonian intermediate volcanic rocks	Camboon Andesite (Pln)	Gogango Overfolded Zone	Andesitic, basaltic and trachytic lava
	Rookwood Volcanics (Pr)	Gogango Overfolded Zone	Spilite, pillow lava
	Owl Gully Volcanics (Plq)	Yarrol Basin	Andesitic lava
	Undifferentiated (Du)	Yarrol Basin	Andesitic lava, tuff, siltstone
	Mt Gerard Complex (PRf)	Yarrol Basin	Diorite, gabbro, granodiorite, granite
5. Tertiary basalt	Unnamed (Tb)	Callide Tertiary Basin	Olivine basalt

Table 3 (cont).

Parent material group	Stratigraphic unit	Structural feature	Dominant lithologies
6. Folded Permian sedimentary rocks	Formations of the Back Creek Group (Pb, Puf, Pur)	Bowen Basin	Sandstone, siltstone, mudstone
	Gyranda formation (Puy)	Bowen Basin	Siltstone, sandstone, mudstone
	Rannes Beds (Pw)	Gogango Overfolded Zone	Cleaved siltstones and mudstones, shale
	Youlambie Conglomerate (Ply)	Yarrol Basin	Conglomerate, feldspathic sandstone, siltstone
7. Flat lying Jurassic sandstone	Precipice Sandstone (Jlp)	Callide Coal Measures	Quartz sandstone, siltstone
8. Deeply weathered Tertiary sedimentary rocks	Undifferentiated (Ta)	Callide Tertiary Basin	Sandstone, pebble conglomerate
9. Unconsolidated Cainozoic alluvial-colluvial sediments	Unnamed (Cza)	Callide Tertiary Basin and Bowen Basin	Clay, silt, sand and gravel deposits
10. Unconsolidated Quaternary alluvium	Unnamed (Qa)	All structural features	Alluvial sand, silt clay and gravel

4.2 Soil profile classes

Sixty-five soil profile classes, three phases and one variant were identified and described over an area of 281,523 ha during this study. The main features of each soil are outlined in the following paragraphs, in the order of the soil reference presented on the map. The soil profile classes within each parent material group, along with their landform, dominant ASC soil order, dominant vegetation association and area are listed in Table 4.

Nearly half of the soil profile classes are only minor in extent, with an area less than 1 000 ha. The Santo, Greycliffe, Earlsfield, Tarramba and Kokotungo are the most extensive soil profile classes, each with areas in excess of 15 000 ha.

The main soil group of the Banana study area is the cracking clay (Vertosol) with 23 soil profile classes giving a combined area of 100 750 ha. This group consists of the well structured, moderately well drained soils high in exchangeable calcium (11 280 ha), and those with strongly sodic and highly saline subsoils (89 470 ha). The other main groups are the uniform, non-cracking clay soils and structured gradational soils (Dermosol) with 13 soil profile classes and a total area of 78 830 ha, (which is mainly due to the Santo soil profile classes that total nearly 57 000 ha), and the sodic duplex soils (Sodosol) that make up 59 640 ha from 15 soil profile classes. The other groups, the deep, massive, gradational soils (Kandosol), the non-sodic duplex soils (Chromosol), acid duplex soils (Kurosol) and the shallow stony soils on steep hills and mountains (Tenosol and Rudosol) are significantly smaller in area, covering between 5 900 to 13 520 each.

Table 4. Parent material, landform, soil order, vegetation and area of each soil profile classes

Parent material	Landform	Soil profile class	Dominant soil order	Dominant vegetation	Area (ha)
1. Devonian, Carboniferous and Permian acid volcanic rocks	Steep hills to low hills and undulating rises	Bertha (Bt)	Bleached-leptic Tenosol	Narrow-leaved ironbark – black wattle	7 320
	Undulating rises to rolling low hills	Drumberle (Db)	Black Sodosol	Narrow-leaved ironbark – false sandalwood	1 909
		Bundalba (Bb)	Brown Sodosol	Poplar box	430
		Ferguson (Fg)	Brown Sodosol	Coowarra box – brigalow scrub	721
2. Cretaceous acid intrusive rocks	Rolling to steep hills	Cooper (Cp)	Brown Kandosol	Narrow-leaved ironbark	963
	Rolling low hills	Olinda (Od)	Brown Sodosol	Narrow-leaved ironbark – rosewood	193
3. Permian granite	Undulating rises	Eugene (Eg)	Grey Sodosol	Coowarra box – brigalow scrub	58
4. Permian and Devonian intermediate volcanic rocks	Dissected rolling low hills to rolling rises	Santo, stony phase (SnSp)	Red Dermosol	Silver-leaved ironbark – gum-topped bloodwood	29 824
	Undulating low hills to gently undulating rises	Harris (Hr)	Black Vertosol	Brigalow scrub	456
		Tiamby (Tm)	Brown Dermosol	Softwood or brigalow scrub	1 123
		Belldeen (Bd)	Black Vertosol	Silver-leaved ironbark – gum-topped bloodwood	3 575
		Santo (Sn)	Red Dermosol	Silver-leaved ironbark – gum-topped bloodwood	19 946
		Santo fertile phase (SnFp)	Red Dermosol	Softwood scrub	7 106
	Colluvial footslopes and pediments	Rannes (Rn)	Brown Vertosol	Softwood or brigalow scrub	398
		Woolein (Wn)	Red Vertosol	Silver-leaved ironbark – gum-topped bloodwood	274
5. Tertiary basalt	Level plateau surfaces	Scoria (Sc)	Black Vertosol	Softwood scrub	277
	Steep escarpments	Kooingal (Kn)	Grey Vertosol	Softwood scrub	853

Table 4 (cont).

Parent material	Landform	Soil profile class	Dominant soil order	Dominant vegetation	Area (ha)
5. Tertiary basalt (continued)	Undulating rises	Overdeen (Ov)	Red Dermosol	Softwood scrub	755
	Low remnant plateaus	Overdeen shallow variant (OvSv)	Red Dermosol	Softwood scrub	145
	Gently undulating plains and rises	Annandale (An)	Black Vertosol	Softwood scrub	688
		Clancy (Cc)	Black Vertosol	Open Downs	521
6. Folded Permian sedimentary rocks	Rolling to steep hills	Youlambie (Ym)	Leptic Rudosol	Narrow-leaved ironbark	2 202
		Lancefield (Lf)	Brown Dermosol	Softwood scrub	807
	Rolling low hills and strike ridges	Benn (Be)	Black Sodosol	Silver-leaved or narrow-leaved ironbark	4 112
	Undulating rises to rolling low hills	Flat Top (Ft)	Leptic Rudosol	Narrow-leaved ironbark	717
		Rundull (Rd)	Brown Kandosol	Rosewood – softwood scrub	643
		Garden (Gd)	Leptic Rudosol	Narrow-leaved ironbark – rosewood	1 481
		Foster (Fs)	Brown Dermosol	Silver-leaved ironbark – gum-topped bloodwood	3 121
	Gently undulating to undulating rises	Banana (Bn)	Black Vertosol	Silver-leaved ironbark – gum-topped bloodwood	2 948
		Bauhinia (Ba)	Black Vertosol	Open downs with isolated white bauhinia clumps	792
		Mungi (Mg)	Black Vertosol	Poplar box	2 300
		Fairview (Fv)	Black Vertosol	Brigalow scrub	4 202
		Cottonham (Ch)	Brown Vertosol	Brigalow scrub	874
		Kianga (Kg)	Red Dermosol	Softwood scrub	5 011

Table 4 (cont).

Parent material	Landform	Soil profile class	Dominant soil order	Dominant vegetation	Area (ha)
6. Folded Permian sedimentary rocks (continued)	Gently undulating to undulating rises	Neimen (Nm)	Black Sodosol	Poplar box – false sandalwood	12 370
		Wandoo (Wd)	Red Chromosol	Silver-leaved ironbark – gum-topped bloodwood	1 695
		Police Camp (Pc)	Brown Sodosol	Coowarra box – brigalow scrub	4 950
7. Flat lying Jurassic sandstone	Undulating low hills and rises	Precipice (Pp)	Red Kurosol	Narrow-leaved ironbark and lemon scented gum – rosewood	91
8. Deeply weathered Tertiary sedimentary rocks	Level to undulating plateau surfaces	Spier (Sp)	Red Kandosol	Narrow-leaved ironbark – long-fruited bloodwood	6 059
		Shield (Sd)	Brown Kandosol	Queensland peppermint – lemon-scented gum	190
	Steep escarpments	Bluff (Bf)	Red Kurosol	Narrow-leaved ironbark – rosewood	5 808
	Undulating residual rises	Granville (Gn)	Brown Sodosol	Coowarra box – brigalow scrub	601
		Mapala (Mp)	Red Chromosol	Softwood scrub	452
9. Unconsolidated Cainozoic alluvial-colluvial sediments	Undulating rises to level plains	Earlsfield (Ef)	Black Vertosol	Brigalow or brigalow-belah scrub	16 671
		Greycliffe (Gc)	Grey Vertosol	Brigalow scrub	26 896
		Greycliffe melonhole phase (GcMp)	Grey Vertosol	Brigalow scrub	13 780
		Kilburnie (Kb)	Black Vertosol	Poplar box	1 620
		Bonwell (Bw)	Red Dermosol	Softwood scrub or coowarra box – brigalow scrub	3 022
		Powerhouse (Ph)	Brown Dermosol	Brigalow scrub	1 445
		Koorngoo (Kr)	Red Kandosol	Softwood scrub	202
		Kokotungo (Kt)	Brown Sodosol	Coowarra box – brigalow scrub	17 621
		Collins (Cn)	Grey Sodosol	Softwood scrub or coowarra box – brigalow scrub	525

Table 4 (cont).

Parent material	Landform	Soil profile class	Dominant soil order	Dominant vegetation	Area (ha)
9. Unconsolidated Cainozoic alluvial-colluvial sediments (continued)	Undulating rises to level plains	Thalberg (Tb)	Brown Chromosol	Softwood scrub or coowarra box – brigalow scrub	1 600
		Nikita (Nk)	Red Chromosol	Coowarra box – shrubby understorey	241
		Desdemona (Dd)	Brown Sodosol	Narrow-leaved ironbark	206
		Ulogie (Ug)	Brown Sodosol	Gum-topped box – narrow-leaved ironbark	6 043
10. Unconsolidated Quaternary alluvium	Active and relict levees	Hodge (Hd)	Black Kandosol	Moreton Bay ash and silver-leaved ironbark – sally wattle	367
		Callide (Cd)	Black Chromosol	Moreton Bay ash and silver-leaved ironbark – sally wattle	6 496
	Plains and backplains	Tognolini (Tn)	Black Vertosol	Forest red gum – sally wattle	1 326
		Tarramba (Tr)	Black Vertosol	Forest red gum or coolibah – sally wattle	16 207
		Jambin (Jb)	Black Vertosol	Brigalow scrub	2 883
		Goovigen (Gv)	Black Vertosol	Brigalow scrub	762
		Melton (Mt)	Black Dermosol	Forest red gum – sally wattle	6 310
		Caroline (Cl)	Black Dermosol	Coolibah – sally wattle	1 071
		Pakington (Pk)	Brown Vertosol	Brigalow – coowarra box scrub	271
		Retro (Rt)	Black Sodosol	Poplar box – sally wattle	8 262
		Grevillea (Gr)	Black Sodosol	Poplar box – sally wattle	1 640
		Tequila (Tq)	Brown Chromosol	Softwood scrub	202
	Seasonally flooded backplains, drainage depressions and ox-bows	Muruguran (Mr)	Aquic Vertosol	Coolibah or forest red gum	1 315

4.2.1 Soils overlying Devonian to Permian acid volcanic rocks

Landform: Steep hills to rolling low hills and minor undulating rises

The **Bertha** soil occurs on some of the most rugged terrain in the study area, the hills of the Banana Ranges. The dominant profile form of the Bertha soil is a shallow to moderately deep (0.3–0.7 m), stony, uniform sandy to sandy clay loam soil (Tenosol or Rudosol). The topsoil can overlie either weathered substrate, a bleached A_2 horizon or a colour B horizon. The profile is freely draining, and has a low CEC (4–8 cmol[+] kg^{-1}) with very low levels of calcium below the surface soil (0.15–0.61 cmol[+] kg^{-1}). The profile is slightly acid throughout with a pH of 5.5 to 6.5. The surface soil fertility is low also, with mean P and N contents of 12 mg/kg and 0.08 %. The Bertha soil has a dominant narrow-leaved ironbark – black wattle vegetation association (Photograph 1).

Landform: Gently undulating and undulating rises to rolling low hills

The other three soils overlying acid volcanic rocks occur on the foothills and rises adjacent to the Banana and Calliope Ranges, each with a differing vegetation. The **Drumberle** soil is a moderately deep, hard setting, dark, brown or grey, sodic duplex soil (Sodosol) with a clay loamy topsoil and a bleached A_2 horizon. The bleached subsurface overlies a prismatic or columnar structured, medium clay subsoil. The subsoil has an ESP of 8 to 10 %, is magnesium dominant (Ca/Mg ratios of 0.5–0.7) and is therefore dispersive. The subsoil overlies little weathered substrate between depths of 0.5 to 0.7 m. The topsoil has a pH of 6.0 to 7.0 and the subsoil a pH of 7.5 to 8.5. The Drumberle soil has low topsoil fertility, with mean P and N levels of 10 mg/kg and 0.1 % respectively. The dominant vegetation association of this soil is a narrow-leaved ironbark woodland with a false sandalwood or wattle (pretty and corkwood wattle and dead finish) understory (Photograph 2).

The **Bundalba** soil is easily identified as it occurs only on gently-sloping footslopes of the low hills and rises of the Calliope Range, and has a characteristic poplar box vegetation association (Photograph 3). It is a moderately deep, hard setting, brown, dark or grey, sodic duplex soil (Sodosol) with a clay loamy topsoil and a sporadically bleached subsurface layer. The subsoil has a coarse, columnar structure and overlies little-weathered substrate between depth of 0.5 to 1.0 m. The subsoil is sodic (ESP 7 to 11 %) with a calcium dominant exchange capacity (Ca/Mg ratios of 1.0 to 1.5). The subsoil therefore does not appear to be as dispersive as indicated by its structure. The topsoil has a pH of 6.0 to 7.0 and the subsoil a pH of 8.0 to 9.0. The Bundalba soil has low topsoil fertility with low mean P and N concentrations of 10 mg/kg and 0.1 % respectively.

The **Ferguson** soil occurs on the moderately inclined low hills and rises formed on acid volcanic rocks (Photograph 4). It is shallow to deep, hard setting, dark, brown or grey, sodic duplex soil (Sodosol), with a clay loamy topsoil and a bleached A_2 horizon. The subsoil is a prismatic structured, medium clay that overlies little-weathered substrate between depths of 0.4 to 1.2 m. The subsoil is sodic (ESP 10–15 %) with a magnesium dominant exchange capacity (Ca/Mg ratios of 0.6–0.7), and is therefore dispersive. The topsoil has a pH of 6.0 to 7.0 and the subsoil a pH of 8.0 to 9.0. The Ferguson soil is the only non-eucalypt soil of this group, with a Coowarra box (Dawson gum) – brigalow vegetation association. This indicates also a higher topsoil fertility that for eucalypt, and Ferguson has moderate fertility with a high mean P content of 22 mg/kg, but only a low mean N level of 0.1 %.

4.2.2 Soils overlying Cretaceous acid intrusive rocks

Landform: Rolling to steep hills

Only two soils, Cooper and Olinda overlie the Cretaceous acid intrusive rocks, which outcrop in only two places to the south of Kokotungo. The **Cooper** soil occurs only on the steep sided, massive intrusive stock of Mt Cooper that stands some 200 m above the surrounding plain. The Cooper soil is a shallow, stony, brown, uniform clay loamy soil (Kandosol) that overlies little-weathered substrate between depths of 0.15 to 0.3 m.

The profile is freely draining, with a neutral pH of 7.5 and a moderate, calcium dominant CEC of 12 to 15 cmol[+] kg^{-1}. The surface soil fertility is moderate, with a very high P content (46 mg/kg) but only a low N concentration (0.08 %) (data from one site only). On the northern slopes of Mt. Cooper, the Cooper soil has a narrow-leaved ironbark – gum-topped bloodwood woodland with only a very sparse shrub layer, while the southern slopes have a narrow-leaved ironbark woodland with a dense shrub understorey.

Landform: Rolling low hills to undulating rises

The **Olinda** soil occurs only on a moderately inclined, low hill, formed from syenite, just to the south of Mt Cooper. It is a shallow, hard setting, brown, sodic duplex soil (Sodosol) with a loamy topsoil and conspicuously bleached subsurface that usually overlies a blocky structured, medium clay subsoil. Occasionally the subsoil is absent and the bleached subsurface directly overlies weathered bedrock. The subsoil or bleached A_2 horizon overlies little-weathered substrate between depths of 0.4 to 0.5 m. The subsoil has an ESP of 10 %, and is magnesic, with very low levels of exchangeable calcium (0.7 cmol[+] kg^{-1}), but 12 to 16 cmol[+] kg^{-1} of magnesium. It is therefore highly dispersive. The topsoil has a pH of 5.5 to 6.5 and the subsurface or subsoil a pH of 6.0 to 8.0. The Olinda soil has moderate soil fertility with a low level of P (5 mg/kg), but very high levels of N (0.21 %) (data from one site only). Olinda is one of the few soils supporting rosewood in a narrow-leaved ironbark – rosewood vegetation association (Photograph 5).

4.2.3 Soils overlying Permian granite

Landform: Gently undulating to undulating rises

The **Eugene** soil is the only soil that overlies granite, and occurs only in one small, isolated area next to the top of the Boundary Hill coal mine lease. Eugene is a shallow, hard setting, grey, strongly sodic duplex soil (Sodosol) with a sandy loam topsoil and a sporadically bleached A_2 horizon. The bleached subsurface overlies a columnar structured, light clay subsoil which in turn overlies little-weathered granite at 0.6 m (only one profile described due to limited area). The subsoil is strongly sodic with an ESP of 16 to 19 % and a magnesium dominant CEC (Ca/Mg ratios of 0.5–0.6). It is therefore highly dispersive. The topsoil has a pH of 6.0 and the subsoil a pH of 7.5. The Eugene soil has high surface soil fertility with P and N concentration of 30 mg/kg and 0.14 % respectively (data from one site only). It typically has a coowarra box (Dawson gum) – brigalow vegetation association (Photograph 6).

4.2.4 Soils overlying Permian intermediate volcanic rocks

Landform: Rolling low hills and undulating to rolling rises

The **Santo stony phase soil** occurs on the steep and strongly dissected hills and rises formed on Permian andesite and spilite (Photograph 7). It is a shallow to moderately deep, stony, red or brown, uniform or gradational soil (Dermosol). It has a structured, friable clay loam or light clay surface soil that overlies a blocky structured, medium clay subsoil. The subsoil overlies little-weathered parent materials between depths of 0.2 to 0.8 m. It has excellent soil chemical and physical properties with a CEC of 30 to 46 cmol[+] kg^{-1} that is calcium dominant (Ca/Mg ratios of 1.6–2.5) and a very low sodicity (ESP <1 %). This soil is therefore structurally very stable and well drained with a very low salt content (EC <0.1 dS/m). The topsoil has a pH of 6.0 to 7.5 and the subsoil a pH of 7.0 to 8.5. Santo stony phase has moderate surface soil fertility with a high mean P content of 33 mg/kg and a moderate mean N level of 0.14 %, which is excellent fertility for a non-alluvial soil with eucalypt vegetation. The dominant vegetation association of this soil is a silver-leaved ironbark – gum-topped bloodwood woodland (Photograph 8).

Photograph 1. Narrow-leaved ironbark – lemon-scented gum woodland on Bertha soil on the Banana Range

Photograph 2. Drumberle soil on the mid-slope of a low hill

Photograph 3. Partially cleared poplar box woodland on Bundalba soil

Photograph 4. Ferguson on undulating rises in the foreground with the steep hills of the Banana Range in the background

Photograph 5. Narrow-leaved ironbark – rosewood association on Olinda soil

Photograph 6. Dawson gum – brigalow vegetation on Eugene soil in granite terrain

Landform: Undulating low hills to gently undulating rises

There are five soils that were identified on the undulating low hills and rises formed on andesite. The first of these is the **Harris** soil, which is a deep, fine self-mulching, black or brown, cracking clay soil (Vertosol). It has a thin, medium clay topsoil that overlies a lenticular structured, medium clay subsoil, which overlies weathered parent materials from 0.8 m to >1.5 m depth. The lower subsoil below 0.5 m is sodic (ESP 10–12 %), and has also a high subsoil salt content (EC 0.7–1.7 dS/m) and is therefore dispersive which impedes subsoil drainage. The exchange capacity is however highly calcium dominant (Ca/Mg ratios of 2 to 5). The surface soil has a pH of 6.5 to 7.5 and the subsoil a pH of 7.5 to 9.0. Harris occurs mainly in small, almost circular areas of less than one to five hectares in size. It has a brigalow scrub vegetation, and these areas have usually been left as shade clumps for stock (Photograph 9). The Harris soil has a high surface soil fertility with a high P content of 18 mg/kg and a very high N content of 0.35 % (data from one site only).

The **Tiamby** soil is restricted to the undulating rises (Photograph 10). It is a moderately deep to deep, black or brown, non-cracking clay soil (Dermosol) or cracking clay (Vertosol) with a fine self-mulching, light medium clay topsoil. The lenticular structured, medium clay subsoil overlies little-weathered substrate between depths of 0.4 to 1.3 m. The lower subsoil has a moderate salt content (EC 0.4–0.8 dS/m), and is sodic with an ESP of 11 to 15 % which indicates impeded subsoil drainage due to a dispersive clay subsoil. The exchange capacity for this soil is also calcium dominant (Ca/Mg ratios of 1.2–3.0). The topsoil has a pH of 6.5 to 8.0, and the subsoil a pH of 7.5 to 9.0. The Tiamby soil originally had softwood scrub vegetation, and has very high surface soil fertility with very high mean P and N levels of 59 mg/kg and 0.29 % respectively.

The **Belldeen** soil is found on the gentler mid and lower slopes of the undulating rises and low hills, and occurs mainly as small to medium sized (10–50 ha), irregular, elongated shaped areas. It is a moderately deep to deep (0.7-1.5 m), black cracking clay soil (Vertosol), with weakly to well developed linear gilgai. The linear gilgai mounds are a fine self-mulching, medium clay, while the depressions vary from firm-surfaced with a crust, to coarse, self-mulching. The subsoil is a strong, fine lenticular structured, medium clay and is only just sodic (ESP 6 %) in the lower subsoil at 0.9 m depth. It has a mainly calcium dominant exchange capacity (Ca/Mg ratios of 0.7–1.8), and only a moderate soluble salt content in the lower subsoil (EC 0.4–0.5 dS/m). This indicates that the subsoil is structurally stable and moderately well drained. The mound profiles are alkaline throughout (pH 7.5–8.5), while the topsoil of the depressions has a pH of 6.5 to 7.0. The surface soil fertility is moderate with mean P and N contents of 11 mg/kg and 0.12 % respectively. Belldeen also has a silver-leaved ironbark – gum-topped bloodwood vegetation association (Photograph 11).

The **Santo** soil occurs on the less dissected, less stony, and gentler sloping rises and hills than the Santo stony phase soil. This soil is a shallow to moderately deep (0.3–0.9 m), red or brown, gradational or uniform, non-cracking clay soil (Dermosol). It has a structured, friable clay loam or light clay topsoil, that overlies a blocky structured, medium clay subsoil. The subsoil has excellent soil chemical and physical properties as the exchange capacity is calcium dominant (Ca/Mg ratios of 1.3–1.8), with a very low exchangeable sodium content throughout (ESP of 1 %). This indicates a structurally stable soil that is freely draining with very low levels of soluble salts (EC <0.1 dS/m). The surface soil pH is 6.0 to 7.0 and the subsoil pH varies from 7.0 to 8.5. The surface fertility is moderate with mean P and N contents of 22 mg/kg and 0.13 % respectively. Santo has a silver-leaved ironbark – gum-topped bloodwood vegetation association (Photograph 8).

The **Santo fertile phase** soil occurs on similar landforms and has almost identical soil properties to the Santo soil, except that it occasionally has a fine self-mulching topsoil and displays a cracking clay form. The main difference is its vegetation and topsoil fertility. Santo fertile phase originally had a softwood scrub vegetation and a very high surface fertility with mean P and N contents of 46 mg/kg and 0.22 % respectively, which are double that of the Santo soil.

Landform: Gently sloping colluvial footslopes and pediments

Two soils occur on the footslopes and pediments of the rises and low hills formed on the Permian intermediate volcanic rocks. These are the **Rannes** and **Woolein** soils. Both of these soils are minor in area though with areas of only 200 to 400 ha.

The **Rannes** soil is a deep (1.1–1.5 m), brown or red, cracking clay soil (Vertosol) with a thin, fine self-mulching, medium clay topsoil (Photograph 14). The surface soil overlies a lenticular structured, medium clay subsoil that is strongly sodic (ESP 15–22 %), with a magnesium dominant exchange capacity (Ca/Mg ratios of 0.24 to 0.95) in the lower subsoil. The subsoil is therefore dispersive with impeded drainage as indicated by the very high subsoil salt content (EC 0.9–1.2 dS/m). The Rannes soil is alkaline throughout with a pH of 7.5 to 9.0. The surface soil fertility is high with mean P and N contents of 31 mg/kg and 0.15 % respectively. Rannes also originally had a softwood scrub vegetation.

The **Woolein** soil is essentially a deeper, footslope variant of the Santo soil, with very similar soil properties. Woolein is a deep (0.9–1.5 m), red, cracking clay soil (Vertosol) with a fine, self-mulching, light medium clay topsoil. The thin surface soil overlies a strong, fine, lenticular structured, medium clay subsoil that has excellent soil chemical and physical properties. The subsoil has a calcium dominant exchange capacity (Ca/Mg ratios of 1.1–1.9), and very low levels of exchangeable sodium (ESP <1–2 %). Woolein is therefore a structurally stable soil with a freely draining profile, as indicated by the low subsoil salt content (EC 0.1–0.4 dS/m). The topsoil has a pH of 6.5 to 8.0, and the subsoil a pH of 7.5 to 8.5. The surface soil fertility is low, with only P and N levels of 6 mg/kg and 0.1 % respectively (data from one site only). Like Santo and Belldeen soils, Woolein has a silver-leaved ironbark – gum-topped bloodwood vegetation association (Photograph 8).

4.2.5 Soils overlying Tertiary basalt

Landform: Elevated, steep-sided plateaus

There are six basaltic soils which occur on five different landforms. The **Scoria** soil occurs only on the flat-lying, plateau surfaces of the elevated, steep-sided, basalt plateaus to the south of Biloela (Photograph 12). Scoria is a shallow or moderately deep, black, strongly cracking clay soil (Vertosol) with a thin, self-mulching, medium heavy clay topsoil. Weakly developed, normal gilgai are present only on the deeper profiles. The surface soil overlies a heavy clay subsoil that has a strong, fine lenticular structure, which in turn overlies little-weathered basalt between depths of 0.4 to 0.7 m. The subsoil has excellent soil chemical and physical properties as it has a very high CEC (62–64 cmol[+] kg^{-1}) that is strongly calcium dominant (Ca/Mg ratios of 2.4–3.0), with low levels exchangeable sodium (ESP 2–4 %). Scoria is therefore a structurally stable soil that drains only slowly due to its very high clay content, which has resulted in a moderate subsoil salt concentration (EC 0.14–0.41 dS/m). The profile is alkaline throughout with a pH of 8.5. The surface soil fertility is very high with mean P and N concentrations of 95 mg./kg and 0.27 % respectively. The basaltic scrub soils have the highest fertility of all the soils of the Banana study area. Before clearing, Scoria had a softwood scrub vegetation.

The **Kooingal** soil occurs on the moderately inclined to steep escarpment slopes of the elevated basalt plateaus (Photograph 13). In contrast to the Scoria soil, Kooingal is a highly saline and strongly sodic, grey or black cracking clay soil (Vertosol). It has a thin, fine self-mulching, heavy topsoil that overlies a weak lenticular structured, heavy clay subsoil, which in turn overlies highly weathered, almost reticulate clay layers below 0.9 m. The subsoil is strongly sodic (ESP 26 %), and highly saline (EC 1.6–1.9 dS/m) by 0.6 m. The subsoil CEC is also highly magnesium saturated (Ca/Mg ratios of 0.14–0.43), and these properties indicate a very slowly draining, dispersive subsoil. The Kooingal soil is alkaline throughout with a pH of 7.5 to 9.0, with the highly-weathered reticulate layers sometimes being strongly acidic (pH 5.5). Like Scoria, Kooingal also has a very high surface soil fertility, with mean P and N levels of 96 mg/kg and 0.37 % respectively. It also had a softwood scrub vegetation.

Photograph 7. Dissected rises and low hills with Santo stony phase

Photograph 8. Silver-leaved ironbark – gum-topped bloodwood association on Santo, Santo stony phase, Wandoo and Woolein soils

Photograph 9. Harris soil with brigalow scrub occurring as small patch surrounded by Santo soil

Photograph 10. Tiamby soil on undulating rises in the foreground with the steep hills of the Banana Range in the background

Photograph 11. Silver-leaved ironbark and gum-topped bloodwood association on Belldeen soil with linear gilgai

Photograph 12. Remnant softwood scrub on the Scoria soil on a level basalt plateau

Landform: Gently undulating to undulating rises and gently undulating plains

The basalt sheets laid down to the west of Goovigen have formed a more subdued landform of rises and plains. The **Overdeen** soil occurs on undulating rises, and is a moderately deep or deep, red, non-cracking clay soil (Dermosol) or a cracking clay (Vertosol) that has a thin, very fine self-mulching, medium clay topsoil (Photograph 14). The surface soil overlies a finely structured, heavy clay subsoil which in turn overlies moderately weathered basalt between depths of 0.6 to 1.1 m. The subsoil has excellent soil chemical and physical properties with a moderate CEC (22–29 cmol[+] kg^{-1}) that is highly calcium dominant (Ca/Mg ratios of 2.0–8.3), with very low levels of exchangeable sodium (ESP $\leq$1 %). Overdeen is therefore a structurally stable, freely draining soil as indicated by the low subsoil salt content (EC 0.5–0.15 dS/m). The lower CEC of this soil also indicates that it may be more weathered, compared to the black basaltic soils. Overdeen is also alkaline throughout (pH 7.5–8.5). The surface soil fertility is very high with mean P and N concentrations of 102 mg/kg and 0.26 % respectively. Overdeen originally had a softwood scrub vegetation.

The **Annandale** and **Clancy** soils occur mainly on the gently undulating plains formed on basalt to the west of Goovigen, and also on the valley basalt flows to the north of Bell Creek. Annandale is a softwood scrub soil, while Clancy is an open downs soil, but otherwise they are very similar.

The **Annandale** soil is a shallow to moderately deep, fine self-mulching, black, strongly cracking clay soil (Vertosol) (Photograph 15**)**. The thin heavy clay surface soil overlies a strong, fine lenticular structured, heavy clay subsoil, that in turn overlies little-weathered basalt between depths of 0.4 to 0.85 m. The subsoil has outstanding chemical and physical properties, as it has a very high CEC (82–87 cmol[+] kg^{-1}), that is dominated by calcium (Ca/Mg ratios of 5). The exchangeable sodium content also is very low (ESP <1 %) and this soil is therefore structurally stable and moderately well drained, as indicated by the low soluble salt content (EC 0.07–0.18 dS/m). Annandale is alkaline throughout the profile with a pH of 7.5 to 8.5. The surface fertility is very high with mean P and N levels of 37 mg/kg and 0.21 % respectively**.**

The **Clancy** soil is also a black cracking clay (Vertosol) with very similar properties to Annandale. The clay content, CEC, calcium, sodium and soluble salt concentrations, and pH are almost identical. The main differences are that Clancy is slightly shallower overall (0.3–0.9 m deep), has a significantly coarser, self-mulching topsoil and a lower surface soil fertility, with mean P and N contents of 23 mg/kg and 0.1 % respectively (compared to a mean of 100 mg/kg P and 0.28% N for the softwood scrub soils), as it is an open downs soil (Photograph 16). Clancy therefore has only moderate fertility.

Landform: Low remnant plateaus

The final basalt soil, **Overdeen shallow variant**, occurs on two small remnant plateaus of low relief, within the basaltic area west of Goovigen (Photograph 17). Overdeen shallow variant is a shallow, stony, red or brown, uniform non-cracking clay soil (Dermosol) that has a very fine self-mulching, medium clay surface soil. The topsoil overlies a strong, fine polyhedral structured, heavy clay subsoil that overlies moderately weathered basalt between 0.2 to 0.4 m depth. Like Overdeen, the subsoil has excellent chemical and physical properties with a calcium dominant exchange capacity (Ca/Mg ratios of 2–3 and CEC of 46 cmol[+] kg^{-1}) with very low levels of exchangeable sodium (ESP $\leq$1 %). The profile is therefore structurally stable and freely draining with very low levels of soluble salts (EC <0.1 dS/m). The topsoil has a pH of 6.5 to 8.0, and the subsoil 7.5 to 8.0. The surface soil fertility is very high with mean P and N contents of 168 mg/kg and 0.27 % respectively. Overdeen shallow variant has a softwood scrub vegetation.

4.2.6 Soils overlying folded Permian sedimentary rocks

Landform: Rolling to steep hills

The **Youlambie** and **Lancefield** soils occur on the steep hills of the Calliope Range to the north of the Boundary Hill Coal Mine (Photograph 18). The **Youlambie** soil is a shallow (0.15–0.5 m), very stony, uniform clay loamy soil. The dark or dark brown surface soil overlies either weathered substrate or a thin sporadically bleached subsurface layer. The profile is freely draining, slightly acid throughout (pH 6.5), with a calcium dominant (Ca/Mg ratio of 1.1–1.6), cation exchange capacity of 9 to 11 cmol[+] kg^{-1}. The surface soil fertility is moderate with mean P and N contents of 12 mg/kg and 0.11 % respectively. Youlambie has a narrow-leaved ironbark vegetation.

The **Lancefield** soil is a shallow (0.35–0.45 m), stony, red or brown, duplex, gradational or uniform, non-cracking clay soil (Dermosol). It has a structured, friable clay loam to light clay surface soil, that overlies a blocky structured light medium clay subsoil, which in turn overlies little-weathered substrate between 0.35 to 0.45 m depth. The subsoil has a high CEC (31 cmol[+] kg^{-1}), that is calcium dominant (Ca/Mg ratio of 4), with very low levels of exchangeable sodium (ESP <1 %), and soluble salts (EC 0.05 dS/m). The profile is therefore structurally stable and freely draining, and has a pH of 7.0 to 8.0.. The surface soil fertility is high with mean P and N concentrations of 36 mg/kg and 0.23% respectively. Lancefield has a softwood scrub vegetation (Photograph 19).

Landform: Undulating to rolling low hills and strike ridges

The **Benn** soil occurs on the dissected, stony low hills and strike ridges to the east of Banana (Photograph 20). It is a shallow to moderately deep, hard setting, dark, brown or red, sodic duplex soil (Sodosol) with a sandy loam to clay loam topsoil that has a sporadically or conspicuously bleached A_2 horizon. The surface soil overlies a prismatic or columnar structured, medium clay subsoil, which in turn overlies little-weathered sandstone between depths of 0.3 to 0.7 m. The subsoil is sodic (ESP 14 %), with a Ca/Mg ratio of 1.1 and is therefore dispersive and imperfectly drained. Benn is usually too shallow for salts to accumulate in the subsoil. The topsoil has a pH of 6.0 to 7.0 and the subsoil a pH of 7.0 to 8.5. The surface soil fertility is low with mean P and N levels of 6 mg/kg and 0.1 % respectively. Benn soil supports a silver-leaved ironbark or narrow-leaved ironbark – dead finish vegetation association.

Landform: Gently undulating to undulating rises and undulating to rolling to low hills

The **Flat Top** soil occurs mainly on the low hills, and is a shallow, stony, uniform sandy to clay loamy soil (Rudosol or Tenosol) that overlies little-weathered sandstone between 0.05 to 0.3 m. The surface soil either directly overlies sandstone, or a conspicuously or sporadically bleached subsurface. The sandy profile is freely draining with a magnesium dominant (Ca/Mg ratios of 0.3–0.7), moderate CEC of 10 cmol[+] kg^{-1}. Flat Top has a pH of 6.0 to 7.5 throughout the profile, and has a low surface soil fertility with mean P and N contents of 10 mg/kg and 0.1 % respectively. The dominant vegetation of this soil is a narrow-leaved ironbark woodland (Photograph 21).

The **Rundull** soil occurs only on the strongly dissected low hills formed and cleaved siltstones and slate to the south of Biloela (Photograph 22). It is a shallow, stony, brown or red, uniform clay loamy soil (Kandosol) that overlies little-weathered substrate between depths of 0.2 to 0.4 m. The profile is freely draining, with a calcium dominant (Ca/Mg ratio of 1.6–3.7), moderate CEC of 8 to 15 cmol[+] kg^{-1}. It has a pH of 5.5 to 6.5, and a very high surface soil fertility with mean P and N contents of 160 mg/kg and 0.29 % respectively. Rundull has a unique vegetation association of rosewood – softwood scrub (Photograph 23).

Photograph 13. Kooingal soil on the steep escarpment of a Tertiary basalt plateau

Photograph 14. Remnant softwood scrub on Overdeen soil

Photograph 15. Annandale soil on gently undulating rises with a remnant patch of softwood scrub vegetation

Photograph 16. Open downs of Clancy soil on gently undulating basalt rises

Photograph 17. Scarp slope of the low, remnant plateau with the Overdeen shallow variant soil

Photograph 18. Youlambie soil on steep, stony, dissected hills of the Calliope Range in the north-eastern corner of the study area

The **Garden** soil is found on strongly dissected low hills and rises to the north-west of Rannes. It is a shallow, stony, uniform clay loamy soil, (Rudosol or Tenosol), that overlies little-weathered shale between depths of 0.2 to 0.4 m. The topsoil overlies either a thin sporadically or conspicuously bleached A_2 horizon, or directly overlies weathered shale. The profile is freely draining with a moderate cation exchange capacity (10 cmol[+] kg^{-1}), that is strongly magnesium dominant in the bleached subsurface (Ca/Mg ratio of 0.14). Garden has a pH of 6.0 to 7.5 throughout the profile. The surface soil fertility is high with mean P and N concentrations of 31 mg/kg and 0.24 % respectively. Garden has a narrow-leaved ironbark – rosewood vegetation association.

The **Foster** soil occurs on the rises and low hills formed on the partially metamorphosed siltstones in the Rannes District. It is a shallow to moderately deep, stony, brown or red, uniform non-cracking clay or gradational soil (Dermosol) that overlies little-weathered parent materials between depths of 0.2 to 0.8 m. It has a fine blocky structured, clay loam or light clay topsoil that overlies a blocky structured, medium clay subsoil. The subsoil has a moderate CEC (13–19 cmol[+] kg^{-1}), that is calcium dominant (Ca/Mg ratios of 1.0–1.4) with low levels of exchangeable sodium (ESP 1–3 %). It is therefore a structurally stable soil and well drained, as indicated by the low soluble salt content (EC <0.1 dS/m). The topsoil has a pH of 6.0 to 7.0, and the subsoil a pH of 7.5 to 8.5. The surface soil fertility is moderate with mean P and N levels of 40 mg/kg and 0.13 % respectively. Foster has a silver-leaved ironbark – gum-topped bloodwood vegetation association (Photograph 24).

Landform: Gently undulating to undulating rises

The **Banana** soil occurs mainly on the midslopes of the gently undulating rises to the north-west of Banana Road, often in association with the Mungi soil on the lower slopes. It is a moderately deep to deep, black cracking clay soil (Vertosol) with well developed, normal gilgai (Photograph 25). Both the mounds and depressions have fine, self-mulching, medium heavy clay surface soils that overlie strong, fine lenticular structured, medium clay subsoils, which in turn overlie little-weathered mudstones between 0.7 to 1.5 m depth. The subsoil has a very high CEC (60–70 cmol[+] kg^{-1}) that is highly calcium dominant (Ca/Mg ratios of 4–7), with low exchangeable sodium contents (ESP 1–5 %). The subsoil is therefore structurally stable but only slowly draining due to the high clay content, as indicated by the moderate subsoil salt content (EC 0.25–0.65 dS/m). The surface soil has a pH of 6.5 to 8.0, and the subsoil a pH of 8.0 to 8.5. The surface soil fertility is low with mean P and N contents of 8 mg/kg and 0.11 % respectively. Banana has a silver-leaved ironbark – gum-topped bloodwood open woodland vegetation association.

The **Bauhinia** soil occurs on the footslopes of the undulating rises to the north-west of Banana. It is a moderately deep to deep, black or brown, cracking clay soil (Vertosol), sometimes with weakly developed linear gilgai. The light medium clay surface soil is fine, self-mulching and overlies a strong lenticular structured, medium clay subsoil, which in turn overlies little-weathered mudstones between depths of 0.8 to 1.4 m. The subsoil has a high CEC (37–48 cmol[+] kg^{-1}) that is calcium dominant (Ca/Mg ratios of 1.5–3.0). It is also sodic (ESP 8–13 %) and slightly dispersive with low to moderate salt levels (EC 0.35–0.62 dS/m) below 0.5 m, indicating the profile is slowly draining. The surface soil has a pH of 7.0 to 8.0, and the subsoil a pH of 8.0 to 9.0. The surface soil fertility is moderate with mean P and N contents of 10 mg/kg and 0.15 % respectively. Bauhinia has a unique vegetation association of open downs with isolated clumps of white bauhinia. The Bauhinia soil is very extensive to the west of the study area.

Photograph 19. The Lancefield soil on the steep hills formed on folded Permian siltstones

Photograph 20. The Benn soil on the crest of a low hill on sandstone

Photograph 21. Narrow-leaved ironbark woodland on Flat Top soil

Photograph 22. The Rundull soil on strongly dissected low hills

Photograph 23. Rosewood – softwood scrub association on Rundull soil

Photograph 24. Remnant silver-leaved ironbark on Foster soil

The **Mungi** soil is always found on the lower slopes of the undulating rises, downslope of the Banana soil. It is a moderately deep to deep, black cracking clay soil (Vertosol), with well developed linear gilgai. The mounds have a fine, self-mulching, medium clay surface, while the depressions have an almost hard setting, surface crust. The medium clay subsoil has a strong or moderate lenticular structure and overlies little-weathered mudstones between depths of 0.7 to >1.5 m. The subsoil has a high CEC (38–46 cmol[+] kg^{-1}) that is calcium dominant (Ca/Mg ratios of 1.5–3.0), and below 0.5 m is sodic to strongly sodic (ESP 7–18 %). It is therefore dispersive and imperfectly drained as indicated by the moderate levels of soluble salts (EC 0.4–0.7 dS/m). The topsoil has a pH of 7.0 to 8.5, and the subsoil a pH of 7.5–8.5. The surface soil fertility is low with mean P and N levels of 11 mg/kg and 0.1 % respectively. The Mungi soil supports a poplar box woodland vegetation.

The **Fairview** soil, like the other clay soils overlying Permian sedimentary rocks occurs on the undulating rises formed on the mudstones of the Gyranda formation to the north-west of Banana (Photograph 26). It is a moderately deep to deep, black or dark brown, cracking clay soil (Vertosol) with a very fine self-mulching, light medium clay surface. The topsoil overlies a moderate or strong lenticular structured, medium clay subsoil which in turn overlies little-weathered mudstones between depths of 0.6 to >1.5 m. The subsoil has a high CEC (38–38 cmol[+] kg^{-1}), that is magnesium dominant (Ca/Mg ratios of 0.8–0.9) and strongly sodic (ESP 21–27 %) below 0.5 m depth. It is therefore dispersive and slowly drained as indicated by the moderate to high subsoil salt content (EC 0.5–1.1 dS/m). The surface soil has a pH of 6.5 to 8.5, and the subsoil a pH of 7.0 to 9.0. The surface soil fertility is high with mean P and N contents of 18 mg/kg and 0.19 % respectively. Fairview supports a brigalow or brigalow-belah vegetation.

The **Cottonham** soil also occurs mainly on the undulating rises to the north-west of Banana. It is a moderately deep to deep, brown or red, cracking clay soil (Vertosol) with a very fine, self-mulching, light medium clay surface. The thin topsoil overlies a fine, lenticular structured, medium clay subsoil, which in turn overlies moderately weathered mudstones between 0.5 to >1.5 m depth. The subsoil has favourable chemical and physical properties with a calcium dominant exchange capacity (CEC of 21–29 cmol[+] kg^{-1}, Ca/Mg ratios of 2.5–4.5) and low levels of exchangeable sodium (ESP 1–3 %). The subsoil is therefore structurally stable and moderately well drained as indicated by the low levels of soluble salts (EC 0.06–0.15 dS/m). The Cottonham soil is also moderately weathered as indicated by its moderate cation exchange capacity. The surface soil has a pH of 6.5 to 8.5 and the subsoil 6.5 to 8.5. The surface soil fertility is very high with mean P and N contents of 64 mg/kg and 0.23 % respectively. Cottonham has a brigalow or brigalow–belah vegetation association.

The **Kianga** soil occurs mainly on the undulating rises in the Rannes area. It is a shallow to deep, red or brown, non-cracking or gradational soil (Dermosol), with a structured clay loam or light clay surface. The topsoil overlies a blocky structured, light medium clay subsoil, which in turn overlies weathered mudstones between 0.3 to 1.2 m. The subsoil has excellent soil chemical and physical properties with a moderate CEC of 25 to 31 cmol[+] kg^{-1}, that is highly calcium dominant (Ca/Mg ratios of 7–15), and a low exchangeable sodium content (ESP 2 %). The subsoil is structurally stable and moderately well drained with low levels of soluble salts (EC 0.1 dS/m). The CEC also indicates a moderately weathered soil. The surface soil has a pH of 6.5 to 7.0 and the subsoil a pH of 6.5 to 8.5. The surface soil fertility is very high with mean P and N contents of 77 mg/kg and 0.23 % respectively. Kianga originally had softwood scrub vegetation.

The **Neimen** soil occurs most extensively on the undulating rises to the north of Banana, formed on the sandstones of the Back Creek Group. It is a shallow to moderately deep, stony, dark or brown, sodic duplex soil (Sodosol) with a hard setting, massive, clay loamy topsoil. A sporadically or conspicuously bleached subsurface overlies a coarse, columnar structured medium clay subsoil, which in turn overlies weathered sandstone between 0.6 to 1.2 m. The subsoil is strongly sodic (ESP 31–35 %) with a highly magnesium dominant exchange capacity (Ca/Mg ratios of 0.35–0.45) and low levels of exchangeable calcium (4–5 cmol[+] kg^{-1}). It is therefore highly dispersive and erodible, and the dense sodic subsoil is only very slowly permeable. Perched watertables would occur following rain. The surface soil has a pH of 6.0 to 7.5 and the subsoil a pH of 7.0 to 9.0. The surface soil fertility is low with mean P and N contents of 10 mg/kg and 0.11 % respectively. Neimen has a dominant poplar box – false sandalwood vegetation association (Photograph 27).

The **Wandoo** soil occurs mainly on the undulating rises to the west and north-west of Banana in the vicinity of the Baralaba Road. It is a shallow to moderately deep, red, duplex soil (Chromosol) with a hard setting, often structured, clay loamy topsoil. The topsoil overlies a prismatic structured, medium clay subsoil, which in turn overlies weathered siltstones between 0.4 to 1.0 m depth. The subsoil has favourable chemical and physical properties with a moderate CEC (19 cmol[+] kg^{-1}) that is calcium dominant (Ca/Mg ratio of 4.5), with low levels of exchangeable sodium (ESP 1–3 %). The subsoil is therefore structurally stable and moderately well drained as indicated by the very low soluble salt content (EC 0.03–0.6 dS/m). The CEC also indicates a moderately weathered soil. Wandoo has a topsoil pH of 6.5 to 7.5 and subsoil pH of 7.5 to 8.5. The surface soil fertility is moderate with mean P and N contents of 11 mg/kg and 0.11 % respectively. Wandoo has a silver-leaved ironbark – gum-topped bloodwood vegetation association (Photograph 28).

The **Police Camp** soil, like the Neimen soil, occurs most commonly on the undulating rises formed on the siltstones and sandstones of the Back Creek Group to the north of Banana. It is a shallow to moderately deep, stony, brown or red, sodic duplex soil (Sodosol) with a hard setting, massive, clay loamy topsoil. It has a sporadically bleached A_2 horizon that overlies a prismatic structured, medium clay subsoil, which in turn overlies little-weathered sandstones or shales by 0.4 to 1.0 m. The subsoil is sodic (ESP 12–17 %) with a high CEC (34–37 cmol[+] kg^{-1}) that is a magnesium dominant (Ca/Mg ratios of 0.8–1.1). However, the exchangeable calcium content is also high (13 – 16 cmol[+] kg^{-1}), so the subsoil is most likely only slightly dispersive and therefore imperfectly drained. In the deeper profiles, subsoil salts build up to moderate levels (EC 0.4–0.65 dS/m). The topsoil pH is 6.0 to 7.5, ,and 7.0 to 8.5 in the subsoil. The surface soil fertility is high with mean P and N contents of 28 mg/kg and 0.22 % respectively. Police Camp has a coowarra box (Dawson gum) – brigalow vegetation association (Photograph 29).

4.2.7 Soils overlying flat-lying, Jurassic sandstone

Landform: Undulating low hills and rises

The **Precipice** soil occurs on the dissected low hills and rises formed on Jurassic sandstone that outcrop on the northern end of the Boundary Hill Coal Mine. It is a moderately deep, stony, red or grey, mottled, acid duplex soil (Kurosol), with a hard setting, massive, clay loam topsoil. A bleached subsurface overlies a blocky structured, strongly acid (pH 4.2–5.1), mottled, medium clay subsoil, which in turn overlies weathered sandstone at 0.9 m depth. The subsoil is highly weathered with a low CEC (7 cmol[+] kg^{-1}) that has very low levels of exchangeable calcium (0.25–0.6 cmol[+] kg^{-1}) and therefore very low Ca/Mg ratios of 0.1 to 0.16. It is also sodic in the lower subsoil with an ESP of 9 %. However, it is structurally stable due to aluminum becoming exchangeable at the strongly acid pH's. The surface soil fertility is moderate with mean P and N contents of 14 mg/kg and 0.14 % respectively. Precipice has a narrow-leaved ironbark and lemon-scented gum – rosewood vegetation association (Photograph 30).

Photograph 25. Well developed linear gilgai on the Banana soil

Photograph 26. Remnant brigalow forest on the Fairview soil

Photograph 27. Poplar box – false sandalwood association on the Neimen soil

Photograph 28. Silver-leaved ironbark – gum-topped bloodwood association on Woolein soil

Photograph 29. Remnant Dawson gum trees and holly bush shrubs on Police Camp soil

Photograph 30. Narrow-leaved ironbark and lemon-scented gum – rosewood association on the Precipice soil

4.2.8 Soils overlying deeply weathered, Tertiary sedimentary rocks

Landform: Level to undulating plateau surfaces

The **Spier** soil is the main soil that occurs on the numerous level or sloping plateaus, formed on Tertiary sedimentary rocks, that are scattered throughout the Callide Valley (Photograph 31). It is a deep, massive, red, gradational soil (Kandosol) with a hard setting, fine sandy loam to clay loam topsoil. The texture gradually increases with depth to a light medium clay in the subsoil, which occasionally overlies deeply weathered sandstone between 0.8 to 1.5 m. The profile is weathered and bleached with a low CEC (2.7–5.4 cmol[+] kg^{-1}) throughout that is mainly magnesium dominant (Ca/Mg ratios of 0.3 to 1.5). The profile is also porous and freely draining, with acid pH's of 5.5 to 6.5 in the topsoil decreasing to 5.0 to 6.0 in the subsoil. The surface soil fertility is low with mean P and N levels of 5 mg/kg and 0.09% respectively. The dominant vegetation association of Spier is a narrow-leaved ironbark – long-fruited bloodwood woodland, often with Queensland peppermint.

On several of the smaller plateaus that have weathered to a harder, more resistant rock layer, the **Shield** soil is found. It is a shallow to moderately deep, stony, brown or black, uniform loamy soil (Kandosol or Tenosol), with a massive sandy loam to clay loam sandy topsoil. The surface soil overlies a massive, gravelly, sandy loam to clay loam sandy subsoil, which in turn overlies a hard, resistant sandstone or pebble conglomerate bedrock between 0.5 to 0.85 m. The sandy profile is freely draining and leached with a very low CEC (1.3–4.4 cmol[+] kg^{-1}) and calcium content (0.17 – 3.1 cmol[+] kg^{-1}), and acid pH's of 5.5 to 6.0. The surface soil fertility is also low with mean P and N concentrations of 5 mg/kg and 0.07 % respectively. Shield has a dominant vegetation association of Queensland peppermint – lemon-scented gum (Photograph 32).

Landform: Moderately inclined to steep escarpments

The **Bluff** soil occurs on the escarpments of the plateaus formed on Tertiary sedimentary rocks (Photograph 33). It is a stony, moderately deep to deep, red, brown or grey, acid duplex soil (Kurosol) with a massive, gravelly, sandy loam to clay loam surface. The topsoil overlies a mottled, blocky structured, strongly acid (pH 4.0–5.5), medium clay subsoil, which in turn overlies weathered parent materials between 0.5 to 1.2 m depth. The subsoil is weathered and leached with an exchange capacity dominated by exchangeable aluminum (6.0–7.3 cmol[+] kg^{-1}) and very low levels of calcium (0.02 cmol[+] kg^{-1}). As a result, the subsoil is structurally stable and moderately well drained. The surface soil fertility is moderate with mean P and N contents of 12 mg/kg and 0.19 % respectively. Bluff has a dominant narrow-leaved ironbark – rosewood vegetation association.

Landform: Gently undulating to undulating residual rises

The residual rises usually occur in close proximity to the plateaus formed on the Tertiary sedimentary rocks. The **Granville** and **Mapala** soils are found on these rises, which are only quite small in area. The **Granville** soil is a moderately deep to deep, brown or grey, sodic duplex soil (Sodosol) with a clay loamy topsoil that has a sporadically bleached A_2 horizon. The bleached subsurface overlies a prismatic structured, light medium clay subsoil which in turn overlies little-weathered substrate between 0.7 to 1.3 m depth. The subsoil is strongly sodic with an ESP of 18 to 23 %, and has a magnesium dominant exchange capacity (Ca/Mg ratios of 0.5–0.9). Exchangeable calcium levels in the subsoil are low to moderate (3.7–6.4 cmol[+] kg^{-1}). The subsoil is therefore dispersive and impedes drainage, resulting in an imperfectly drained profile. Perched watertables would occur following rain. The topsoil has a pH of 6.0 to 7.0, and the subsoil a pH of 7.0 to 9.0. The surface soil fertility is high with mean P and N contents of 38 mg/kg and 0.11 % respectively. Granville has a coowarra box (Dawson gum) – brigalow vegetation association (Photograph 34).

The **Mapala** soil, however, is a moderately deep or deep, red or brown, duplex soil (Chromosol). It has a massive, clay loamy topsoil that usually has either an A_2 or sporadically bleached A_2 horizon, which overlies a blocky structured, light medium clay subsoil. The subsoil overlies little-weathered parent materials between 0.9 to 1.5 m. The subsoil has a calcium dominant (Ca/Mg ratio of 2), moderate CEC (22 cmol[+] kg^{-1}), with a low exchangeable sodium content (ESP 3 %). It is therefore structurally stable and moderately well drained. The topsoil pH is 6.0 to 7.5, while the subsoil pH is 6.0 to 8.5. The surface soil fertility is high with mean P and N contents of 68 mg/kg and 0.15 % respectively. Mapala originally had a softwood scrub vegetation association (Photograph 35).

4.2.9 Soils overlying unconsolidated, Cainozoic alluvial-colluvial sediments

Landform: Undulating rises to level plains

The Cainozoic colluvial soils are a large group of soils and cover one third of the map area. They fall into two subgroups. The sandy-surfaced soils, which usually occur around the deeply weathered Tertiary sandstone plateaus, and the clay surfaced soils, which occur greater distances from these plateaus. The clay surfaced soils would be derived as much, if not more, from the weathering of the surrounding intermediate and basic igneous rocks, as from the former Tertiary land surface.

The **Earlsfield** soil is a deep, black, dark brown or grey cracking clay (Vertosol), that has a thin, very fine self-mulching, medium clay topsoil (Photograph 36). The surface soil overlies a lenticular structured, medium clay subsoil that is strongly sodic (ESP 18–20 %) and highly saline (EC 1.1 dS/m) by 0.9 m depth. Although the CEC is high (31–49 cmol[+] kg^{-1}), and calcium dominant (Ca/Mg ratios of 1.4–2.3), the lower subsoil is dispersive which impedes subsoil drainage causing soluble salts to accumulate at depth. The surface soil and upper subsoil are neutral alkaline (pH 7.0 to 8.5),while the deep subsoil often become strongly acid (pH 5.5). Widely spaced melonhole gilgai can sometimes be present. The surface soil fertility is high with mean P and N contents of 44 mg/kg and 0.15 % respectively. Earlsfield has a brigalow, or brigalow–belah vegetation association.

The **Greycliffe** and **Greycliffe melonhole phase** soils are subdivided on the density of melonhole gilgai. **Greycliffe melonhole phase** is all mound – depression micro-topography (Photograph 37), while the **Greycliffe** soil has widely-spaced melonhole gilgai with intergilgai flats 10 to 50 m in width (Photograph 38). Both of these two soils occur over large areas of the Callide Valley, and on the extensive clay sheet to the west of Banana.

The **Greycliffe** soil is a deep, grey or occasionally brown, cracking clay soil (Vertosol), with a thin pedal or weak, coarse self-mulching, medium clay surface soil that overlies a weak lenticular structured, medium clay subsoil. On the mounds the upper subsoil is strongly sodic (ESP 17–23 %), with very high salt contents (EC >1.0 dS/m) by 0.5 m. The salts are leached deeper under the intergilgai flats and depressions. The CEC is magnesium dominant (Ca/Mg ratios of 0.11–0.37), and the subsoil is therefore highly dispersive from a shallow depth. This greatly restricts profile drainage so that soluble salts accumulate in the upper subsoil. The surface soil and upper subsoil have a pH mainly of 6.0 to 7.5, while the lower subsoil is usually strongly acid (pH 5.0–5.5), but can be also neutral or alkaline. The surface soil fertility is high with mean P and N concentrations of 53 mg/kg and 0.16 % respectively. The Greycliffe soil has a brigalow scrub vegetation association.

Photograph 31. Spier soil on a plateau formed on deeply weathered Tertiary sandstone

Photograph 32. Lemon-scented gum – narrow-leaved ironbark association on Shield soil

Photograph 33. Bluff soil with narrow-leaved ironbark – rosewood association on scarp slopes of Tertiary sandstone

Photograph 34. Remnant Dawson gum on Granville soil

Photograph 35. The Mapala soil on a residual rise of Tertiary sandstone with remnant softwood scrub vegetation

Photograph 36. The fine self-mulching Earlsfield soil on gently undulating rises with remnant brigalow – belah vegetation

The **Greycliffe melonhole phase** soil is a deep, grey, cracking clay (Vertosol) with well developed melonhole gilgai. The gilgai are between 20 to 60 m across, and 0.5 to 1.6 m deep. The mounds have a coarse self-mulching surface soil, while the depressions have a crust with an underlying moderately structured topsoil. The subsoil is a weak to moderate lenticular structured, medium clay that on the mounds is strongly sodic (ESP 18–25 %) and highly saline (EC >1.0 dS/m) by 0.5 m depth. Under the depressions, the soluble salts and exchangeable sodium have been leached lower into the subsoil from the seasonally ponded water. The exchange capacity of the mounds is magnesium dominant (Ca/Mg ratios of 0.5–0.93), and the subsoil is highly dispersive from 0.3 m. This soil is therefore poorly drained due the dispersive clay subsoil and gilgai microrelief. The profile usually has a pH of 6.0 to 7.5 on the surface with the subsoil becoming strongly acid, with a pH of 5.0 to 6.5. However, alkaline layers (pH 8.0–8.5) in the upper subsoil are not uncommon. The surface soil fertility is high with mean P and N contents of 48 mg/kg and 0.16 % respectively. Greycliffe melonhole phase has a brigalow scrub vegetation.

The **Kilburnie** soil occurs only on the lower slopes of the plains and rises formed on Cainozoic colluvial-alluvial sediments, where they join the floodplains and valley flats. Kilburnie is a deep, black, cracking clay (Vertosol) with weakly developed linear gilgai (Photograph 39). The mounds have a fine self-mulching topsoil, while the depressions have a surface crust that is firm or hard setting. The thin surface soil overlies a lenticular structured, medium clay subsoil that is strongly sodic (ESP 18–23 %) with a moderate to high salt content (EC 0.6–1.0 dS/m) by 0.6 m. Although the subsoil has a high CEC (30–43 cmol[+] kg^{-1}) which is calcium dominant (Ca/Mg ratios of 1.0–1.5) the lower subsoil is dispersive and slowly drained as indicated by the high salt content. The surface soil and upper subsoil have a pH of 6.5 to 8.5, while the lower subsoil often becomes acid (pH 5.5–6.5). The surface soil fertility is high with mean P and N contents of 8 mg/kg and 0.08 % respectively. Kilburnie has a poplar box vegetation association.

The **Bonwell** soil occurs mainly on the undulating rises to the north of Biloela and Banana. It is a deep, red or brown, uniform non-cracking clay soil (Dermosol), with a fine, blocky structured, light clay topsoil (Photograph 40). The surface soil overlies a blocky structured, medium clay subsoil that has favourable chemical and physical properties. It has a moderate CEC (17–25 cmol[+] kg^{-1}) that is mainly calcium dominant (Ca/Mg ratios of 0.6–3.2), with a low exchangeable sodium content (ESP <1–2 %). The subsoil is therefore structurally stable and moderately well drained as indicated by the low levels of soluble salts (EC 0.1–0.15 dS/m). The surface soil fertility is high with mean P and N contents of 40 mg/kg and 0.2 % respectively. Bonwell has either a softwood scrub, or coowarra box (Dawson gum) – brigalow vegetation association.

The **Powerhouse** soil occurs on the Cainozoic clay sheets mainly to the north and south of Biloela. Powerhouse is a deep, dark brown or black, uniform non-cracking clay soil (Dermosol) with a fine, blocky structured, light clay surface soil (Photograph 41). The topsoil overlies a dense, coarse prismatic structured, medium clay subsoil that is strongly sodic (ESP 18–32 %) with a high salt content (EC 0.8–1.2 dS/m) below 0.6 m depth. The CEC (19–22 cmol[+] kg^{-1}) is mainly magnesium dominant (Ca/Mg ratios of 0.3–1.3), and the lower subsoil is therefore dispersive with impeded drainage. The topsoil has a pH of 6.0 to 7.5, and the subsoil a pH of 7.5 to 9.0. The surface soil fertility is high with mean P and N contents of 65 mg/kg and 0.15 % respectively. Powerhouse has a brigalow scrub vegetation association.

The **Koorngoo** soil occurs mainly on the upper colluvial slopes adjacent to a few Tertiary sandstone plateaus. It is a deep, massive, red gradational soil (Kandosol) with a hard setting, sandy loam or sandy clay loam topsoil. The texture gradually increases with depth to a light medium clay in the lower subsoil. This soil is highly weathered and leached with a low CEC of 5 to 7 cmol[+] kg^{-1} throughout the profile. It is porous and well drained as indicated by the very low soluble salt content (EC 0.03–0.05 dS/m). The topsoil has a pH of 6.0 to 7.5, and subsoil a pH of 6.5 to 7.5. The surface soil fertility is moderate with mean P and N contents of 20 mg/kg and 0.07 % respectively. Koorngoo originally had a softwood scrub vegetation association (Photograph 42).

Photograph 37. Well developed melonhole gilgai on Greycliffe melonhole phase soil

Photograph 38. Widely spaced melonhole gilgai on Greycliffe soil

Photograph 39. Weakly developed linear gilgai on Kilburnie soil. Note the self-mulching mounds and hard setting depressions

Photograph 40. Bonwell soil on gently undulating rises

Photograph 41. Cultivated Powerhouse soil in the foreground with a Tertiary basalt plateau in the background

Photograph 42. Remnant trees from a softwood scrub forest on Koorngoo soil

The **Kokotungo** soil is widespread throughout the Callide and Dawson Valleys and is one of the most extensive soils of this study. It is a deep, brown or grey, sodic duplex soil (Sodosol) with a clay loamy topsoil and sporadically bleached A_2 horizon. The bleached subsurface overlies a prismatic structured, medium clay subsoil. The subsoil is sodic to strongly sodic (ESP 12–29 %) with a mainly magnesium dominant CEC (Ca/Mg ratios of 0.5–1.8) that has low levels of exchangeable calcium (3.4 – 6.4 cmol[+] kg^{-1}). The subsoil is therefore highly dispersive with impeded drainage as indicated by the high soluble salt content of the lower subsoil (EC 0.82–0.92 dS/m). The topsoil pH is 6.0 to 7.5 and the subsoil varies from 5.5 to 9.0. The surface soil fertility is high with mean P and N contents of 41 mg/kg and 0.13 % respectively. Kokotungo originally had a coowarra box (Dawson gum) – brigalow vegetation association (Photograph 43).

The **Collins** soil occurs on the upper slopes as an apron around several of the Tertiary sandstone plateaus in the Callide Valley (Photograph 48). It is a deep, grey or brown, mottled, sodic duplex soil (Sodosol), with a very thick sandy topsoil that has a conspicuously bleached A_2 horizon. The bleached subsurface overlies a coarse, prismatic structured, light medium clay subsoil. The weathered clay subsoil (CEC of 10–11 cmol[+] kg^{-1}) is sodic (ESP 9–13 %) with a low exchangeable calcium content (4.4 – 4.7 cmol[+] kg^{-1}). It is therefore dense, poorly structured and impermeable and limits the rooting depth. The profile is imperfectly drained. Perched water tables may occur over the summer months following rain, with significant input from subsurface flow. The topsoil has a pH of 6.0 to 7.0 and the subsoil pH varies from 5.0 to 8.0. The surface soil fertility is high with mean P and N contents of 37 mg/kg and 0.08 % respectively. Collins originally had a softwood scrub vegetation.

The **Thalberg** soil occurs sporadically, usually in small areas, throughout the Callide Valley in association with the Kokotango soil. Thalberg is a deep, red or brown, duplex soil (Chromosol) with a clay loamy topsoil that occasionally has a bleached subsurface. The topsoil overlies a prismatic structured, medium clay subsoil that is only sodic in the lower subsoil (ESP 7–15 %) below 0.6 m. The subsoil is weathered with a low CEC of 6.8 to 10 cmol[+] kg^{-1}, that is mainly calcium dominant (Ca/Mg ratios of 0.8–4.1). The upper subsoil is therefore structurally stable and moderately well drained as indicated by its low salinity (EC 0.03–0.14 dS/m). The topsoil has a pH of 6.0 to 8.0, and the subsoil pH varies from 5.5 to 8.5. The surface soil fertility is high with mean P and N contents of 41 mg/kg and 0.13 % respectively. Thalberg has a coowarra box (Dawson gum) – brigalow vegetation association.

The **Nikita** soil occurs in only two small areas just to the south of Goovigen. It is a deep, red duplex soil (Chromosol) that has a thin, clay loam topsoil. The surface soil overlies a blocky structured, light medium clay subsoil that has a CEC of 17 to 26 cmol[+] kg^{-1}. The lower subsoil is sodic by only 0.9 m depth with an ESP of 6 to 9 %. The cation exchange capacity is also calcium dominant until this depth (Ca/Mg ratios of 1.2–2.6), after which it is magnesium dominant (0.8–0.9). The upper subsoil is therefore structurally stable, and overall the profile is moderately well drained, as indicated by the low soluble salt content (EC 0.04–0.25 dS/m). The topsoil has a pH of 6.5 to 7.0, and the subsoil a pH of 8.0 to 9.0. The surface soil fertility is high with P and N levels of 25 mg/kg and 0.14 % respectively (data from one site only). Nikita has a softwood scrub, or coowarra box (Dawson gum) – shrubby understorey vegetation association (Photograph 45).

The **Desdemona** soil occurs in only a few small areas on the extensive colluvial plains to the north-east of Goovigen. It is a brown, sodic duplex soil (Sodosol), that has a very thick (0.4 – 0.9 m), sandy topsoil with a sporadically or conspicuously bleached A_2 horizon. The bleached subsurface overlies a coarse prismatic structured, light medium clay subsoil. The subsoil is weathered with a low CEC (8–13 cmol[+] kg^{-1}), sodic (ESP 10–18 %), dense and impermeable, and limits water entry and rooting depth. Perched watertables would therefore occur in the sandy topsoil following rain. The topsoil has a pH of 6.0 to 7.0, and the subsoil 6.5 to 8.0. The surface soil fertility is low with mean P and N contents of 13 mg/kg and 0.05 % respectively. Desdemona has a narrow-leaved ironbark vegetation association (Photograph 46).

The **Ulogie** soil occurs throughout the Cainozoic colluvial plains, often in close proximity to the Tertiary sandstone plateaus. It is a brown or grey, sodic duplex soil (Sodosol) that has a very strongly, sodic subsoil. It has a sandy loam to clay loam topsoil, with a sporadically or conspicuously bleached A_2 horizon that overlies a coarse, columnar structured subsoil. The subsoil is dense and impermeable and strongly sodic throughout (ESP 20–33 %), with a highly magnesium dominant exchange capacity (Ca/Mg ratios of 0.19–0.26) that also has a low exchangeable calcium content (1.2–1.6 cmol[+] kg^{-1}). It is therefore highly dispersive and erodible (Photograph 47), and limits the rooting depth. Perched watertables would occur in the topsoil following rain. The topsoil has a pH of 6.0 to 7.0 and the subsoil a pH of 5.5 to 9.0. The surface soil fertility is low, with mean P and N contents of 9 mg/kg and 0.06 % respectively. Ulogie has a dominant gum-topped box – narrow-leaved ironbark vegetation association (Photograph 48).

4.2.10 Soils overlying unconsolidated Quaternary alluvium

Landform: Relict and active levees

The **Hodge** soil is found only on the active levee of the Callide Creek, just to the north of Biloela (Photograph 49). Its dominant profile type is a deep, black or brown, gradational or uniform loamy soil (Kandosol), that is porous and well drained. It has a massive sandy loam or sandy clay loam topsoil that grades into a massive or weak, coarse, prismatic structured, sandy clay loam or clay loam subsoil. Buried soil materials occur always below depths of 0.3 to 1.0 m. The subsoil has a moderate CEC (17–26 cmol[+] kg^{-1}) that is highly calcium dominant (Ca/Mg ratios of 3.0–4.0), with very low levels of exchangeable sodium (ESP <1 %) and soluble salts (EC 0.06 dS/m). The topsoil has a pH of 6.0 to 7.0 and the subsoil 7.0 to 8.0. The surface soil fertility is typical of alluvial soils of the Callide Valley with very high levels of phosphorous (69 mg/kg), but less than optimal levels of nitrogen (0.08 %). Hodge has a Moreton Bay ash and silver-leaved ironbark – sally wattle vegetation association.

The **Callide** soil occurs on the active levee of the Callide, Kroombit and Grevillea Creeks, on the relict levees of the many overflow channels that cross the floodplain, and onto the plains adjacent to these levees (Photograph 50). It is a deep, crusting, black or brown, duplex soil (Chromosol) with a silty loam or silty clay loam surface soil. The topsoil overlies a blocky structured, silty light medium clay subsoil with excellent soil chemical and physical properties. It has a moderate to high CEC (23–28 cmol[+] kg^{-1}), that is calcium dominant (Ca/Mg ratios of 2.3–2.6), with low levels of exchangeable sodium (ESP 3–5 %). The subsoil is therefore structurally stable and moderately well drained with low levels of soluble salts (EC 0.11–0.33 dS/m). Buried soil materials usually underlie the subsoil below 0.3 m. The topsoil has a pH of 6.0 to 7.5, and the subsoil a pH of 6.5 to 8.5. The surface soil fertility is high with mean P and N contents of 92 mg/kg and 0.15 % respectively. Callide has a Moreton Bay ash and silver-leaved ironbark – sally wattle vegetation association.

Landform: Level plains and backplains

The **Tognolini** soil occurs mainly between Biloela and Jambin on the backplains of the Callide Creek floodplain. It is a deep, black, cracking clay (Vertosol) with a fine self-mulching, silty medium heavy clay topsoil (Photograph 51). The thin surface soil overlies a fine lenticular structured, silty medium heavy clay subsoil that has excellent soil chemical and physical properties. The subsoil has a high CEC (41–50 cmol[+] kg^{-1}) that is calcium dominant (Ca/Mg ratios of 1.2–1.6), but slightly sodic in the upper metre of the profile (ESP 6–12 %). The subsoil is therefore structurally stable and imperfectly drained with salts accumulating to medium levels below 1.0 m (EC 0.5–0.8 dS/m). The topsoil has a pH of 6.0 to 8.5 and the subsoil a pH of 8.0 to 8.5. The surface soil fertility is high with mean P and N concentrations of 76 mg/kg and 0.12 % respectively. Tognolini had a forest red gum-topped – sally wattle vegetation association.

Photograph 43. Remnant Dawson gum trees on Kokotungo soil

Photograph 44. Collins soil with a Tertiary sandstone plateau in the background

Photograph 45. Dawson gum and belah with a shrubby understorey on the Nikita soil

Photograph 46. Remnant narrow-leaved ironbark vegetation on the Desdemona soil

Photograph 47. Severe gully erosion on Ulogie soil due to the highly dispersive subsoil

Photograph 48. Gum-topped box – narrow-leaved ironbark association on Ulogie soil

The **Tarramba** soil is the most extensive alluvial soil, and occurs on the backplains throughout the Callide and Don River floodplains and their tributaries, as well as on the valley flats of Banana Creek. It is a deep, black, cracking clay (Vertosol) with a coarse self-mulching topsoil (Photograph 52). The thin, medium heavy clay surface soil overlies a coarse lenticular structured, medium heavy clay subsoil that is strongly sodic (ESP 15–18 %) with high levels of soluble salts (EC 0.8–1.1 dS/m) by 0.6 m depth. The subsoil has a high CEC (49–52 cmol[+] kg^{-1}), that is magnesium dominant (Ca/Mg ratios of 0.5–0.9), and is therefore dispersive which impedes drainage and causes salts to accumulate higher in the profile (compared to Tognolini). The topsoil has a pH of 6.5 to 8.5, and the subsoil a pH of 8.0 to 9.0. The surface soil fertility is high with mean P and N levels of 45 mg/kg and 0.12 % respectively. Tarramba has a forest red gum or coolibah – sally wattle vegetation association.

The **Jambin** soil is very similar to the Tarramba soil, except that it has a finer self-mulching surface and brigalow vegetation. It occurs mainly on the backplains of the Callide Creek floodplain to the north of Jambin and on the backplains of the Don River floodplain. It is a deep, black, cracking clay (Vertosol) with a fine self-mulching, medium heavy clay surface. The thin surface layer overlies a lenticular structured, medium heavy clay subsoil that is strongly sodic (ESP 15 %), with high levels of salts (EC 0.8–1.2 dS/m) below 0.9 m. The subsoil has a high CEC (45–52 cmol[+] kg^{-1}) that is calcium dominant in the upper metre (Ca/Mg ratios of 0.8–1.6). As a result, only the lower subsoil is dispersive with impeded drainage which causes salts to accumulate. The topsoil has a pH of 6.5 to 8.5, and the subsoil a pH of 8.0 to 9.0. The surface soil fertility is high with mean P and N contents of 74 mg/kg and 0.18 % respectively. Jambin has a brigalow scrub vegetation.

The **Goovigen** soil occurs mainly on the valley flats of the Banana Creek and on the backplains of the Callide Creek floodplain to the north of Goovigen. It is a deep, black, cracking clay (Vertosol) with well developed melonhole gilgai. It has a thin, blocky structured medium clay topsoil that overlies a weak, lenticular structured, medium clay subsoil. The gilgai mounds are strongly sodic (ESP 18–30 %) and highly saline (EC >1.0 dS/m) in the upper 0.5 m of the subsoil. The exchangeable sodium and soluble salts have been leached deeper in the profile under the depressions. The major part of the subsoil is also magnesium dominant (Ca/Mg ratios of 0.5–1.1), and poorly drained due to the dispersive subsoil and gilgai microrelief. The topsoil has a pH of 6.5 to 7.5, and the subsoil a pH of 8.0 to 9.0. The surface soil fertility is high with mean P and N contents of 82 mg/kg and 0.15 % respectively. Goovigen has a brigalow scrub vegetation.

The **Melton** soil is a fairly extensive soil that occurs throughout the backplains of Callide Creek floodplain and its tributaries, as well as the valley flats of Banana Creek. It is a deep, black, uniform non-cracking clay soil (Dermosol) with a blocky structured, silty light medium clay topsoil. The topsoil overlies a strong, blocky structured, silty medium clay subsoil that often overlies buried soil materials below 0.6 m depth. The subsoil has excellent chemical and physical properties as it has a high CEC (28–34 cmol[+] kg^{-1}), that is calcium dominant (Ca/Mg ratios of 2.5–2.7) with low levels of exchangeable sodium (ESP 1–2 %). The subsoil is therefore structurally stable and moderately well drained with low levels of soluble salts (EC 0.1–0.28 dS/m). The topsoil has a pH of 6.0 to 7.5, and the subsoil a pH of 7.5 to 8.5. The surface soil fertility is high with mean P and N contents of 93 mg/kg and 0.19 % respectively. Melton has a forest red gum, or coolibah – sally wattle vegetation association (Photograph 53).

The **Caroline** soil, which is essentially a sodic version of the Melton soil, occurs only on the plains and backplains of the Don River floodplain to the north of Rannes. It is a deep, black, sodic non-cracking clay soil (Dermosol), or weakly cracking clay (Vertosol), with a blocky structured, silty medium clay topsoil. The surface soil overlies a blocky to lenticular structured, silty medium clay subsoil that is strongly sodic (ESP 14–18 %) and highly saline (EC 0.8–1.5 dS/m) in the lower subsoil below 0.5 m depth. The subsoil has a high CEC (40–46 cmol[+] kg^{-1}) that is calcium dominant (Ca/Mg ratios of 1.1–1.5), however its dispersive in the lower subsoil which impedes subsoil drainage thus causing salts to accumulate. The topsoil has a pH of 6.0 to 7.0 and the subsoil a pH of 8.0 to 8.5. The surface soil fertility is high with P and N levels of 105 mg/kg and 0.21 % respectively (data from one site only). Caroline has a coolibah – sally wattle vegetation association.

The **Pakington** soil is found only on the valley flat of an unnamed tributary of the Don River, just to the east of Kokotango. It is a deep, brown, weakly cracking clay (Vertosol), with a silty light medium clay surface soil. The topsoil overlies a blocky structured, silty medium clay subsoil that is strongly sodic (ESP 17–21 %) and highly saline (EC 0.8–1.2 dS/m) in the lower subsoil below 0.6 m. Although the subsoil has a mainly calcium dominant exchange capacity (Ca/Mg ratios of 2.7–0.8), the lower subsoil is dispersive which impedes soil drainage and causes salts to accumulate there. The topsoil has a pH of 6.5 to 7.0, and the subsoil a pH of 8.5 to 9.0. The surface soil fertility is high with P and N contents of 88 mg/kg and 0.2 % (data from one site only). Pakington originally had a brigalow – coowarra box (Dawson gum) vegetation association.

The **Retro** soil is widespread throughout the Callide Creek floodplain, and it is also the dominant soil of the valley flats of Banana Creek, and tributaries of Callide Creek and the Don River. It is a deep, hard setting and crusting, black, sodic duplex soil (Sodosol), with a silty clay loam topsoil that has a sporadically bleached A_2 horizon. The bleached subsurface overlies a coarse prismatic structured, medium clay subsoil that is sodic throughout (ESP 10–15 %) with a moderate to high CEC (22–38 cmol[+] kg^{-1}) that is calcium dominant (Ca/Mg ratios of 1.0–2.0). The lower subsoil is only slightly dispersive which impedes soil drainage and causes soluble salts to accumulate to moderate levels (EC 0.4–0.7 dS/m). The topsoil has a pH of 6.0 to 7.5, and the subsoil a pH of 8.0 to 9.0. The surface soil fertility is high with mean P and N contents of 42 mg/kg and 0.13 % respectively. Retro has a poplar box – sally wattle vegetation association (Photograph 54).

The **Grevillea** soil occurs mainly around Biloela in the south, and Lake Victoria in the north of the Callide Creek floodplain. Its main form is a strongly sodic, black, sodic duplex soil (Sodosol), or uniform non-cracking clay (Dermosol), with a very thin (<0.15 m), hard setting, silty clay loam or silty light clay surface soil. The topsoil has a sporadically bleached A_2 horizon that overlies a coarse prismatic structured, silty medium clay subsoil that is strongly sodic (ESP 17–33 %) and highly saline (EC 0.8–1.7 dS/m) from the top of the subsoil. The subsoil has a high CEC (35–45 cmol[+] kg^{-1}) that is magnesium dominant throughout (Ca/Mg ratios of 0.6–1.0), and by 0.6 m depth, exchangeable sodium levels exceed those of calcium. The subsoil is therefore highly dispersive and poorly drained with very high salt levels at 0.3 m depth. The topsoil has a pH of 6.0 to 7.0, and the subsoil a pH of 8.5 to 9.0. The surface soil fertility is high with mean P and N contents of 56 mg/kg and 0.16 % respectively. Grevillea has a poplar box – sally wattle vegetation association (Photograph 55).

The **Tequila** soil occurs only on a valley flat of a tributary of Callide Creek just to the south of Goovigen. It is a hard setting, brown, duplex soil (Chromosol), with a thick (0.35–0.55 m), fine sandy loam topsoil that has a sporadically bleached subsurface. The topsoil overlies a clay loam fine sandy or fine sandy light clay, prismatic structured subsoil that, below 0.8 m depth, is underlain by sandy buried soil materials. The subsoil and buried soil materials have a moderate CEC (8–13 cmol[+] kg^{-1}) that is calcium dominant (Ca/Mg ratios of 1.5–2.1) with very low levels of exchangeable sodium (ESP 2 %). The profile is sandy, porous and well drained as indicated by the low levels of soluble salts throughout the profile (EC 0.06–0.23 dS/m). The topsoil has a pH of 6.5 to 7.5, and the subsoil 7.5 and 8.5. The surface soil fertility is moderate with P and N contents of 17 mg/kg and 0.1 % respectively. Tequila originally had a softwood scrub vegetation (Photograph 56).

Photograph 49. Hodge soil on the active levee of Callide Creek

Photograph 50. Callide soil on the levee of a prior stream channel on the Callide Valley alluvial plain

Photograph 51. An irrigated maize crop on Tognolini soil

Photograph 52. Tarramba soil on the level alluvial plain of Callide Creek

Photograph 53. Partially cleared forest red gum open forest on Melton soil

Photograph 54. Poplar box – sally wattle woodland on the Retro soil

Photograph 55. Failed wheat crop on Grevillea soil next to an actively growing crop on Tarramba soil at Jambin

Photograph 56. Tequila soil on a valley flat of a tributary of Callide Creek

Landform: Seasonally flooded backplains, drainage depressions and ox-bows

The **Muruguran** soil occurs on the seasonally flooded backplains on the most northern parts of the Callide Creek floodplain around Lake Victoria, and on the Don River floodplain in and around Lake Caroline. The Muruguran soil is a mottled, black cracking clay (Vertosol) that is characterised by striking reddish, orange and brown colours, and strongly acid pH (5.0–5.5) in the upper 0.1 to 0.2 m of the subsoil. The thin topsoil is a fine granular structured, silty light clay that grades into a black, mottled, lenticular structured, medium clay subsoil. The pH increases in the lower subsoil to 6.5 to 9.0. The Muruguran soil also has well developed normal gilgai that are up to 10 m across and 0.4 m deep. This soil-landscape is very poorly drained in all but drought years, and in inundated for several months each summer due to overflow from the surrounding drainage lines. The surface fertility is very high with mean P and N contents of 122 mg/kg and 0.32 % respectively. Muruguran has a coolibah or forest red gum open woodland.

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6. Glossary

Alluvial deposits (alluvium)	Material transported by rivers/creeks and deposited on alluvial plains, terraces, swamps etc.
Annual plant	Plant that completes its lifecycle from seed germination to seed production and death in a single season.
Apedal	Soil with no observable peds, see single grained and massive.
Basalt	A fine grained, basic igneous rock. Generally low in silica, with high contents of iron, magnesium and calcium.
Cainozoic	That period from 65 m.y to 2 m.y.
CEC (Cation exchange capacity)	The total amount of exchangeable cations that a soil can absorb being made up of calcium, magnesium, potassium, sodium, aluminium and hydrogen. CEC affects soil properties and behaviour, stability of structure, the availability of some nutrients for plant growth and soil pH.
Clay	Soil particles <0.002 mm
Coarse fragments	Particles >2 mm, but not segregations of pedogenic origin (formed in soil profile)
Coarse sand	Particles 0.6 to 2.0, has a feel similar to raw sugar.
Cracking surface condition	Cracks at least 5 mm wide and extending upwards to the surface or to the base of any plough layer or thin (<0.03 m) surface horizon.
Devonian	That period from 395 m.y to 345 m.y.
Drainage	How water drains from the soil profile. Rapid drainage will cause water to move past the root zone in a short period limiting water uptake by the plant, while slow drainage will cause the soil profile to become saturated with water. A saturated profile will exclude most of the oxygen from the soil which leads to root cell death and greatly reduced uptake of moisture by the plant. Drainage is dependent on landscape position (controls external drainage and run-on), permeability of soil (texture, structure and distribution of pore spaces) and impediments in the profile to water movement such as hardpan and rock. • Very poorly drained: Water is removed from the soil so slowly that the watertable remains at or near the surface for most of the year. • Poorly drained: Water is removed very slowly in relation to supply, all horizons remain wet for several months. • Imperfectly drained: Water is removed slowly in relation to supply. Some horizons may be mottled and remain wet for several weeks. • Moderately well drained: Water is removed from the soil somewhat slowly in relation to supply. Some horizons may remain wet for one week after water addition. • Well drained: Water is removed from the soil readily but not rapidly. The soils are often medium in texture with some horizons remaining wet for several days. • Rapidly drained: Water is removed from the soil rapidly in relation to supply. Soils are usually coarse textured or shallow and no horizon is normally wet for more than several hours.
Duplex	Term defined in Northcote (1979), also known as texture contrast soils, i.e. profiles in which the clay content increases significantly between the surface and subsoils over a boundary of less than 5 cm.

Earthy fabric	The soil material is coherent and characterised by the presence of pores and few if any peds.
EC	Electrical conductivity (mS cm^{-1}). Indicates level of salt (sodium and others) in soil/water, the higher the salt content the higher the conductivity.
ESP	Exchangeable sodium percentage. ESP=100* exchangeable Na^+/CEC.
	ESP <6 % - non-sodic; ESP 6-15 % - sodic; ESP >15 % - strongly sodic.
Ferruginous gravel	Gravel which is dominantly composed of iron-rich material; also know as ironstone and laterite gravel.
Fine sand	Particles 0.06 to 0.1 mm, just visible with the naked eye and which feel similar to coarse flour or table salt.
Firm surface condition	Coherent mass of individual particles or aggregates. Surface disturbed or indented by moderate pressure of forefinger.
Gilgai Microrelief	Associated with soils with shrink-swell characteristics. Consists of mounds and depressions.
Gradational	Term defined in Northcote (1979), used to describe those profiles where the clay content increases gradually with depth.
Granodiorite	A coarse grained acid igneous consisting of quartz (20-40 %), calc-alkali feldspar and various ferromagnesian minerals (usually hornblende and biotite).
Great Soil Group	A soil classification by Stace *et al*. (1968).
Gully erosion	A channel in soil more than 0.3 m deep. Formed by the action of water moving over bare soil washing away soil material.
Hard setting	Compact, hard, apparently apedal condition formed on drying but which softens on wetting. When dry, the material is hard below any surface crust or flake, and is not disturbed or indented by pressure of the forefinger.
Holocene	Period of time from the last ice age to the present.
Horizons	Layers within a soil profile which have morphological properties different from those above and below (Northcote 1979).
Igneous rock	Broad groups of rocks, usually crystalline formed from magma.
Loam	A medium textured soil of approximate composition 10 to 25 % clay, 25 to 50 % silt and < 50 % sand.
Loose	Incoherent mass of individual particles or aggregates. Surface easily disturbed by pressure of forefinger.
Massive	Apedal coherent soil. When disturbed, soil separates into fragments which may be crushed to ultimate particles.
Medium sand	Particles 0.2 to 0.6 mm, which can be seen easily and feel similar to white sugar.
Mesozoic	That era of time 230 m.y. to 70 m.y. comprising Triassic, Jurassic, Cretaceous periods.
Meta-sediments	Rocks of sedimentary origin that have undergone varying grades of heating and pressure to form low grade metamorphic type rocks.
Metamorphic rocks	Material (usually sedimentary) altered by heat and pressure and chemically active fluids.

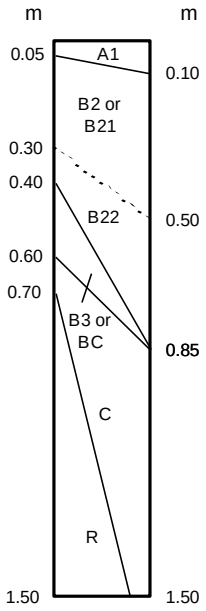
Plant Available Water Capacity	This is a measure or rating of the amount of moisture held in the soil which is available to the plant. It is defined as the difference between the field capacity of the soil and the wilting point. Field capacity occurs when the soils large pores (>30 microns) have drained but when all the small pores and capillary channels are still filled with water. Wilting point occurs when the soil is dry to the point where the plants can extract no more water. Soil texture has the greatest effect on the availability of water to the plant.
Palaeozoic	The era ranging in time from 600-230m.y. Preceded by Precambrian and followed by Mesozoic.
Permian	Period of time from 280-225 m.y. at end of Palaeozoic era.
pH	Soil pH is a measure of the acidity or alkalinity. A pH of 7.0 denotes a neutral soil with a log scale of increasing alkalinity of pH 7 to 14 and a log scale of increasing acidity of pH 7 to 1 (most soils have a range of 4 to 10). Each unit change in pH doubles the acidity or alkalinity.
PPF (Principal Profile Form)	The term given to the end point in the Northcote factual key soil classification.
Syenite	Coarse grained intermediate igneous rocks dominated by alkali feldspars.
Quaternary	The period of time from the present to 2 m.y. continues from top of Pliocene.
Rhyolite	Fine grained to glassy acid volcanic rock.
Rill erosion	A small channel up to 0.3 m deep which can be largely obliterated by tillage operations.
Salinity	Salinity is the build-up of soluble salts, especially sodium chloride within the profile. High salt levels in the soil water increase the osmotic pressure and the plant's ability to take up moisture. Salinity in the soil profile can come from rising saline groundwaters and by addition of water which has generally low to moderate levels of salt, which is concentrated as the water evaporates.
Sandy fabric	The soil material is coherent, with few if any peds. The closely packed sand grains provide the characteristic appearance of the soil mass.
Saprolite	A form of decomposed rock. Characterised by the preservation of structures that were present in the unweathered rock.
Sedimentary rocks	Rocks formed from material derived from pre-existing rocks by processes of denudation (weathering, transport, erosion) together with material of organic origin.
Self-mulching surface	Strongly pedal loose surface mulch forms on wetting and drying. Peds commonly <5 mm in least dimension.
Shale	A group of sedimentary rocks formed in water environment which have bedding planes and a particle size < $^{1}/_{16}$ mm.
Sheet erosion	The relatively uniform removal of soil from an area without the development of conspicuous channels.
Silcrete	Strongly indurated (cemented) siliceous material.
Siltstone	A group of sedimentary rocks formed in water which have a silt sized particle range.
Soft surface condition	Coherent mass of individual particles of aggregates. Surface easily disturbed by pressure of forefinger

APPENDIX 1 Description of the Soil Profile Classes

Annandale (An)

Concept: Annandale is a moderately deep (0.4-0.85 m), black, fine to coarse self-mulching, strongly cracking clay soil that is formed on basalt. Weakly developed normal gilgai can be present on the deeper profiles.
Geology: Little-weathered, Tertiary olivine basalt (Tb)
Aust Class: Black Vertosol
PPF: Ug5.12, Ug5.13
Landform: Crests and simple slopes of gently undulating to undulating rises that have slopes of 1 to 5% and a relief of 10 to 15 m.
Vegetation: Softwood scrub mid-high (6-12 m) closed forest of narrow and broad-leaved bottle trees, red and white-flowered bauhinia, brigalow and kurrajong, with an understorey of bitter bark, scrub ironbark, holly bush and *Cassia spp*.
Microrelief: Weakly developed normal gilgai on the deeper profiles. VI-0.1 m; HI-2-3 m.
Runoff: Slow
Permeability: Slowly permeable
Drainage: Moderately well drained
Surface cond: Fine to coarse self-mulching (peds 1-5 mm), strongly cracking

Profile Description



A1: Black or very dark brown (10YR 2/1, 2/2); medium or medium heavy clay. The self-mulching topsoil forms mainly large polyhedral peds, 2 to 10 mm in size, which upon drying give the appearance of a coarse, open surface structure. These larger peds readily breakdown to a strong, 1 to 2 mm, polyhedral structure; occasionally <2%, calcium carbonate nodules, <2-6 mm, usually only on the gilgai mounds; and <2-10%, basalt or quartz gravels, 2-20 mm; pH 7.0 to 8.5. Abrupt to -

B2 or B21: Black or very dark brown (10YR 2/1, 2/2); medium or medium heavy clay texture; strong, <2-5mm, lenticular structure, with few slickensides; 2-10%, basalt gravels, 2-20 mm; occasionally <2-10%, calcium carbonate nodules, <2 to 6 mm; very firm dry consistence; pH 7.5 to 8.5. Gradual to a B22 or clear to a B3 or BC -

B22: (when present) Dark brown, black or grey-brown (10YR 3/3, 2/1, 2/2; 7.5YR 3/4; 2.5Y 3/2); the dark brown subsoils usually have 2-20%, <5 mm, dark mottles; medium heavy or heavy clay texture; strong, 5 to 20 mm, lenticular structure, parting to 2 to 5 mm lenticular primary peds; common slickensides; 2-20%, soft or nodular calcium carbonate segregations, 2-20 mm; usually <2-10%, basalt or quartz gravels, 2-20 mm; pH 8.0 to 8.5. Clear to –

B3, BC or C: The subsoil grades into either a B3, BC or C horizon from 0.4 to 0.85m. The weathered basalt horizons are lighter in colour, usually dark brown to yellow-brown (10YR 3/3, 5/6; 2.5 Y 5/4), with up to 50 to 90% of soft, weathered basalt fragments. The textures are clay loam sandy to sandy light clay and these horizons are usually calcareous with 10-20%, soft or nodular, calcium carbonate segregations, 2-20 mm; pH 8.5. Abrupt to -

R: (when present) Hard, unweathered basalt.

Soil Chemistry

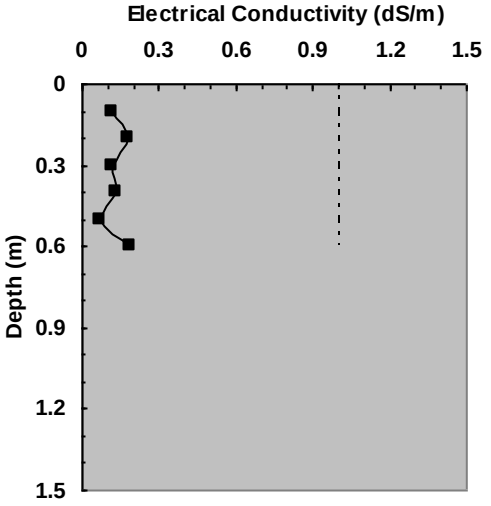
Horizon	Depth (m)	pH	EC dS/m 1:5,soil:water	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp ratio	CEC: clay ratio
A1	0.1	7.6	.12	.001	3	10	12	71	82	68	13	.70	.99	5.2	0.9	.30	1.2
B2	0.2	7.8	.18	.010													
B2	0.3	7.9	.12	.008	2	13	12	71	87	73	13	.61	.33	5.6	0.7	.30	1.2
B2	0.4	7.7	.13	.010													
B2	0.5	8.0	.07	.001													
BC	0.6	8.3	.19	.010	23	36	14	29	63	54	10	.68	.17	5.4	1	.41	2.2

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

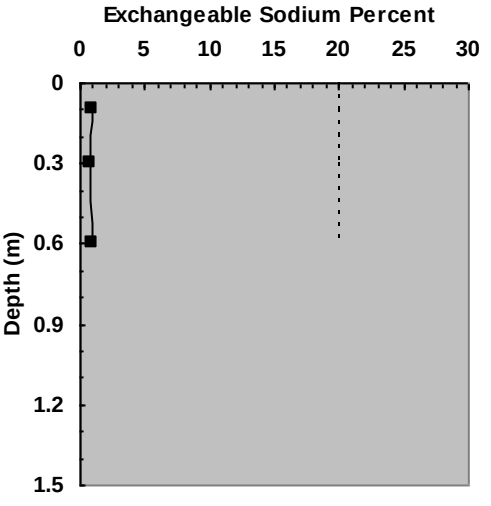
Annandale is alkaline throughout the profile, with a very high clay content (>70%), that decreases markedly in the weathered substrate layers. The CEC and calcium contents are also very high with calcium strongly dominant over magnesium (Ca/Mg ratios 5.2-5.6). The subsoil sodicity is also very low (ESP ≤1) and Annandale is structurally very stable (e.g. low R1 dispersion ratio 0.3).

Annandale is therefore moderately well drained with low levels of soluble salts due to water draining below the profile (see salt graph below). The CEC:clay ratios (1.2-2.2) indicate a smectite clay mineralogy. Surface soil properties are also excellent due to the high level of calcium.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

The Annandale soil has a rooting depth range of 0.7 to 1.5 m that is limited only by hard, unweathered bedrock, as subsoil sodicity and salinity are very low and not limiting (see above graphs). The PAWC varies from 105 to 185 mm for these rooting depths. Annandale has a high water holding capacity per unit depth of soil due to its high clay content. The salt graph shows also that there is significant deep drainage below the soil profile, as soluble salts have not accumulated in the subsoil (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	37	0.21	2.6	1.1	9	52	19
Range	17-77	.15-.38	1.7-4.0	.80-1.9	4-16	44-61	12-29
No of samples	8	8	8	7	7	2	2
Rating	Very high	Very high	High	High	Moderate	Very high	Very high

Annandale has a very high surface soil fertility as the mean phosphorous and nitrogen contents are very high. This is typical for basalt soils with softwood scrub, which are the most fertile soils of the Banana study area. All other nutrients measured are also high or very high, except for sulphate-sulphur which has a moderate mean concentration

Banana (Bn)

Concept: Banana is a moderately deep to very deep (0.7->1.5 m), fine self-mulching, black, strongly cracking clay soil formed on Permian mudstones. Well-developed, linear gilgai are present on profiles deeper than 0.8 m .

Geology: Little-weathered, folded, Permian mudstones of the Gyranda (Puy), Flat Top (Puf) and Barfield (Pur) formations of the Bowen Basin sedimentary rocks.

Aust Class: **Mound:** Black Vertosol **Depression:** Black Vertosol

PPF: **Mound:** Ug5.12, Ug5.15 **Depression:** Ug5.12, Ug5.13, Ug5.15

Landform: Mid to lower slopes of gently undulating to undulating rises with slopes of 1 to 3% and a relief of 10 to 25 m. The Banana soil often forms a catenary sequence with the Wandoo soil on the crests and the Mungi soil on the upper and mid slopes particularly in the Banana to Baralaba road area.

Vegetation: Mid-high (6-12 m), woodland or open woodland of a silver-leaved ironbark – gum-topped bloodwood association. The understorey is absent while the lower stratum or ground layer consists of medium quality native pastures of forest blue grass, black spear grass, Queensland blue grass and kangaroo grass.

Microrelief: Linear gilgai: VI-0.1-0.3 m; HI-4-9 m.

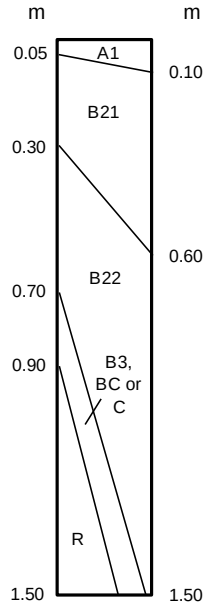
Runoff: Slow

Permeability: Slowly permeable

Drainage: Moderately well drained

Surface cond: Fine self-mulching (peds 1-2 mm), strongly cracking

Profile Description **(mounds and depressions)**



A1: Black to very dark grey (10YR 2/1, 3/1); light medium to medium clay texture; strong 1 to 2 mm, granular structure. The topsoil is fine, self-mulching on both the mounds and depressions, and is usually thicker on the mounds; 2-10%, calcium carbonate nodules, 2-6 mm sometimes present in the topsoil of the linear gilgai mounds; pH varies from 6.5 to 8.0. Abrupt to -

B21: Black to very dark grey (7.5YR 2/0; 10YR 2/1, 3/1); medium to medium heavy clay texture; strong, <2-5 mm, lenticular structure; 2-20%, calcium carbonate nodules, 2-6 mm occur throughout the subsoil of the mounds, but are only present below 0.3 m in the depressions; sometimes <2-10%, mudstone gravels, 2-20 mm; firm to very firm dry consistence; pH 8.0 to 8.5 (mounds) and 7.0 to 8.0 (depressions). Clear or gradual to -

B22: Black to very dark grey (7.5YR 2/0; 10YR 2/1, 3/1, 3/2), sometimes becomes dark brown or brown (7.5YR 4/4, 4/6, 5/6; 10YR 4/3, 4/4, 5/3) below 0.6 m; occasionally <2-20%, brown, dark or grey mottles, <5-15 mm; medium to medium heavy clay texture; strong, 2-10 mm, lenticular structure; common slickensides; <2-10%, calcium carbonate nodules and mudstone gravels; 2-20 mm; pH of 8.0 to 8.5 (mounds and depressions). Abrupt or clear to -

B3, BC or C: (when present) The subsoil grades into either B3, BC or C horizons of weathered mudstones. These horizons are usually lighter in colour, very dark grey, grey-brown or olive-brown (2.5Y3/2, 5/4; 10YR4/2, 4/3), with 20 to 90% of weathered, mudstone fragments; clay loam, light or light medium clay texture; usually 2-50%, soft and nodular calcium carbonate segregations, 2-20 mm; pH 8.5. Abrupt to -

R: Hard, unweathered bedrock (when present).

Soil Chemistry

(a) mound

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.05	7.9	.09	.001	5	18	14	61	55[2]	47	6.9	.25	1.0	6.8	0.5	.24	.90
B_2	0.3	8.4	.14	.001	6	14	14	63	62[2]	53	8.1	.62	.41	6.5	1	.24	.98
B_2	0.6	8.6	.18	.001	7	14	11	66	64	53	10	1.6	.29	5.3	3	.33	.97
B_2	0.9	8.6	.26	.007	6	14	13	65	65	48	11	2.5	.27	4.4	4	.32	1.0

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

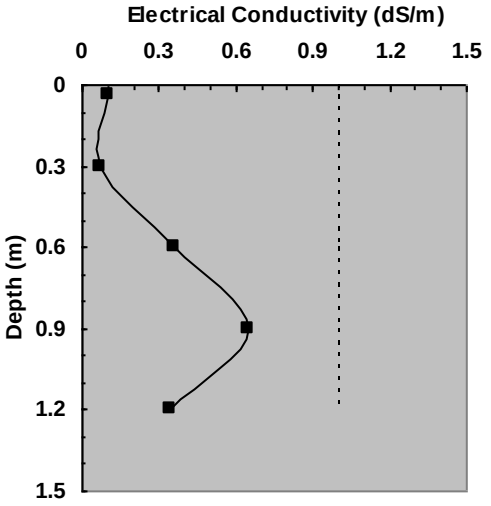
(b) depression

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.04	6.9	.10	.003	4	15	17	63	52[2]	41	8.5	.35	1.3	4.8	0.7	.35	.83
B_{21}	0.3	7.5	.07	.003	1	13	17	67	68	57	8.8	1.3	.73	6.5	2	.40	1.0
B_{22}	0.6	7.4	.36	.047	1	13	15	69	69	57	8.3	2.0	.68	6.9	3	.36	1.0
B_{23}	0.9	7.9	.65	.080	2	11	16	68	68	55	9.0	2.7	.72	6.1	4	.38	1.0
B_3	1.2	8.5	.34	.018	5	12	13	69	67	51	12	3.1	.27	4.3	5		0.97

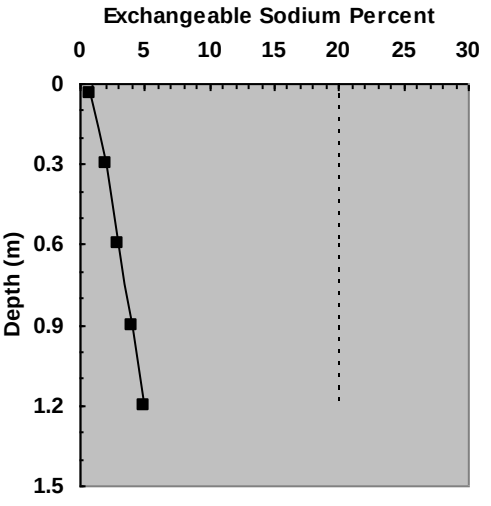
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

The above tables present the analytical data for the Banana soil. The topsoil is typically neutral to alkaline with an alkaline subsoil. The Banana soil has a uniform very high clay content (61-69%) throughout the profile, that is similar between the mound and depression. The CEC is also very high (52-69 cmol[+] kg^{-1}) and dominated by calcium (Ca/Mg ratios 4-7), which is also at very high contents (41-57 cmol[+] kg^{-1}). The subsoil is non-sodic (ESP <1-5) and therefore structurally stable (low R1 dispersion ratios 0.25-0.4) and moderately well drained with only low to moderate salt levels due to significant deep drainage (see salt graph below). The CEC:clay ratios of 0.83 to 1.0 indicate smectite clay mineralogy. Surface soil properties are excellent due to the clay mineralogy and high calcium content.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Banana has a rooting depth range of 0.9 m to 1.5 m and is restricted only by hard, unweathered bedrock as subsoil salinity and sodicity are low and not limiting (see above graphs). These rooting depths result in a PAWC that varies from 120 mm to 205 mm. Banana has a high water holding capacity per unit depth of soil due to its high clay content. The salt graph shows also that there is significant deep drainage below the soil profile, as soluble salts have not accumulated in the subsoil (i.e. a salt bulge is absent).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	8	0.11	1.5	0.74	9	34	8.7
Range	2-18	.08-.15	1.0-2.0	.51-1.2	4-16	18-52	6.5-13
No of samples	12	12	12	4	7	10	10
Rating	Low	Moderate	Low	Moderate	Moderate	High	High

The Banana soil has low fertility as available phosphorous is mainly low, with only a just moderate mean total nitrogen content. The mean organic carbon content is also low which is typical of eucalypt woodlands. Other nutrients are moderate to high.

Bauhinia (Ba)

Concept: Bauhinia is a moderately deep to deep (0.8-1.2 m), black or brown, cracking clay soil with a fine self-mulching topsoil, that is formed on Permian mudstones and siltstones. Weakly-developed linear gilgai microrelief may be present.

Geology: Little-weathered mudstones and siltstones of the Permian sedimentary rocks of the Bowen basin. Bauhinia occurs mainly on sediments of the Gyranda formation (Puy).

Aust Class: **Mound:** Black Vertosol **Depression:** Black or Brown Vertosol

PPF: **Mound:** Ug5.12 **Depression:** Ug5.12, Ug5.13

Landform: The Bauhinia soil occurs on the gently inclined (0.5-1.5%) lower slopes and footslopes of the gently undulating to undulating rises to the north-west of Banana.

Vegetation: Open plains of Queensland blue grass with forest blue and black spear grass, with a mosaic of isolated clumps of white and red-flowered bauhinia and brigalow trees.

Microrelief: Weakly developed linear gilgai may be present. VI: 0.05 to 0.1 m, HI: 7 to 9 m

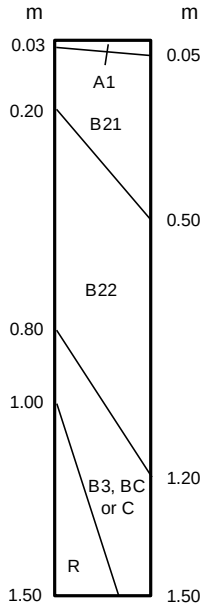
Runoff: Slow

Permeability: Slowly permeable

Drainage: Moderately well drained

Surface cond: Fine self-mulching (peds 1-2 mm), and cracking

Profile Description **(mounds and depressions)**



A1: Very dark grey or occasionally dark brown (10YR 3/1, 3/3; 2.5Y 3/2; 7.5YR 3/3); light medium or medium clay texture; strong, 2 to 5 mm, subangular blocky structure that parts readily to fine, granular or subangular blocky peds, <2 mm. The self-mulching topsoil is thicker on the mounds (0.05 m) with <2%, calcium carbonate nodules, 2-6 mm; pH 7.0 to 8.0. Abrupt to -

B21: Very dark grey or occasionally dark brown (10YR 3/1, 3/3, 4/3; 2.5Y 3/2); medium or medium heavy clay texture; strong, 2 to 10 mm, lenticular structure; common slickensides; very firm or strong dry consistence; occasionally <2-10%, mudstone and quartz gravels, 2-20 mm; 2-10%, calcium carbonate nodules, 2 to 6 mm are always present in the mound subsoils, usually below 0.2 m in the subsoil of the depression soils; pH 7.5 to 8.5. Clear or gradual to -

B22: As above, except that calcium carbonate segregations are always present and the pH increases to 8.5 to 9.0. Occasionally 2-10%, gypsum crystals, <2-6 mm occur. Abrupt or clear to -

B3, BC or C: The subsoil grades into either a B3, BC or C horizon that contain mostly (>50%) weathered mudstone or siltstone fragments, with tongues of very dark grey or yellow-brown (10YR 5/4; 2.5Y 3/2, 5/4), medium clay subsoil amongst the weathered rock in the B3 and BC horizons; and 2-20%, soft or nodular calcium carbonate segregations, <2-6 mm. Abrupt to -

R: Hard, unweathered mudstone.

Soil Chemistry

(a) mound

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.05	7.9	.07	.001	11	27	18	44	39[2]	28	10	.41	.65	2.8	1	.44	.89
B_{21}	0.3	9.0	.16	.001	10	22	17	49	45[2]	31	12	2.0	.54	2.6	4	.51	.92
B_{22}	0.6	9.0	.34	.018	10	23	17	51	45[2]	26	15	4.0	.18	1.7	9	.62	.88
B_{22}	0.9	9.0	.46	.030	9	21	19	52	45[2]	24	16	4.9	.19	1.5	11	.63	.87
B_{22}	1.2	9.0	.47	.033	6	22	20	56	48[2]	26	16	5.5	.17	1.6	12		.86
B_3	1.5	9.2	.37	.029	4	34	22	41	36[2]	21	10	4.8	.03	2.1	13	.71	.88

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

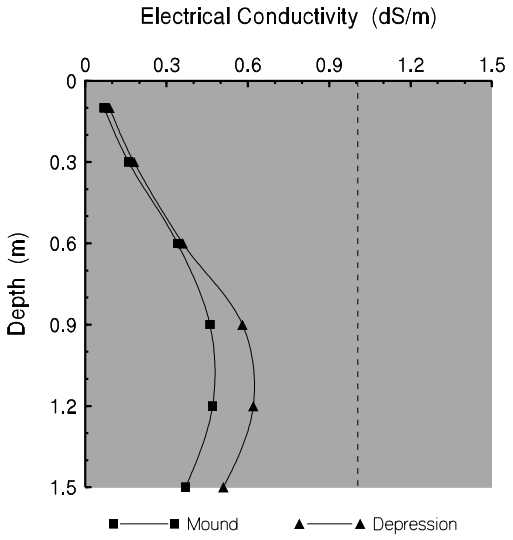
(b) depression

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.03	8.4	.09	.001	10	26	19	47	36	28	8.8	.35	.74	3.2	1	.49	.77
B_{21}	0.3	8.4	.08[3]	.009	7	22	22	50	37	27	10	1.8	.15	2.7	5	.44	.74
B_{22}	0.6	8.3	.36	.037	6	20	21	55	49[2]	31	14	3.9	.34	2.2	8	.54	.89
B_{23}	0.9	8.7	.58	.070	6	20	21	56	47[2]	28	14	4.7	.29	2.0	10	.60	.84
B_3	1.2	8.5	.62	.071	5	20	18	60	48[2]	28	15	5.2	.18	1.9	11		.80
B_3	1.5	8.7	.51	.056	2	23	22	64	44	26	14	5.1	.07	1.9	12	.79	.69

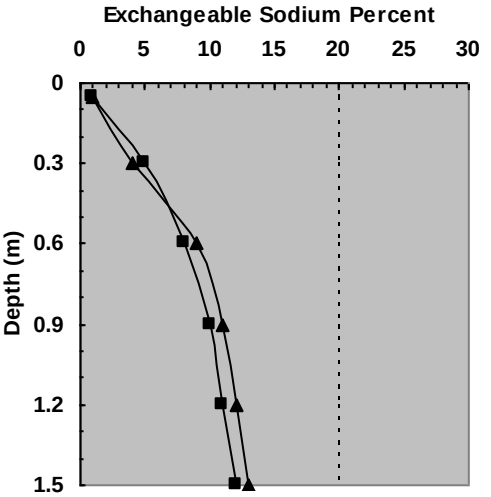
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC [3] Cl^- used to estimate EC

The above table shows the analytical data for the Bauhinia soil. Bauhinia is typically alkaline throughout the profile. It has a high clay in the surface soil and upper subsoil (44-50%) that increases to very high contents below 0.5 m (51-64%) with similar levels in the mounds and depressions. The CEC is high (36-49 cmol[+] kg^{-1}) with high calcium contents (24-31 cmol[+] kg^{-1}) that are dominant over magnesium throughout the profile (Ca/Mg ratios 1.5-3.2). The lower subsoil below 0.5 m is sodic (ESP 8-13) and slightly dispersive as the high calcium levels limit the effect of the sodicity as indicated by the only moderate R1 dispersion ratios (0.54-0.79). The profile is therefore moderately well drained with moderate levels of subsoil salts due to significant deep drainage. The CEC:clay ratios of 0.7 to 0.9 indicate a mixed clay mineralogy to a dominant smectite clay mineralogy. Surface soil properties are favourable due to the clay mineralogy and high calcium content.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

The Bauhinia soil has a rooting depth range of 1.0 to 1.5 m that is limited only by hard, unweathered bedrock, as subsoil salinity and sodicity are only moderate in the lower subsoil and do not affect the rooting depth (see above graphs). These rooting depths result in a PAWC that varies from 115 mm to 145 mm. The salt graph shows also that the salt concentration reaches equilibrium at 1.0 m, which indicates the long-term average depth of wetting. The salt content however is only moderate due to significant deep drainage below the soil profile.

Surface Soil Fertility

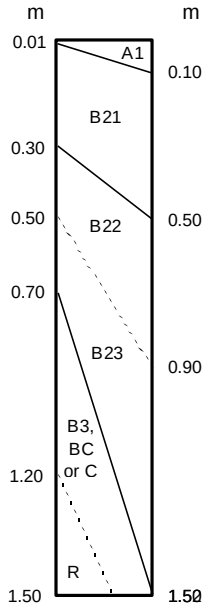
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg-1
Mean	10	0.15	1.5	0.72	5	21	9.2
Range	2-17	.08-.33	.9-1.9	.4-1.2	4-7	16-25	8.8-10
No of samples	3	3	3	3	2	3	3
Rating	Moderate	Moderate	Low	Moderate	Low	High	High

The surface fertility varied considerably between the three sampled sites, as seen by wide data ranges and interpretation of these data is limited by the small number of samples. The Bauhinia surface soil fertility is best described as moderate, due to the moderate mean phosphorous and total nitrogen levels. However one of the sites had very low P (2 mg/kg) and low N levels (0.08%). The mean organic carbon content is also low as Bauhinia had originally a grassland vegetation. Sulphate-sulphur levels are also low, while the other nutrients measured are moderate to high.

Belldeen (Bd)

Concept: Belldeen is a moderately deep to very deep (0.7->1.5 m), black, cracking clay soil formed on Permian volcanic rocks. It usually has well developed linear gilgai that have fine self-mulching mounds, with pedal or coarse self-mulching topsoils in the depressions.
Geology: Permian basic lavas of the Camboon andesites (Pln) and Owl Gully volcanics (Plq).
Aust Class: **Mound:** Black Vertosol **Depression:** Black Vertosol
PPF: **Mound:** Ug5.12, Ug5.13, Ug5.15 **Depression:** Ug5.12, Ug5.13, Ug5.15
Landform: Belldeen occurs on the mid and lower slopes of the gently undulating or undulating rises or undulating low hills, with slopes of 1 to 3%. Belldeen occurs usually in small areas of only 20 to 50 ha.
Vegetation: Mid-high (6-12 m) open woodland of a silver-leaved ironbark – gum-topped bloodwood association, occasionally with Moreton Bay ash or kurrajong. A mid-stratum is absent and a lower stratum of moderate quality native grass pastures, consists mainly of forest blue grass, Queensland blue grass and black spear grass.
Microrelief: Linear gilgai. VI: 0.1-0.25 m HI: 3-9 m
Runoff: Slow to moderately rapid
Permeability: Slowly permeable
Drainage: Moderately well drained
Surface cond: Fine self-mulching (mounds), pedal or coarse self-mulching (depressions), strongly cracking

Profile Description **(mounds and depressions)**



A1: Black, very dark brown or very dark grey-brown (10YR 2/1, 2/2, 3/2); light medium or medium clay texture; gilgai mounds have a fine self-mulching topsoil, 0.05 to 0.1 m thick, that have a strong, fine (1-2 mm), granular structure, while the surface soil in the depressions is thinner (0.01-0.06 m), pedal or coarse, self-mulching with a strong, 2 to 5 mm, subangular blocky structure. Usually <2-10%, calcium carbonate nodules, <2-6 mm on the mounds; sometimes <2-10%, andesite gravels, 2-20 mm; pH 7.0 to 8.5 (mounds), and 6.5 to 7.0 (depressions). Abrupt to -

B21: Black to very dark grey-brown (10YR 2/1, 2/2, 3/1, 3/2; 2.5Y 3/2); light medium to medium heavy clay texture; strong, 2 to 10 mm, lenticular structure that parts to <2-5mm, primary lenticular peds; few slickensides; <2-10%, calcium carbonate nodules, <2 to 6 mm (mounds only); occasionally <2-10%, andesite gravels, 2-20 mm; very firm dry consistence; pH of 8.0 to 8.5 (mounds) and 7.0 to 8.5 (depressions). Clear or gradual to -

B22 and B23: Either black to very dark grey brown (7.5YR 2/0; 10YR 2/1, 3/1, 3/2) or dark brown (7.5YR 4/4; 10YR 3/3, 4/3, 4/4); sometimes 2-20%, brown, dark or yellow mottles, <5-15 mm; medium or medium heavy clay texture; strong, 5-20 mm, lenticular structure, that usually parts to finer 2 to 5 mm peds; few slickensides; 2-20%, soft or nodular calcium carbonate segregations, <2-20 mm; <2-10 mm, andesite gravels, 2-20 mm; very firm or strong, dry consistence; pH 8.5 to 9.0. Abrupt or clear to –

B3, BC or C: The B3 and BC horizons are dark grey-brown to yellow-brown (10YR 4/2, 4/4, 5/4, 6/6; 2.5Y 6/4); usually 2-20%, dark, grey or brown mottles, <5 to 15 mm; sandy or fine sandy light clay texture; highly calcareous with 10-50%, soft or nodular, calcium carbonate segregations, 2-60 mm; 10-50%, weathered volcanic rock fragments. The C horizons are composed entirely of weathered basic volcanic rocks; sometimes 2-20%, carbonate segregations, 6-20 mm. Abrupt to –

R: (when present)Hard, unweathered basic volcanic rock.

Soil Chemistry
a) mound

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl⁻ %	Particle Size CS %	FS %	S %	C %	CEC cmol[+] kg⁻¹	Exchangeable Cations[(1)] Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.05	8.6	.16	.001	7	15	19	57	53	31	17	1.0	1.1	1.8	2	.50	.93
B_{21}	0.3	8.9	.15	.002	5	14	19	61	54	27	22	1.1	.26	1.2	2	.50	.89
B_{22}	0.6	9.0	.27	.017	6	14	19	60	51	22	28	2.4	.20	0.8	5	.56	.85
B_{22}	0.9	8.9	.49	.050	8	13	19	58	49	18	27	3.0	.23	0.7	6	.55	.84

[(1)] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

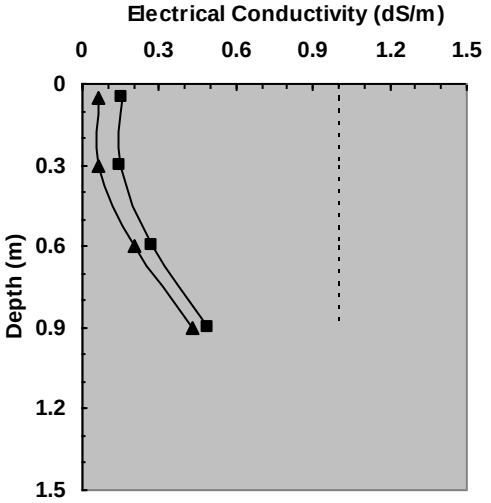
(b) depression

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	CEC cmol[+] kg^{-1}	Exchangeable Cations[1] Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.04	7.2	.06	.001	5	18	23	52	43[2]	24	17	.37	1.3	1.4	0.9	.56	.83
B_{22}	0.3	8.4	.06	.001	3	13	21	63	56	32	20	1.0	.30	1.6	2	.53	.89
B_{22}	0.6	8.6	.20	.017	3	12	21	63	58	29	26	2.3	.28	1.1	4	.58	.92
B_{23}	0.9	8.8	.43	.040	7	13	23	57	51	24	25	2.6	.27	1.0	5	.59	.90

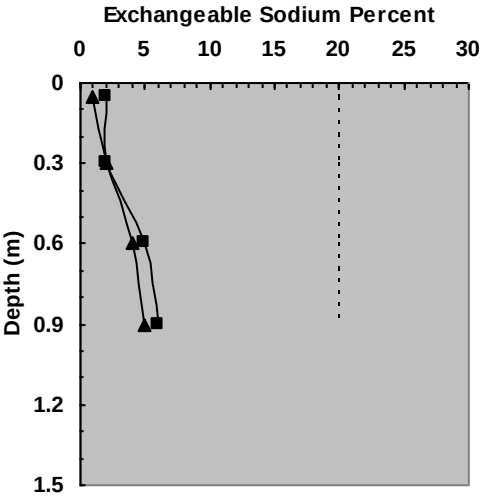
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

The above table presents the analytical data for the mounds and depressions of the Belldeen soil. The surface soil is typically alkaline on the mounds and neutral on the depressions, while the subsoil is alkaline. Belldeen has a uniform, high clay content throughout the profile (52-63%) with little difference between the mounds and depressions. The CEC is also high (43-58 cmol[+] kg^{-1}) with a high calcium content (43-58 cmol[+] kg^{-1}), that is dominant over magnesium throughout the depression, while magnesium becomes the dominant cation of the lower subsoil of the mound (Ca/Mg ratios 1.8-0.7). The subsoil mainly has a low sodicity, with only the lower subsoil of the mound just becoming sodic (ESP 6) and is therefore structurally stable (mod R1 dispersion ratios 0.55-0.6) and moderately well drained with low soluble salt content due to significant deep drainage. The CEC:clay ratios of 0.85 to 0.95 indicate smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Belldeen has a rooting depth range of 1.2 to 1.5 m that is restricted only by hard, unweathered bedrock, as subsoil salinity and sodicity are low and not limiting (see above graphs). These rooting depths result in a PAWC that varies from of 130 to 180 mm. Belldeen has a high water holding capacity per unit depth of soil due to its high clay content. The salt graph shows also that there is significant deep drainage below the soil profile, as soluble salts have not accumulated in the subsoil (i.e. a salt bulge is absent).

Surface Soil Fertility

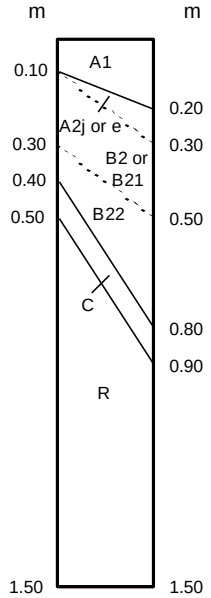
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg-1
Mean	11	0.12	1.7	0.67	6	25	15
Range	2-25	.06-.18	1.0-3.0	.33-1.1	3-10	22-28	-
No of samples	13	13	13	7	11	2	2
Rating	Moderate	Moderate	Moderate	Moderate	Low	Very high	Very high

The above table summarises the fertility data for the Belldeen soil. Belldeen has a moderate surface soil fertility, as both mean available phosphorous and total nitrogen contents are moderate. However it is not uncommon for these two nutrients to be low. The organic carbon content is also moderate to low, which is typical of eucalypt woodland soils, and sulphur levels are also low.

Benn (Be)

Concept: Benn is a shallow or moderately deep (0.3-0.7 m), black, brown or red, sodic duplex soil with a hard setting, stony, sandy loam to clay loam topsoil, 0.1 to 0.3 m thick, sometimes with a sporadic or conspicuously bleached subsurface that overlies a sodic, medium clay subsoil. Benn has mainly a neutral soil reaction trend and is formed on folded, Permian sandstone.
Geology: Little-weathered, folded, Permian sandstones of the Back Creek Group of the Bowen Basin (Purc, Purs).
Aust Class: Black, Brown or Red Sodosol
PPF: Db1.12, Dd1.12, Dr2.12
Landform: Benn occurs on the hill slopes and crests of the undulating rises to rolling low hills and strike ridges formed on sandstone to the east and north-east of Banana. The hill slopes are normally in the order of 3 to 15%, and these landforms have a relief of up to 50 m
Vegetation: Benn has either mid-high (6-12 m), silver-leaved ironbark, or tall (12-20 m) narrow-leaved ironbark woodlands. Gum-topped bloodwood occasionally occurs as an associated species. The understorey shrubs and low trees are widely spaced and 2 to 4 m high, and consist mainly of dead finish, pretty wattle, corkwood wattle and occasionally false sandalwood, while the native grass pastures vary from forest blue grass dominant to pitted blue grass dominant pastures with mainly wire grasses.
Runoff: Rapid to very rapid
Permeability: Slowly permeable
Drainage: Well drained
Surface cond: Hard setting, with 20-90% gravels and cobbles of sandstone and occasional rock outcrop.

Profile Description



A1: Very dark brown to dark grey-brown (10YR 2/2, 3/2, 3/3, 4/2); clayey sand to clay loam, sandy texture; massive or weak, 2 to 10 mm, subangular blocky or platy structure; usually very stony with 10-90%, sandstone gravels or cobbles 2-200 mm; weak to very firm dry consistence (depending upon soil texture); pH 6.0 to 7.0. Sharp or abrupt to either an A2j or B2 -
A2j or e: (when present) Dark grey-brown to brown (10YR 4/2, 5/2, 5/3, 6/2), light grey or white, dry, bleach colour (10YR 7/1, 7/2, 8/1); sand to clay loam, sandy texture; massive or weak, 2 to 5 mm, subangular blocky structure; 10-50%, sandstone gravels to cobbles 2-20 mm; pH of 6.5 to 7.5. Sharp or abrupt to -
B2 or B21: Dark grey-brown, dark brown or dark red-brown (2.5Y 3/2; 10YR 3/2, 3/3; 7.5YR 3/4; 5YR 3/4, 4/3); occasionally mottled with 2-50%, dark or brown mottles, <5 to 15 mm; light medium to medium heavy clay texture; strong, 50-200 mm, prismatic or columnar structure, sometimes parting to moderate, 5 to 20 mm, subangular blocky primary peds; very firm to strong dry consistence; 2-20%, sandstone gravels, 2-60 mm; pH 6.5 to 7.5. Abrupt or clear to either a B22 or C -
B22: Very dark grey-brown, dark brown or red-brown (10YR 4/3; 2.5Y 3/2, 4/2; 5YR 3/4) lower subsoil is present in the deeper profiles; light medium or medium clay texture; strong, 5-20 mm, subangular blocky or occasionally a moderate, 10-50 mm, lenticular structure; sometimes <2-10%, soft or nodular calcium carbonate segregations, <2-6 mm; 2-20%, sandstone gravels, 2-60 mm; pH 7.5 to 8.5. Abrupt or clear to –
C: The subsoil usually grades into C horizons of weathered sandstone that are up to 0.3 m thick. Sharp or abrupt to -
R: Hard, unweathered bedrock

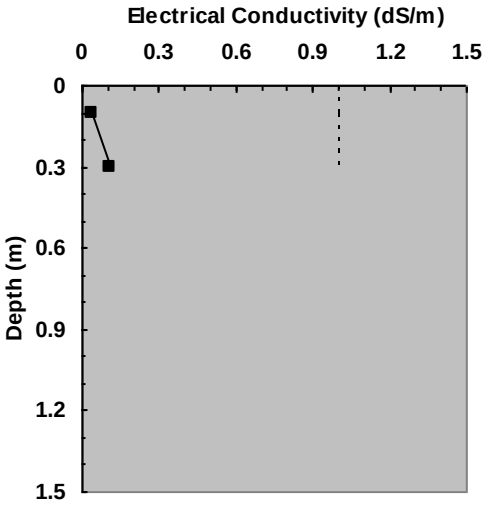
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.9	.04	.002	24	53	10	15	9	5.7	1.8	.24	1.1	3.2	3	.58	
B_2	0.3	7.9	.11	.005	9	27	10	56	20	8.0	7.1	2.7	1.6	1.1	14	.85	.36

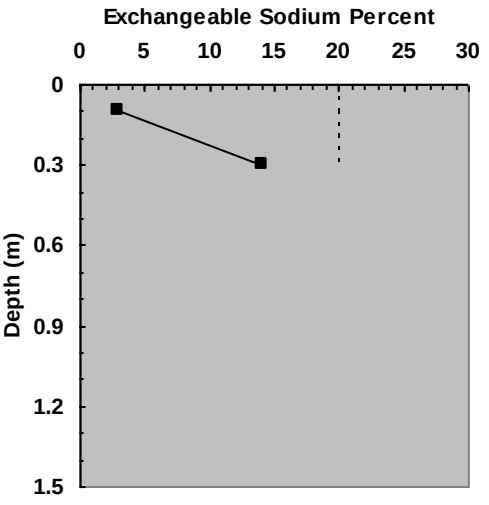
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

The above table presents the analytical data for the Benn soil. Typically the topsoil is slightly acid or neutral with a neutral to alkaline subsoil. The topsoil has a high fine sand content and only a moderate clay content (15%), making it prone to har setting and crusting. The clay content increases markedly in the subsoil (56%), showing a strong texture contrast. The CEC of the surface soil is therefore only low and increases to a moderate level in the subsoil CEC (9-20 cmol[+] kg^{-1}), indicating a moderately weathered soil. Calcium is the dominant cation in both the topsoil and subsoil (Ca/Mg ratio 3.2-1.1) and the subsoil is also sodic with a significant exchangeable sodium content (ESP 14). It is therefore dispersive (high R1 dispersion ratio 0.85) with impeded drainage. However subsoil salts are only low (0.04-0.11 dS/m) as the subsoils are only thin and significant deep drainage occurs (see salt graph below). The CEC:clay ratio of 0.36 indicates a mixed clay mineralogy with high proportions of kaolinite and illite clay minerals.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Benn has a rooting depth range of 0.5 to 0.9 m that is restricted only by hard, unweathered bedrock, as subsoil salinity and sodicity are low and moderate respectively and not limiting (see above graphs). Benn therefore has a PAWC that varies from 50 to 75 mm, depending upon rooting depth and thickness and clay content of the topsoil to a lesser degree. The high stone content of the topsoil also significantly reduces the water holding capacity. The salt graph shows also that there is significant deep drainage below the soil profile, despite the sodic subsoil, as the salt concentration is very low and has not reached equilibrium (i.e. a "salt bulge is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg-1
Mean	6	0.1	1.3	1.1	4	5.9	3.4
Range	2-30	.07-.14	.85-2.2	.8-1.5	3-5	3.9-13	1.8-6.0
No of samples	6	6	6	3	3	6	6
Rating	Low	Low	Low	High	Low	Moderate	Moderate

Benn has low surface soil fertility as the mean phosphorous and total nitrogen contents are both low. The organic carbon level is also low which is typical for eucalypt woodland soils. The sandy surfaced topsoils of Benn are also only just sufficient for calcium and magnesium, as well being low in sulfur, which could affect seca stylo productivity and persistence. Potassium is the only nutrient that is consistently high.

Bertha (Bt)

Concept: Bertha is a shallow to moderately deep (0.3-0.7 m), stony, uniform sand to clay loamy soil with an acid to neutral soil reaction trend, that is formed on acid volcanic rocks. The surface soil either directly overlies weathered rock or has a pale, sporadic or conspicuously bleached subsurface horizon and/or a dark brown or yellow-brown, B2 horizon that overlies weathered rock.

Geology: Carboniferous acid volcanic rocks of the Torsdale beds (Ct) and minor granites of the Glandore granodiorites *(Cul).*

Aust Class: Bleached-Leptic Tenosol; Leptic Rudosol; or Brown Kandosol

PPF: Uc5.11, Um2.12, Um5.51, Um1.44, Uc2.12, Uc3.

Landform: Strongly dissected, steep hills to rolling low hills of the Banana range in the south, and the Rannes range in the north-west of the study area. A large area of Bertha, to the south-east on Rannes, also occurs on a strongly dissected, undulating rise. The hills have a relief of 50 to 240 m and are the highest landforms in the survey area, while the gradients vary from 5 to 60%. The dissected rises have a more moderate slope range of 3 to 12%.

Vegetation: Bertha has a tall (12-20 m), narrow-leaved ironbark woodland, sometimes with associated species such as lemon-scented gum, gum-topped and long fruited bloodwoods, Queensland peppermint and silver-leaved ironbark. The mid-stratum consists predominantly of black wattle, with occasional trees or shrubs of pretty wattle, bats wing coral tree, quinine tree and corkwood wattle. The low quality native pastures are made up of mainly wire grasses (*Aristida spp.*), with lesser amounts of barbed wire grass, silky oil grass, pitted blue grass and occasionally back spear grass.

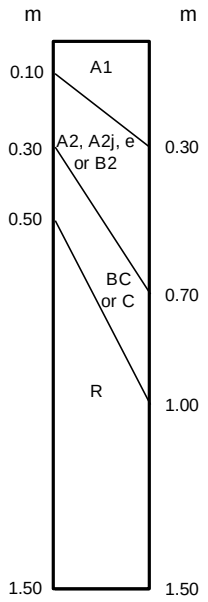
Runoff: Rapid to very rapid

Permeability: Highly permeable

Drainage: Rapidly drained

Surface cond: Firm or occasionally hard setting, with 20-90% gravels and cobbles and 2-20% rock outcrop.

Profile Description



A1: Black, very dark brown to dark brown (10YR 2/1, 2/2, 3/3, 4/2, 4/3); loamy sand to clay loam, sandy texture; massive or weak, 2-5 mm, subangular blocky structure; very stony with 50-90%, quartz and acid volcanic rock gravels to cobbles, 2-200 mm; very weak to firm dry consistence (depending upon texture); pH 5.5 to 6.5. Clear to either an A2 or B2 horizon -

A2, 2j or e: (when present) Dark grey-brown to yellow-brown (10YR 4/2, 5/2, 5/3, 5/4, 6/4) colour (moist), sometimes bleached with a light grey to white, dry colour (10YR 7/1, 8/1, 8/2); clayey coarse sand to clay loam, sandy texture; massive structure; weak to firm dry consistence; 50-90%, quartz and acid volcanic rock gravels and cobbles, 2-200 mm; pH 5.5 to 6.5. Abrupt or clear to -

B2: (when present) Dark brown to yellow-brown (10YR 3/3, 4/4, 5/6; 7.5 YR 3/4, 4/4); clayey sand to clay loam, sandy texture; massive to weak, 2-5 mm, subangular blocky structure; weak to firm dry consistence; 10-50%, quartz and acid volcanic rock gravels to cobbles, 2-200 mm; pH 5.5 to 7.0. Clear or gradual to -

BC: Grey-brown to pale yellow-brown (10YR 5/2, 5/3, 6/4; 7.5YR 5/4, 6/4); coarse sand to sandy clay loam texture; massive structure; 20-90%, acid volcanic rock gravels, 6-60 mm; pH 5.5 to 6.5.

C: The C horizons consist entirely of weathered parent materials.

R: Hard, unweathered bedrock

Duplex variant

A non-sodic, duplex soil occurs in small areas on the Banana Range to the south of the Biloela to Banana road. This duplex variant of Bertha occurs where the parent material changes to the more intermediate, intrusive rock of the Glandore Granodiorite.

It has a black to dark grey-brown (10YR 2/1, 2/2, 3/2, 4/2), sandy loam to clay loam topsoil, 0.1 to 0.25 m thick. The topsoil overlies a non-sodic, black, dark grey-brown or dark brown (10YR 2/1, 3/2, 3/3; 7.5YR 3/3, 3/4, 4/4), light to medium clay subsoil that has a strong, 5-20 mm, subangular blocky or 20-100 mm, prismatic structure. The subsoil grades into a B3 or C horizon from 0.4 to 0.6 m. It has a neutral soil reaction trend with a topsoil pH of 6.5 to 7.0, and a subsoil pH of 7.0.

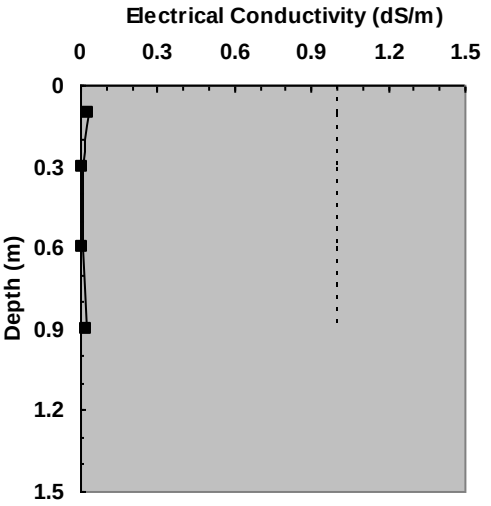
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl⁻ %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg⁻¹	Ca	Mg	Na	K	Al	Exch. acidity	Ca/Mg ratio
A_1	0.1	6.1	.03	.001	40	24	21	16	7	4.8	1.6	.08	.60			3.0
B_2	0.3	5.8	.01	.001	30	25	27	20	4	.61	1.9	.12	.23	1.1	1.2	.32
BC	0.6	5.9	.01	.001	20	23	31	27	6	.22	3.0	.25	.18	2.5	2.7	.07
BC	0.9	6.2	.02	.001	25	25	24	27	8	.15	7.6	.69	.26			.02

[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 ECEC= Ca + Mg + Na + K + exchangeable acidity

The above table presents the analytical data for the Bertha soil. Bertha has only a moderate clay content (16-20%) and is freely draining due to its sandy texture and high stone content. It is therefore leached with very low levels of soluble salts (<0.1 dS/m)and an acid pH. The CEC is also low throughout the profile (4-7 cmol[+] kg^{-1}) with very low calcium contents in the subsoil and weathered substrate (0.15-0.65 cmol[+] kg^{-1}). These horizons are strongly magnesium dominant (Ca/Mg ratios 0.15-0.65), while the surface soil is calcium dominant and at a moderate content due to biological cycling. The ESP, R1 dispersion and CEC:clay ratios are not relevant at these clay contents.

Plant Available Water Capacity



Mean profile salt graph

The Bertha soil has a rooting depth range of 0.5 to 1.0 m that is restricted only by hard, unweathered bedrock, as subsoil salinity and sodicity are very low and not limiting (see above graphs. The PAWC varies from 35 to 50 mm for these rooting depths. The high sand and stone content of this soil significantly reduce the water holding capacity. The very low salt levels throughout the profile indicate that nearly all water that infiltrates this soil is lost to deep drainage as it is freely draining with a low water holding capacity. The salt profile is therefore typical of a recharge soil.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	12	0.08	1.5	0.57	3	3.6	1.9
Duplex variant	(39)	(0.14)	(2.9)		(4)		
Range	4-37	.04-.14	.8-2.9	.54-.6	2-4	2.7-4.7	1.6-2.2
No of samples	9	9	9	2	7	2	2
Rating	Moderate	Low	Low	Moderate	Very low	Low	Low

The surface soil fertility is quite variable for Bertha as both phosphorous and nitrogen vary from very low to moderate or high. Overall, mean phosphorous levels are moderate, but the mean total nitrogen concentration is low (0.08%). Bertha therefore has a low fertility, as most nutrients, and especially nitrogen, are at low levels. The mean nutrient contents for the duplex variant of Bertha are shown, as the duplex variant has significantly higher phosphorous, nitrogen and organic carbon than Bertha. The areas of the duplex variant considerably improve the overall fertility of the Bertha soil profile class.

Bluff (Bf)

Concept: Bluff is a moderately deep to deep (0.5-1.2 m), red, brown or grey, strongly acid duplex soil, with a stony, sandy loam to clay loam topsoil, 0.1 to 0.35 m thick, overlying a strongly acid, sometimes mottled, medium clay subsoil. Bluff has an acid soil reaction trend and is formed on deeply weathered, Tertiary, sedimentary rocks.

Geology: Deeply weathered, Tertiary sedimentary rocks (siltstone and sandstone) (Ta).

Aust Class: Red, Brown or Grey Kurosol

PPF: Dr4.11, Db3.11, Dy3.11

Landform: Moderately inclined to steep, scarp slopes and dissected remnants of the level to undulating plateaus formed on deeply weathered, Tertiary sedimentary rocks. Gradients vary from 8 to 45%, and the plateaus stand some 40 to 70 m above the surrounding plains. At times the surrounding scarp slopes were not wide enough to map at 1:100 000 and were included in the map unit with the plateau soil, Spier

Vegetation: The main association is a narrow-leaved ironbark woodland with a thick rosewood understorey. Lemon-scented gum, gum-topped box and yapunyah sometimes occur as associates. Coowarra box and rosewood form another minor association. Other mid-stratum species are soap bush, bitter bark, currant bush and *Croton insularis*. The sparse native grasses of the lower stratum are predominantly wire grasses (*Aristida spp.*) and *Sporobolus spp.* Introduced grasses such as buffel and green panic have often invaded from nearby pasture lands and persist due to high soil nitrogen levels.

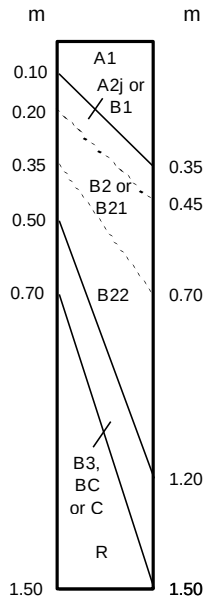
Runoff: Very rapid

Permeability: Moderately permeable

Drainage: Rapidly drained

Surface cond: Firm or hard setting, with 10-90%, gravels and cobbles of siltstone or sandstone, and <2-20% rock outcrop.

Profile Description



A1: Black to dark brown (10YR 2/1, 2/2, 3/2, 3/3; 7.5YR 3/2, 3/4); fine sandy loam to clay loam, fine sandy texture; massive, or weak to moderate, 2 to 10 mm, subangular blocky or polyhedral structure; weak or firm dry consistence; usually 10-50%, gravels to cobbles, 2-200 mm; pH 4.5 to 6.5. Abrupt or clear to -

A2j: (when present) The sporadically bleached A2 horizon has similar properties to the topsoil, except that it has a dark brown to brown (10YR 4/2, 4/3, 5/3; 7.5YR 4/3) moist colour with a light grey to white (10YR 7/2, 8/1) dry, bleach colour.

B1: (when present) Dark grey-brown to dark brown (10YR 2/2, 3/2, 4/1; 7.5 YR 4/6); clay loam to light medium clay texture; moderate or strong, 5-10 mm, polyhedral or subangular blocky structure; 10-50%, gravels to cobbles, 6-200mm; pH 4.5 to 5.5. Clear to -

B21, 22: Dark red, red-brown, dark brown to grey (2.5YR 3/4; 5YR 3/2, 3/4; 7.5YR 4/4; 10YR 3/3, 4/1, 4/2); sometimes 10-50%, grey, brown or red mottles, <5-15 mm; light medium to medium clay texture; strong, 5-10 mm, polyhedral or subangular blocky structure; firm or very firm consistence; usually 10-50%, gravels to cobbles, 2-200 mm; pH 4.5-6.0. The B22 horizon is only present in the deeper profiles and only differs from the upper subsoil with slightly stronger subsoil colours. Abrupt or clear to -

B3, BC or C: Dark to light grey, or red (10YR 4/1, 4/2, 6/1, 7/1; 5Y 7/1; 5YR 4/4; 2.5YR 4/4; 5R 5/2); 20-50%, prominent, red, brown or grey, 5->30 mm, mottles. The C horizons consist entirely of deeply weathered substrate, while the B3 and BC horizons have a light to light medium clay texture with 20-90%, weathered fragments of sandstone or siltstone. These horizons either continue to 1.5 m or overlie bedrock below 0.7 m. Sharp or abrupt to –

R: (when present) Hard, unweathered sandstone or occasionally siltstone.

Soil Chemistry

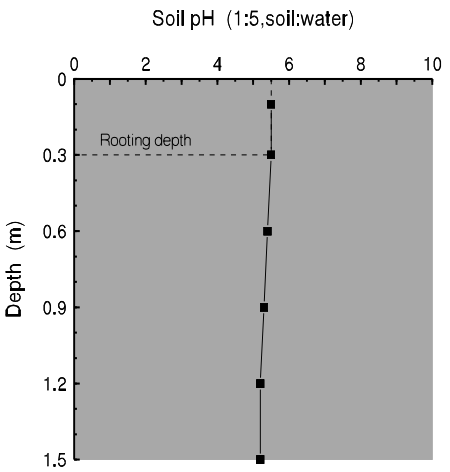
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Al	Exch. acidity	Ca/ Mg ratio	ESP	R1 Disp ratio	CEC: clay ratio
A_1	0.1	4.3	.09	.003	34	29	17	19	5.7	.70	1.3	.07	.40	2.9	3.2	.54	1	.51	
B_2	0.3	4.7	.07	.004	9	20	15	60	10	.07	2.9	.42	.19	6.7	6.7	.02	4	.64	.16
B_2	0.4	4.6	.14	.013	12	14	14	63	11	.03	3.3	.63	.13	6.6	6.6	.009	6	.69	.17
BC	0.6	4.3	.38	.044	2	4	4	89	13	.02	4.7	1.2	.10	7.3	7.4	.004	9	.57	.15
BC	0.9	4.1	.49	.055	1	2	7	89	12	.02	4.0	1.4	.14	6.0	6.0	.005	12	.50	.14

(1) Cations extracted with aqueous 1M NH_4Cl at pH 7.0

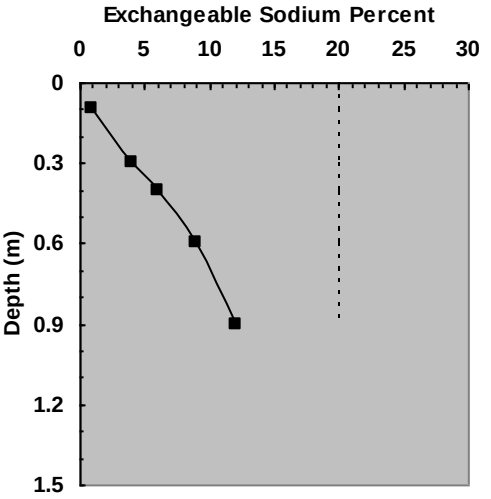
The above table shows the analytical data for the Bluff soil. The feature of this soil is its very strongly acid pH throughout the profile (typically though the surface soil pH is mainly 5.5 to 6.0). The clay content is moderate in the surface soil (19%), and increases to very high levels in the subsoil (60-63%).

The BC horizon consists of substrate that has been deeply weathered to almost pure kaolinite. The subsoil CEC is low (10-11 cmol[+] kg^{-1}), and the calcium level is extremely low (<0.1 cmol[+] kg^{-1}), with aluminium and magnesium the dominant cations, and therefore very low Ca/Mg ratios <0.1. The subsoil is sodic (ESP 6) with the sodicity increasing the weathered substrate, but these horizons are non-dispersive due to the exchangeable aluminium (not reflected by the moderate R1 dispersion ratios 0.5-0.7). The Bluff soil is therefore well drained with only moderate levels of soluble salts in the weathered substrate. The CEC:clay ratios of 0.14 to 0.17 indicate a kaolinitic clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Bluff has a shallow rooting depth range of only 0.2 to 0.45 m that is limited by the strongly acid subsoil pH (see abovegraph), and extremely low exchangeable calcium contents. Bluff therefore has a low PAWC of only 20 to 40 mm, depending upon topsoil thickness.

Surface Soil Fertility

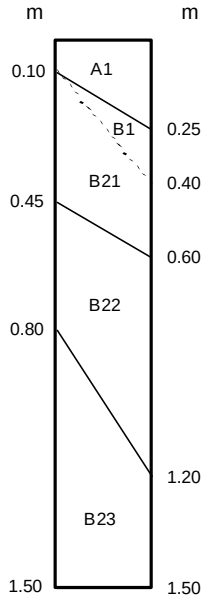
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	12	0.19	3.4	0.52	15	0.7	1.3
Range	4-31	.11-.33	1.6-6.6	.46-.66	7-39	-	-
No of samples	10	10	10	3	9	1	1
Rating	Moderate	High	High	Moderate	High	Very low	Low

The above table summarises the surface soil fertility for the Bluff soil. Bluff has a moderate fertility as phosphorous contents are mainly moderate to high with a mean of 12 mg/kg, while total nitrogen levels are mainly high due to the thick rosewood understory. The vegetation could also account for the high organic carbon levels. Bluff is one of the few soils with a high mean sulphur level (15 mg/kg). The calcium and magnesium concentrations are very low and low respectively, but these were measured from one site only.

Bonwell (Bw)

Concept: Bonwell is a very deep (>1.5 m), red or brown, non-cracking clay soil with a 0.1 to 0.25 m thick, pedal light medium clay topsoil that overlies a structured, medium clay subsoil and has an alkaline soil reaction trend.
Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza).
Aust Class: Red or Brown Dermosol
PPF: Uf6.31
Landform: Crests and hill slopes of the gently undulating or undulating rises, formed on unconsolidated Cainozoic sediments, that have slopes of 0.5 to 6% and a relief of 10 to 30 m.
Vegetation: Closed or open, tall (12-20 m) forest of a brigalow and coowarra box association. The understorey is made up of a wide variety of species which include holly bush, currant bush, lime bush, wilga, wallaby apple and occasionally red or white-flowered bauhinia. Only very sparse brigalow grasses, such as *Paspalidium spp*., curly windmill grass and *Sporobolus spp*. are present in the ground layer under the forest canopy.
Runoff: Slow to moderately rapid
Permeability: Moderately rapid
Drainage: Moderately well drained
Surface cond: Firm to hard setting, <2-10%, quartz or ironstone gravels, occasionally with 10-50%, cobbles of silcrete.

Profile Description



A1: Dark brown or dark red-brown (10YR 3/3; 7.5YR 3/2, 3/3; 5YR 3/2, 3/3); light clay or fine sandy light medium clay texture; strong, 5-10 mm, subangular blocky structure parting to strong, <2-5 mm, subangular blocky peds; usually <2-20%, quartz or ironstone gravels, 2-20 mm; firm to very firm dry consistence; pH 6.0 to 8.5. Clear or gradual boundary to -
B1: (when present) Dark brown or dark red-brown (7.5YR 3/4, 4/3; 5YR 3/4, 4/3); light to medium clay texture; strong, 5 to 20 mm, subangular blocky structure; 2-20%, quartz or ironstone gravels, 2-20 mm; pH of 6.0 to 8.5. Gradual to -
B21: Dark brown, red-brown or dark red-brown (10YR 3/3; 7.5YR 3/4, 4/4; 5YR 4/4, 4/6); light medium clay or medium clay texture; strong, 5 to 20 mm, subangular blocky structure; <2-10%, quartz and ironstone gravels, 2-20 mm; occasionally <2-10%, soft or nodular calcium carbonate segregations, <2-6 mm; very firm to strong dry consistence; pH 7.0 to 8.5. Gradual to -
B22: Smilar to the B21, except usually dark brown or yellow-brown (10YR 3/3, 4/3, 5/6; 7.5YR 4/4, 4/6) as well as red-brown (5YR 3/4, 4/4, 4/6); occasionally 2-10%, dark, red or brown mottles, <5 mm; sometimes a moderate to strong, 5-20 mm, lenticular structure; 2-50%, soft or nodular calcium carbonate segregations, <2-20 mm; occasionally 2-10%, soft manganiferous segregations, < 2mm; pH 8.0 to 9.0. Gradual to -
B23: (when present) occasionally light grey-brown or light grey (2.5Y6/2; 5Y 7/1); 10-50%, red or brown mottles, <15 mm; otherwise the dark brown or red-brown subsoil continues to 1.5 m, and is mottled with few or common (2-20%), fine or medium (<5-15 mm), dark, brown or red mottles. The other properties are the same as for the B22.

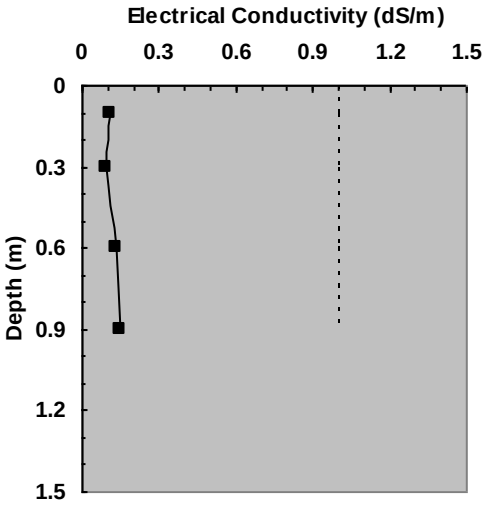
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	8.3	.11	.002	11	36	17	41	25	20	3.8	.14	1.5	5.3	.6	.33	.61
B_{21}	0.3	8.6	.09	.001	9	29	13	53	25	20	6.3	.18	1.0	3.2	.7	.35	.47
B_{22}	0.6	9.0	.13	.001	12	24	22	43	20	10	9.4	.26	.57	1.1	1	.43	.47
B_{23}	0.9	9.2	.15	.001	11	26	24	41	17	6.6	11	.38	.60	0.6	2	.58	.41

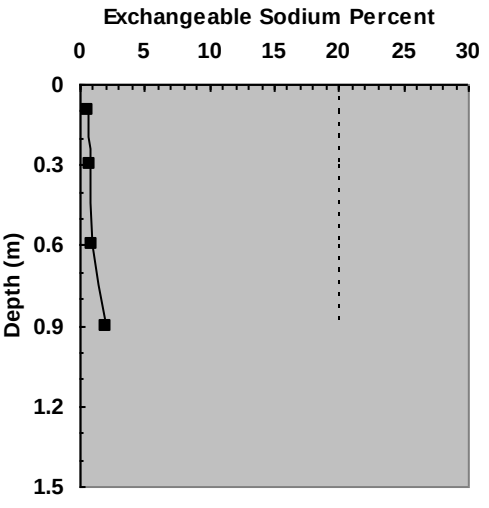
[(1)] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

The above table presents the soil analytical data for the Bonwell soil. The pH is typically alkaline throughout the profile. Bonwell has a high, uniform clay content (41-53%), and the level of high fine sand of the surface soil makes it prone to crusting. The CEC is only moderate throughout the profile (17-25 cmol[+] kg^{-1}) indicating a moderately weathered profile. The exchangeable cations are strongly calcium dominant in the upper 0.5 m, with the lower subsoil dominated by magnesium (Ca/Mg ratios 5.3-0.6) as the calcium content decreases significantly with depth. However Bonwell has a very low sodicity (ESP <1-2) so that it is structurally stable (low R1 dispersion ratios 0.3-0.5) and moderately well drained with low levels of subsoil salts indicating significant deep drainage (see salt graph below). The CEC:clay ratios of 0.4 to 0.6 indicate a mixed clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Bonwell has a very deep rooting depth of 1.5 m, as subsoil salinity and sodicity are very low and not limiting (see above graphs). However the clay content of 41% throughout most of the profile does limit the soil water holding capacity to some degree, compared to a soil with a higher clay content (e.g. see the Tognolini soil). As a result, Bonwell has a PAWC of only 120 mm. The salt graph shows also that there is significant deep drainage below the soil profile, as soluble salts have not accumulated in the subsoil (i.e. a "salt bulge is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	40	0.20	2.4	1.3	6	18	4.4
Range	25-59	.15-.28	1.7-3.8	-	3-13	13-22	3.3-7.4
No of samples	5	5	5	1	4	3	3
Rating	Very high	High	Moderate	High	Low	High	High

Bonwell has high surface soil fertility as the mean phosphorous content is very high (40 mg/kg), and the total nitrogen levels are always high. All other nutrients are high except for sulphur which is low (6 mg/kg). The organic carbon levels are moderate to high (1.7-3.8%), which is typical for brigalow and softwood scrub soils.

Bundalba (Bb)

Concept: Bundalba is a hard setting, shallow to moderately deep (0.5-1.0 m), brown, grey or black, sodic duplex soil with a 0.15-0.3 m thick, stony, clay loamy topsoil with a sporadically bleached subsurface, that overlies a sodic, mottled, columnar structured, medium clay subsoil. Bundalba has an alkaline soil reaction trend and is formed on acid volcanic rocks (tuff).

Geology: Little-weathered tuffs of the Devonian undifferentiated acid volcanic rocks (Du) and Permian Owl Gully volcanics (Plq).

Aust Class: Brown, Grey or Black Sodosol

PPF: Db1.33, Dy3.33, Dd1.33

Landform: Gently inclined footslopes of the undulating rises formed on the acid volcanic rocks of the Yarrol Basin, to the north-east of Jambin. The footslopes have slopes of 1 to 3% and always stand just above the floodplain and valley flats of the Don River or its tributaries

Vegetation: Tall (12-20 m) woodland of poplar box, occasionally with narrow or silver-leaved ironbark as an associated species. The understorey is sparse, with 2 to 4 m high widely spaced low trees or shrubs of canthium, whitewood and occasionally false sandalwood. The low quality native pastures consist mainly of pitted blue grass and wire grasses, with a minor component of forest blue grass and black spear grass.

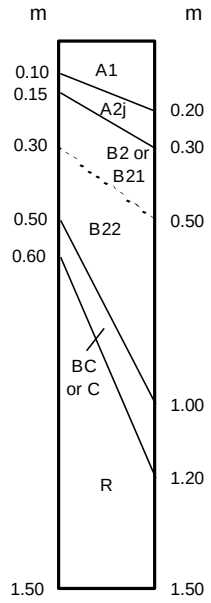
Runoff: Slow

Permeability: Slowly permeable

Drainage: Imperfectly drained

Surface cond: Hard setting, with 10-50%, gravels and cobbles of acid volcanic rock and occasional rock outcrop.

Profile Description



A1: Black, dark grey-brown or dark brown (10YR 2/1, 2/2, 3/2, 3/3, 4/2); fine sandy clay loam or clay loam, fine sandy texture; massive or weak, 2 to 5 mm, subangular blocky structure; 20-50%, tuff gravels, 2-60 mm; firm dry consistence; pH 6.0 to 7.5. Clear to –

A2j: Similar to A1 except dark grey brown or brown (10YR 4/2, 5/2, 5/3) with a white (10YR 8/1, 8/2) dry bleach colour; pH 6.0 to 7.0. Sharp or abrupt to –

B2 or B21: Black, dark brown, grey-brown or yellow-brown (10YR 2/1, 2/2, 3/3, 4/2, 5/4; 7.5YR 4/4); usually 20-50%,), brown, grey or yellow mottles, <5-30 mm; medium clay texture; strong, 100-500 mm, columnar structure often parting to moderate, 10-50 mm, lenticular structure; strong or very strong consistence; <2-10%, tuff gravels, 2-20 mm; pH 7.0 to 8.5. Clear or gradual to weathered tuff or a B22 –

B22: (when present) Dark brown or dark grey-brown (10YR 4/3, 4/2; 7.5YR 4/4, 5/6); medium clay; strong, 10-20 mm,, lenticular structure; 2-20%, soft calcium carbonate segregations, <2-20 mm; occasionally 2-10%, tuff gravels, 6-20 mm; strong or very strong consistence; pH 8.5 to 9.0. Abrupt to –

BC or C: The BC horizon has abundant (50-90%) weathered tuff with dark brown (7.5YR4/6), medium clay fragments amongst the weathered rock. The C horizons are composed entirely (>90%) of weathered rock and both these horizons are calcareous with 2-20%, soft calcium carbonate segregations, <2-20 mm; pH 8.5

R: Hard, unweathered bedrock

Soil Chemistry

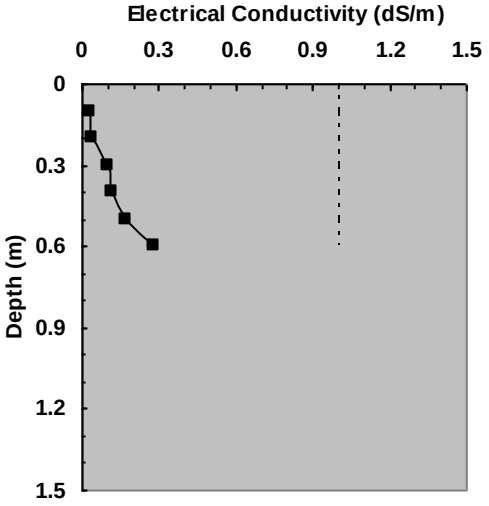
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.4	.03	.001	30	35	12	23	13	9.3	1.4	.05	.21	6.6	.4	.57	.56
A_{2j}	0.2	8.0	.04	.001													
B_{21}	0.3	8.6	.10	.002	11	11	7	68	30	15	10	2.2	.13	1.5	7	.47	.44
B_{21}	0.4	8.8	.12	.002	10	11	7	69	27	14	12	2.6	.13	1.2	10	.54	.39
B_{22}	0.5	8.9	.17	.003													
B_{22}	0.6	9.0	.28	.004	15	15	10	58	27	11	11	3.0	.11	1.0	11	.61	.47

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

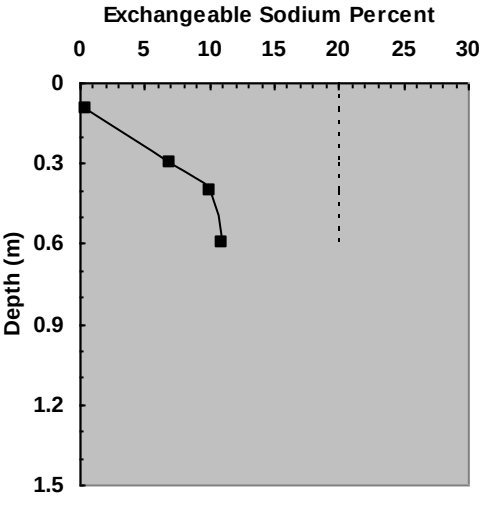
The above presents the analytical data for the Bundalba soil. Bundalba typically has a strongly alkaline subsoil. The surface soil has a moderate clay content (23%) and high level of fine sand (35%) that makes it prone to hard setting and crusting. There is a large increase in clay content in the subsoil (69%) showing the strong texture contrast. The topsoil CEC is moderate (13 cmol[+] kg^{-1}) and strongly calcium dominant. The subsoil has a high CEC (27 to 30 cmol[+] kg^{-1}) and calcium is at moderate contents and is the dominant or codominant cation (Ca/Mg ratios 1.5-1.0). The subsoil is also sodic (ESP 7-11) and dispersive (not reflected by the moderate R1 dispersion ratios 0.5-0.6) and therefore slowly permeable.

Deep drainage occurs on the shallower soils indicated by the low soluble salt content (<0.3 dS/m), but is minimal on the soils deeper than 0.6 m with high subsoil salt contents (see graph below). The subsoil CEC:clay ratios of 0.4 to 0.5 indicate a mixed clay mineralogy with significant illite.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Bundalba has rooting depth of 0.6 m that is restricted by either hard, unweathered bedrock for the shallower soils, or high subsoil salinity for the deeper profiles. Subsoil sodicity is only moderate and not limiting (see above graphs). The PAWC varies from 60 to 80 mm, depending on the thickness, and clay and stone content of the topsoil, and the depth of subsoil. The salt graph shows that for the deeper soils, there is minimal deep drainage as soluble salts increase to high levels.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	10	0.10	1.7	0.60	5	9.2	1.4
Range	6-13	.08-.13	1.5-2.0	0.4-.72	4-6	-	-
No of samples	6	6	6	6	6	1	1
Rating	Low	Low	Moderate	Moderate	Low	Moderate	Moderate

Bundalba has low surface soil fertility as both the mean phosphorous and nitrogen contents are low (10 mg/kg and 0.1% respectively). All other nutrients except for sulphur are moderate. The consistently low sulphur levels could affect seca stylo productivity and persistence on this soil. Organic carbon levels are only moderate which is typical for a eucalypt woodland soil.

Callide (Cd)

Concept: Callide is a hard setting and crusting, very deep (>1.5 m), black or brown, duplex or gradational soil, with a 0.1 to 0.35 m thick fine sandy or silty clay loamy topsoil that overlies a black or brown, fine sandy light medium to medium clay subsoil. Sandy buried soil materials are usually present below 0.3 m. Callide has a neutral or alkaline soil reaction trend.

Geology: Unconsolidated, Quaternary, alluvial sediments (Qa*)*

Aust Class: Black or Brown Chromosol or Dermosol

PPF: Gn3.42, Dd1.1, Db1.1, Dd3.12, Gn3.43

Landform: Levees of the main creek channels and relict prior stream channels, and nearby associated plains of the Callide alluvial plain. It is also found on some of the valley flats of the minor tributaries of the Callide creek and Don River.

Vegetation: Tall (12-20 m) open forest or woodland of a Moreton bay ash – silver-leaved ironbark association, with associates of forest red gum, poplar box and long-fruited bloodwood. The mid-stratum is dominated by closely spaced, 4 to 8 m high trees of sally wattle and occasionally other species such as white wood, white-flowered bauhinia and beef wood. The original native grass pastures are of high quality and consisted of forest blue and Queensland blue grass and black spear grass. However due to the high surface soil fertility these grasses have largely been replaced by introduced grasses such as green panic and buffel grass.

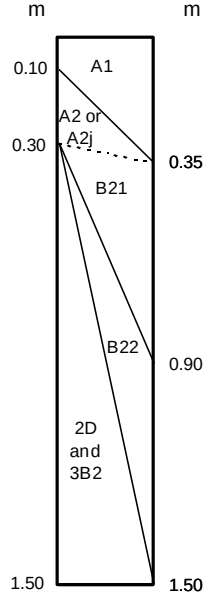
Runoff: Very slow

Permeability: Moderately permeable

Drainage: Well drained

Surface cond: Hard setting and crusting

Profile Description



Ap or A1: Black to very dark grey-brown (10YR 2/1, 2/2, 3/1, 3/2); fine sandy loam to silty or clay loam, fine sandy texture; massive or weak or moderate, 2 to 5 mm, subangular blocky structure; occasionally <2-10%, gravels, 2-20 mm; weak or firm dry consistence; pH 6.0 to 7.5. Abrupt or clear to -

A2 or A2j: (when present) Dark grey-brown to dark brown (10YR3/2, 4/2, 4/3), light grey (10YR 7/1, 7/2) dry bleach colour; fine sandy loam, fine sandy clay loam to clay loam, fine sandy texture; massive or weak, 2 to 10 mm, subangular blocky structure; pH 6.5 to 7.5. Abrupt or clear to -

B21: The subsoil either continues to 1.5 m or is underlain by buried soil materials below 0.3 m. Black to very dark grey-brown, or occasionally dark brown (10YR 2/1, 2/2, 3/1, 3/2, 3/3; 7.5YR 3/4); sometimes <2-20%, brown mottles, <5-15 mm; fine sandy or silty light clay to medium clay texture; strong, 5 to 20 mm, subangular blocky or prismatic structure; firm or very firm dry consistence; pH 6.5 to 8.5. Clear or gradual to -

B22: Commonly dark brown (10YR 3/3, 4/3; 7.5YR 3/4, 4/4), sometimes black to very dark grey-brown (10YR 2/1, 2/2, 3/2); otherwise similar to the upper subsoil except that it often has very few or few (<2-10%), soft or nodular calcium carbonate segregations, <2-6 mm. Sharp or abrupt to –

2D: (when present) Buried soil materials are highly variable in composition but are characterised by their sandy textures and browner colours (10YR 3/3, 4/3, 4/4) in comparison to the overlying subsoil. Textures vary from a coarse sand through to a sandy clay, and structure is single grain, massive, or weak to moderate subangular blocky or prismatic; can also be very gravely with 2-50%, rounded gravels, 2-20 mm; sometimes 2-20%, soft or nodular, calcium carbonate segregations; pH 7.0 to 8.5.

3B2: Buried subsoils are also sometimes present as a layer within the sandy D horizons. These materials are black to very dark grey-brown (10YR 2/1, 2/2, 3/2), light to medium clays; with a strong, subangular blocky, prismatic or occasionally lenticular structure; often mottled; usually <2-10%, calcium carbonate nodules, 2-6 mm.

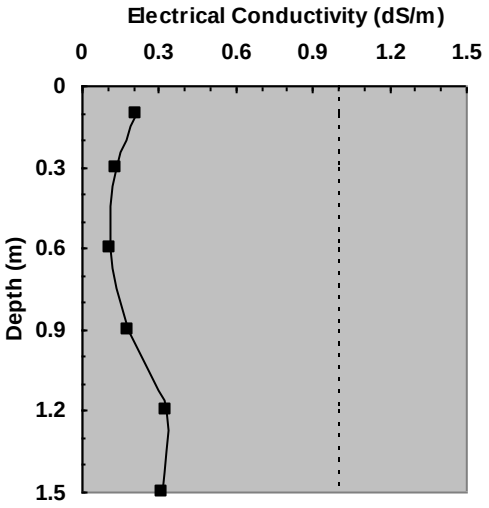
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_p	0.1	7.0	.21	.007	2	34	35	32	21[2]	14	6.0	.53	.22	2.3	2	.61	.66
B_{21}	0.3	7.5	.13	.003	2	35	30	40	24[2]	16	6.9	.80	.57	2.3	3	.54	.60
B_{22}	0.6	7.7	.11	.005	2	39	23	40	28	18	7.0	1.4	.26	2.6	5	.64	.70
B_{22}	0.9	7.8	.18	.014	10	43	19	33	25	17	6.4	1.0	.20	2.7	4	.56	.76
B_{23}	1.2	8.3	.33	.029	5	44	19	33	23	15	5.8	.80	.20	2.6	3		.70
2D	1.5	8.2	.31	.035													

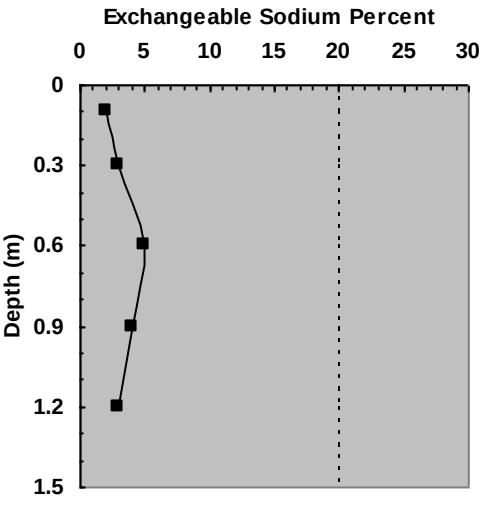
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

The above table presents the analytical data for the Callide soil. Typically Callide soil has a neutral surface and an alkaline subsoil. The surface soil has a moderate clay content (32%), but high levels of silt (35%) and fine sand (34%) which make the topsoil prone to crusting and surface sealing. There is only a slight increase in clay content to 40% in the upper subsoil which also has a high silt and fine sand content. The CEC is moderate throughout the profile CEC (21-28 cmol[+] kg^{-1}) and is dominated by calcium (Ca/Mg ratios 2-3), which is also at high levels (14 to 18 cmol[+] kg^{-1}). The subsoil is non-sodic (ESP 2-5) and is therefore structurally stable (R1 dispersion ratios inflated due to high fine sand and silt) and well drained with low levels of soluble salts due to significant deep drainage (see salt graph below). The CEC:clay ratios of 0.6 to 0.7 indicate a mixed clay mineralogy dominated by smectite clay minerals.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Callide has a rooting depth of 1.5 m, as subsoil salinity and sodicity are low and not limiting (see above graphs). A rooting depth of 1.5 m results in a PAWC of 120 mm. The water holding capacity is limited to some degree by the moderate profile clay content of 30 to 40%, and the presence of the buried sandy soil materials. The salt graph shows also that there is significant deep drainage below the soil profile as there is only a low salt concentration in the lower subsoil, indicating that salts are mainly leached by deep drainage.

Surface Soil Fertility

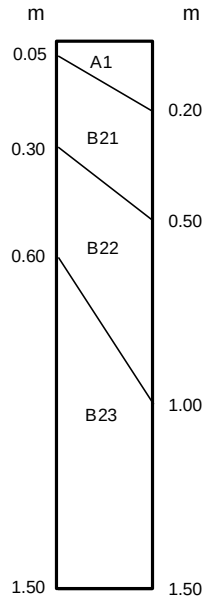
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	92	0.15	2.3	1.5	7	14	4.7
Range	52-140	.09-.22	1.6-3.3	-	2-22	11-19	3.8-6.5
No of samples	6	6	6	1	6	6	6
Rating	Very high	Moderate	Moderate	High	Moderate	Moderate	Moderate

Callide has a high surface soil fertility due to the very high mean phosphorous content (92 mg/kg) and moderate mean total nitrogen level of 0.15%. Phosphorous levels are always very high for Callide Valley alluvial soils. All other nutrients measured are moderate to high, indicating an overall high soil fertiltiy.

Caroline (Cl)

Concept: Caroline is a very deep (>1.5 m), black, non-cracking to weakly cracking clay soil with a thin, pedal topsoil overlying a strongly sodic and highly saline subsoil. Caroline has an alkaline soil reaction trend and is formed on unconsolidated Quaternary alluvium.
Geology: Unconsolidated, Quaternary, alluvial sediments (Qa).
Aust Class: Black Dermosol or Black Vertosol
PPF: Uf6.32
Landform: Level plains and backplains of the floodplain between the Don and Dee Rivers to the north of Rannes. The floodplain has slopes that are less than 1%, with a relief of only 1 to 3 m.
Vegetation: Tall (12-20 m) coolibah woodland, which occasionally has forest red gum or poplar box as associated species, with a closely spaced, 4 to 8 m high understorey of sally wattle. Occasionally other species such as red and white-flowered bauhinia and myrtle tree are also present in the mid-stratum. The native grass pastures are dominated by black spear grass and forest blue grass, with curly windmill grass, *Sporobolus spp,.* and wire grasses (*Aristida spp.)* present also in the wetter areas.
Runoff: Very slow
Permeability: Slowly permeable
Drainage: Imperfectly drained
Surface cond: Firm, occasionally with a surface flake and weakly cracking

Profile Description



A1: Black to very dark grey-brown (10YR 2/1, 2/2, 3/2); silty light medium or medium clay texture; strong, 5 to 10 mm, subangular blocky structure that sometimes parts to a strong, 2 to 5 mm, subangular blocky primary structure; firm or very firm dry consistence; pH 6.0 to 7.0. Clear or gradual to -

B21: Black to very dark grey-brown (10YR 2/1, 3/1, 3/2); silty light medium or medium clay texture; strong, 5 to 20mm, subangular or angular blocky structure; strong dry consistence; pH 6.5 to 8.5. Gradual to -

B22: Similar to B21 except that sometimes 2-20%, calcium carbonate concretions, 2-20 mm, and occasionally develops a strong, 2 to 5 mm, lenticular structure; pH 8.0 to 8.5. Gradual to -

B23: Black to very dark grey-brown (10YR 2/1, 2/2, 3/1, 3/2) or occasionally dark brown (10YR 3/3, 4/3); sometimes <2-10%, brown mottles, <5-15 mm; fine sandy or silty light to medium clay texture; strong, 2 to 10mm, lenticular or 10 to 50 mm, prismatic or angular blocky structure parting to 5-10 mm, angular blocky primary structure; <2-10%, soft or concretionary calcium carbonate segregations, <2-6 mm; strong dry consistence; pH 8.0 to 8.5.

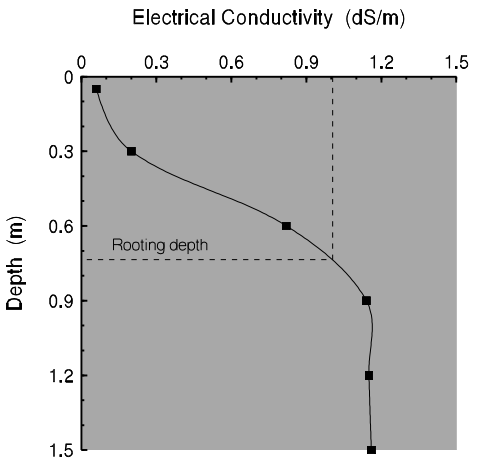
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.7	.18	.003	4	14	40	42	27[2]	15	10	.69	.70	1.5	3	.54	.64
B_{21}	0.3	7.7	.42	.031	2	11	30	56	40[2]	22	15	2.7	.23	1.5	7	.56	.71
B_{22}	0.6	8.1	1.5	.182	2	11	28	57	43	20	17	6.0	.19	1.2	14	-	.75
B_{22}	0.9	8.1	1.7	.208	2	12	30	56	46[2]	20	18	8.1	.17	1.1	18	.71	.82
B_{23}	1.2	8.0	1.7	.221	1	13	30	55	45[2]	19	18	8.2	.20	1.1	18		.82
B_{23}	1.5	8.1	1.8	.223													

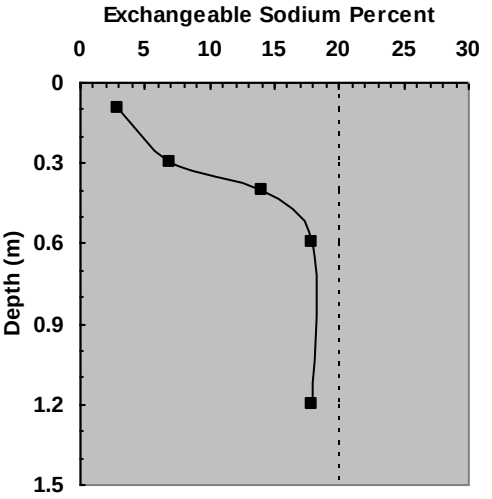
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

The above table presents the analytical data for the Caroline soil. Typically Caroline has a neutral surface soil and alkaline subsoil. Caroline has a high clay content throughout the profile (42-57%) and typically for alluvial soils a high level of silt (30-40%). The CEC is high also throughout the profile (27-46 cmol[+] kg^{-1}) and is dominated by calcium (Ca/Mg ratios 1.5-1.1) which is also at high contents (15-22 cmol[+] kg^{-1}). The subsoil is sodic to strongly sodic (ESP of 7-18) and therefore highly dispersive (R1 dispersions ratios 0.7-0.8) with impeded drainage that causes soluble salts to accumulate to high levels due to restricted deep drainage (see salt graph below). The CEC:clay ratios of 0.64 to 0.82 indicate a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

The Caroline soil has a rooting depth of 0.75 m that is limited by the high subsoil soluble salt content (≥1.0 dS/m). Subsoil sodicity is also high but not limiting. A rooting depth of 0.75 m results in a PAWC of 110 mm. The salt graph shows also that the salt concentration reaches equilibrium at 0.9 m, due to impeded subsoil drainage, which indicates the long-term average depth of wetting and water uptake.

Surface Soil Fertility

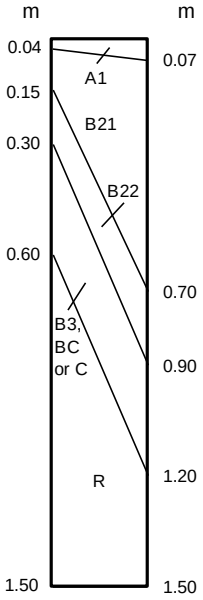
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Nutrient content	105	0.21	3.2	1.0	14	10
No of samples	1	1	1	1	1	1
Rating	Very high	Very high	High	Moderate	Moderate	High

Although limited by the low number of samples, Caroline has a very high surface soil fertility as typically for Callide Valley alluvial soils, Caroline has a very high phosphorous content. Total nitrogen is unusually also very high. Total nitrogen concentrations for alluvial clay soils are normally aound 0.12 to 0.15%. All other nutrients measured are moderate or high.

Clancy (Cc)

Concept: Clancy is a shallow to moderately deep (0.3-0.9 m), black, very coarse self-mulching, strongly cracking clay soil with an alkaline soil reaction trend.
Geology: Little-weathered, Tertiary olivine basalt (Tb)
Aust Class: Black Vertosol
PPF: Ug5.12
Landform: Crests and hillslopes of gently undulating rises with slopes of 0.5 to 3% and a relief of 10 to 20 m. Clancy is often associated with Annandale, a similar cracking clay with softwood scrub vegetation and a finer self-mulching topsoil.
Vegetation: Open downs vegetation that consists of isolated trees of either gum-topped bloodwood and silver-leaved ironbark or occasionally isolated clumps of red or white-flowered bauhinia and narrow and broad-leaved bottle trees, and grasslands of Queensland blue grass, black spear grass and forest blue grass, occasionally with a minor component of Flinders grass.
Runoff: Very slow to slow
Permeability: Slowly permeable
Drainage: Moderately well drained
Surface cond: Coarse self-mulching (peds 2-5 mm), and strongly cracking, <2-20%, gravels and cobbles of basalt

Profile Description



A1: Black (10YR 2/1); medium heavy or heavy clay texture; moderate, 5-10 mm, polyhedral parting to strong <2 to 5 mm, polyhedral structure; loose dry consistence; rarely <2%, basalt or quartz gravels, 2-6 mm; pH 6.5 to 7.5. Abrupt to -

B2 or B21: Black or very dark grey (10YR 2/1, 3/1); medium heavy or heavy clay texture; strong, 5 to 10 mm, lenticular structure parting to <2 to 5 mm lenticular; few slickensides; very firm dry consistence; usually <2-10%, quartz or basalt gravels, 20-20 mm; sometimes <2-20%, calcium carbonate nodules, <2-6 mm; pH 7.0 to 8.5. Clear to a B22, B3, BC or C -

B22: Similar to B2 except that it stonier with 2-20%, basalt gravels, 6-20 mm; usually <2-10%, carbonate nodules, 2-6 mm. pH 8.0 to 8.5. Clear to -

B3 or BC: The subsoil either grades into a B3 or BC horizon or directly overlies a C horizon which is soft, weathered basalt; often 2-20%, soft or nodular carbonate segregations, 2 to 20 mm in size The B3 and BC horizons are black or very dark grey (10YR 2/1, 3/1); light medium or medium clay; weak or moderate, 2 to 5 mm lenticular structure or massive; 20-90%, weathered basalt coarse fragments, 6-200 mm; 2-20%, soft or nodular carbonate segregations, 2-20 mm. Abrupt or clear to -

R: Hard, unweathered bedrock

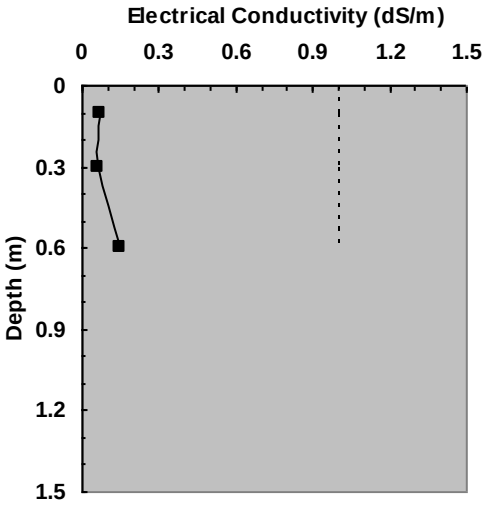
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.1	.07	.001	3	7	12	78	78	46	29	.38	.62	1.6	0.5	.45	1.0
B_{21}	0.3	7.5	.06	.001	3	7	12	78	82	49	31	.66	.36	1.6	0.8	.45	1.1
B_{22}	0.6	8.2	.15	.007	3	7	11	76	85	50	31	.94	.31	1.6	1	.46	1.1

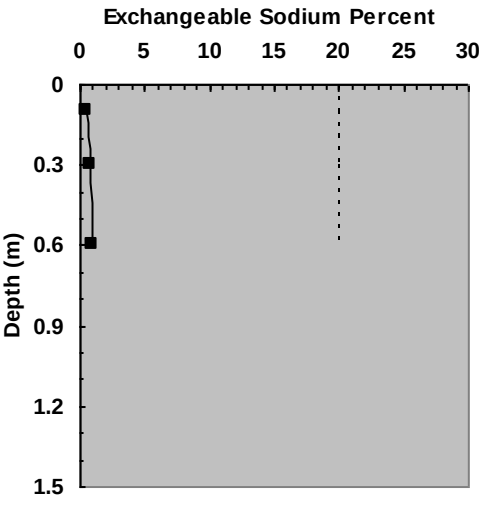
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

The above table presents the analytical data for the Clancy soil. Clancy typically has a neutral surface soil and alkaline subsoil. Typically for basalt soils, the clay content is very high (76-78%) with very little sand. It has also an extremely high CEC throughout the profile (78-85 cmol[+] kg^{-1}) that is dominated by calcium (Ca/Mg ratio 1.6), which is also at very high contents (46-50 cmol[+] kg^{-1}). Clancy has a very low sodicity (ESP ≤1) and is therefore structurally stable (low R1 dispersion ratio 0.45) and well drained with a very low soluble salt content due to significant deep drainage (see salt graph below). The CEC:clay ratios of 1.0 to 1.1 indicate a pure smectite clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

The Clancy soil has a rooting depth range of 0.6 to 1.2 m that is restricted only by the presence of hard, unweathered bedrock, as subsoil salinity and sodicity are very low and not limiting (see above graphs). This results in a PAWC that varies from 95 mm to 180 mm. The extremely high clay content of Clancy gives it a high water holding capacity per unit depth of soil. The salt graph shows also that there is significant deep drainage below the soil profile, as soluble salts have not accumulated in the subsoil (i.e. a salt bulge is absent).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	23	0.10	1.6	0.56	6	50	21
Range	8-48	.06-.21	1.1-2.7	.30-.95	4-9	41-61	17-26
No of samples	8	8	8	6	7	2	2
Rating	High	Low	Moderate	Moderate	Low	Very high	Very high

The above table summarises the surface soil fertility data for the Clancy soil. Clancy has a moderate surface soil fertility as it has a high mean phosphorous content (23 mg/kg), but generally only low levels of total nitrogen with a mean of 0.10%. Organic carbon levels are also only low to moderate as it has a grassland vegetation. The Annandale soil with softwood scrub vegetation has a significantly higher organic carbon (2.6%) and total nitrogen (0.21%). The higher levels of organic matter also promote a finer self-mulching surface soil. All other nutrients except sulfur, which is low, are moderate or very high.

Collins (Cn)

Concept: Collins is a very deep (>1.5 m), hard setting or firm surfaced, grey or brown, sodic duplex soil with a very thick (0.5-0.9 m), sandy or sandy loam topsoil with a conspicuously bleached A2 horizon. The topsoil overlies a dense, grey or brown, mottled fine sandy light clay subsoil. Collins has an acid to slightly alkaline soil reaction trend.

Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza)

Aust Class: Grey or Brown Sodosol

PPF: Dy3.42, Dy3.41, Dy5.4

Landform: Fringing apron or fan, only some 300 to 700 m in width, around the base or part of the base, of some of the Tertiary sandstone plateaus in the Callide Valley, with slopes of 1 to 7%. The sandy outwash from the erosion of these plateaus has been deposited close to the plateaus thus forming this thick sandy-surfaced, duplex soil. The fringing aprons represent slightly steeper upper slopes of the undulating plains or rises formed on the unconsolidated Cainozoic sediments that surround the Tertiary plateaus.

Vegetation: Either a mid-high (6-12 m), closed forest of softwood scrub or an open forest of a brigalow – coowarra box (Dawson gum) association. The softwood scrub consists of species such as narrow and broad-leaved bottle trees, crow's ash, coowarra box and brigalow as emergents with wilga, *Croton spp.*, *Canthium spp.* and scrub ironbark in the upper stratum. The main understorey species of the brigalow – coowarra box association are wilga, sandalwood, soap bush, lime bush, holly bush and currant bush with holly bush, currant bush and wallaby bush most common in the shrub layer of the softwood scrubs. The lower stratum had originally sparse brigalow grasses, such as *Paspalidium spp.*, with curly windmill grass and fairy grasses (*Sporobolus spp.*) as well as various sedges (*Cyperus gracilis)*.

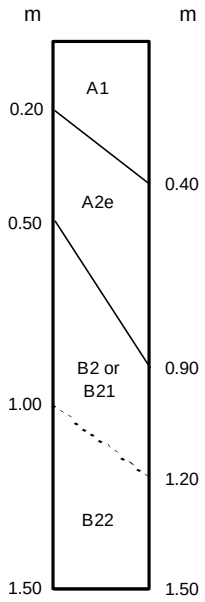
Runoff: Moderately rapid

Permeability: Slowly permeable

Drainage: Moderately well drained

Surface cond: Hard setting, or firm to soft for very sandy topsoils, usually with <2-20% quartz gravels.

Profile Description



A1: Dark brown (10YR 3/3, 4/3; 7.5YR 3/3); loamy fine sand, sandy loam or occasionally sandy clay loam texture; single grain structure (sands) or massive; 2-90%, quartz gravels, 2-20 mm; loose to weak consistence; pH 6.0 to 7.0. Clear to –

A2e: Grey-brown, grey-brown, brown or light brown-grey (10YR 4/2, 5/2, 5/3, 6/2), very pale brown or white dry colour (10YR 7/3, 8/1, 8/2); fine sand, sand or sandy loam texture; massive structure; very weak to firm consistence; usually 2-50%, quartz and sandstone gravels and cobbles, 2-200 mm; sometimes <2-20%, ferruginous nodules, 2-20mm; pH 5.0 to 7.0. Sharp or abrupt to –

B2 or B21: Dark grey to light grey-brown, or occasionally brown to yellow-brown (10YR 4/1, 5/2, 5/4, 5/8, 6/1, 6/2; 2.5Y 5/2); 20-50%, orange, brown, grey or red mottles, 5-30 mm; fine sandy light or light medium clay texture; strong, 100-500mm, prismatic or occasionally columnar structure, sometimes parting to weak or moderate 20-50 mm, angular or subangular blocky primary structure; very strong dry consistence; usually 2-20%, quartz or sandstone gravels, 2-20 mm; occasionally <2-10%, ferruginous nodules, 2-6 mm; pH 5.0-8.0. Gradual to –

B22: (when present) The B22 is similar to the B21, except that the structure is prismatic, sometimes parting to 5 to 10 mm, lenticular primary peds.

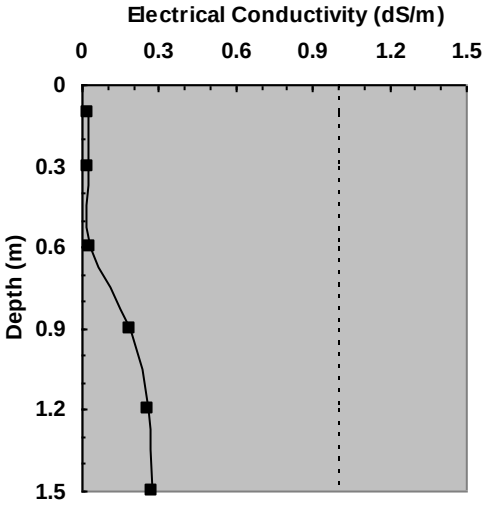
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.7	.02	.001	35	50	6	9	3[2]	1.5	.65	.06	.46	2.3			
A_1	0.3	7.5	.02	.001	30	53	8	9	3[2]	2.0	.54	.01	.44	3.7			
A_{2e}	0.6	7.6	.03	.002	34	54	6	6	4	2.0	.57	.01	.22	3.5			
B_2	0.9	8.0	.19	.018	22	42	7	27	10	4.7	3.0	.86	.47	1.6	9	.54	.37
B_2	1.2	8.2	.26	.025	19	41	7	34	11	4.4	3.9	1.4	.54	1.1	13		.32
B_2	1.4	8.3	.27	.026													

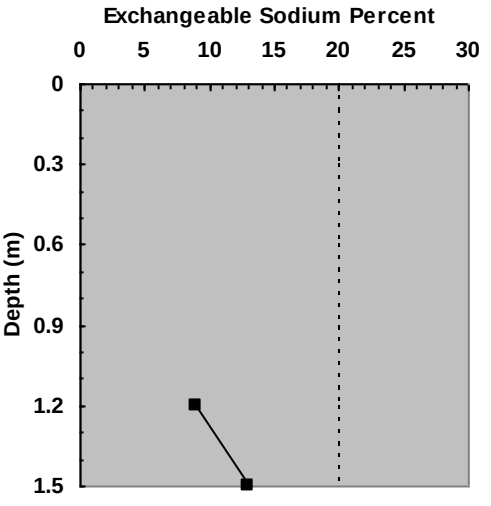
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Collins typically has a neutral topsoil and a slightly alkaline subsoil. The topsoil is very sandy with only 6-9% of clay, with a significant increase in clay content in the subsoil (27-34% - the particle size method underestimates the clay content of subsoils that have a high proportion of kaolinite) showing the texture contrast. The sandy topsoil has a low CEC (3 to 4 cmol[+] kg^{-1}) due to its low clay content, with low calcium and magnesium contents. The subsoil CEC is only moderate (10 to 11 cmol[+] kg^{-1}) indicating a weathered soil. The subsoil calcium content is low (4 cmol[+] kg^{-1}) and only dominant over magnesium (Ca/Mg ratios 1.1-1.6). The subsoil is also sodic (ESP 9-13) and therefore dispersive (not reflected by the R1 dispersion ratio) and slowly permeable, though there is still significant deep drainage as soluble salt contents are low (see salt graph below). The subsoil CEC:clay ratios 0.3 to 0.4 indicate a kaolinite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Collins has a rooting depth of 0.5 to 0.9 m that is limited by the dense subsoil. Even though subsoil salinity and sodicity are low, it is felt that the coarse primary structure and tough consistence of the subsoil prevents root penetration. Collins therefore has a PAWC that varies from 55 mm to 90 mm for these rooting depths. The thick sandy topsoil, which has a low water holding capacity, reduces the water holding capacity significantly compared to a surface soil with a higher clay content. The salt graph shows also that significant deep drainage below the soil profile occurs, despite the tough, dense subsoil, as the salt content is low throughout the profile and only reaches equilibrium at low concentrations (i.e. only a small "salt bulge" is present due to the leaching of salts by deep drainage).

Surface Soil Fertility

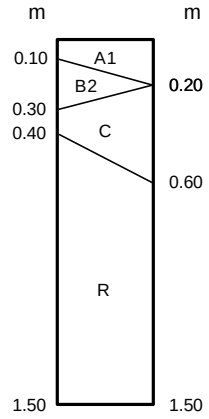
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	37	0.08	1.2	0.49	6	1.5	0.65
Range	12-169	.03-.13	.49-1.7	-	2-25	-	-
No of samples	6	6	6	1	6	1	1
Rating	Very high	Low	Low	Moderate	Low	Low	Low

The data for most nutrients is quite variable as indicated by the wide range of values. The surface soil fertility for Collins is rated as moderate to high as the phosphorous content is always high to very high, with a mean of 42 mg/kg. The very high level of 169 mg/kg is atypical for Collins as the next highest level is 57 mg/kg with most sites being between 12 and 57 mg/kg. Total nitrogen however is low, due to the sandy topsoil, with a mean of 0.08%, and with one very low level of 0.03%. Organic carbon levels are also low, with a mean of 1.2%, as organic matter tends to break down more rapidly in sandy topsoils. The mean sulphur content is also low (6 mg/kg), however two of the sites had very high levels of 16 and 25 mg/kg, once again demonstrating the variability in the Surface Soil Fertility. Potassium, calcium and magnesium were only measured at the one site, with calcium and magnesium at low levels, while potassium is at a moderate content.

Cooper (Cp)

Concept: Cooper is a shallow (0.15-0.3 m), stony, brown, uniform clay loamy soil with a neutral soil reaction trend that is formed on rhyolite or quartz porphyry.
Geology: Little weathered, Cretaceous, acid intrusive rocks - rhyolite and quartz porphyry (Ki).
Aust Class: Brown Kandosol
PPF: Um5.51
Landform: Steep, strongly dissected hillslopes of the steep hill of Mt. Cooper. Gradients vary from 10% on the lower slopes, to 35 to 50% on the steeper mid and upper slopes. The crests are rounded with more gentle slopes of 2 to 5%. Mt. Cooper has a relief 160 to 180 m and covers an area of 963 ha.
Vegetation: On the north-facing slopes of Mt Cooper, the vegetation consists of a narrow-leaved ironbark – gum-topped bloodwood woodland with a sparse understorey of shrubs such as pretty wattle, Leicharrdt bean and soap tree. The native grasses consist mainly of a *Themeda spp*. and kangaroo grass. The south-facing slopes however have a different more shrubby vegetation that consists of a narrow-leaved ironbark woodland with a dense, overlapping shrub layer of wallaby apple, *Jasminum simplicifolium* and *Oleoria canescens.* As a result the grasses are quite sparse and consist mainly of *Aristida* and *Enneapogon spp*.
Runoff: Rapid
Permeability: Highly permeable
Drainage: Well drained
Surface cond: Firm, with 2-10% rock outcrop and 20-50% gravels, cobbles and stones of ryholite, 2-600 mm

Profile Description



A1: Dark brown (7.5YR 2/2, 3/2); fine sandy clay loam or clay loam texture; massive or weak, 2 to 5 mm, subangular blocky structure; 50-90%, angular, rhyolite gravels and cobbles, 2-200 mm; weak dry consistence; pH 6.0 to 7.5. Gradual to -

B2: Dark brown (7.5YR 3/3, 3/4); clay loam; massive or weak, 2 to 10 mm, subangular blocky or polyhedral structure; 50-90%, rhyolite gravels to stones 2-600mm; weak dry consistence; pH 6.5 to 7.5. Occasionally the topsoil directly overlies the C horizon. Clear to -

C: Weathered rhyolite; non-calcareous.

R: Hard, unweathered rhyolite

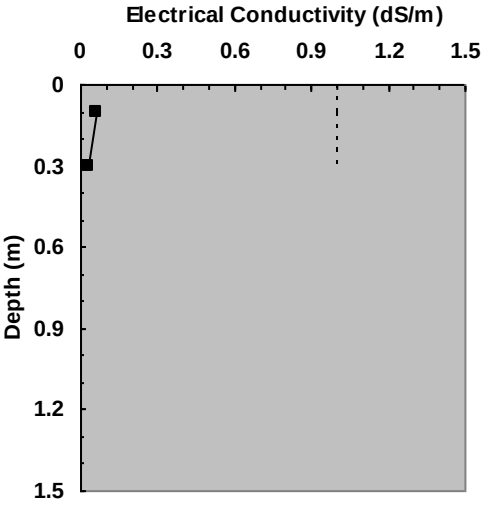
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio
A_1	0.1	7.5	.06	.001	29	35	20	22	15	12	2.0	.05	1.2	6.0
B_2	0.3	7.5	.03	.001	22	42	19	22	12	9.4	2.2	.08	.54	4.3

[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 ECEC= Ca + Mg + Na +K

Cooper has a moderate clay content of 22% in both the surface soil and subsoil, while fine sand dominates the particle sizes (35-42%). The CEC and calcium contents are moderate (12-15 and 12-9.4 cmol[+] kg^{-1}respectively), and calcium is highly dominant over magnesium (Ca/Mg ratios of 4-6). Cooper is freely draining with very low levels of soluble salts (0.03-0.06 dS/m). The ESP, dispersion and CEC:clay ratio are not reported as they are not considered relevant at a clay content of only 22%.

Plant Available Water capacity



Mean profile salt graph

Cooper has a rooting depth of only 0.4 to 0.6 m that is limited only by hard unweathered bedrock as profile salinity and sodicity are negligible (see above graph). The PAWC varies from only 20 to 35 mm for these rooting depths. The high stone content also significantly reduces the water holding capacity. The very low salt level throughout the profile indicates that nearly all water that infiltrates this soil is lost to deep drainage, as it is freely draining with a low water holding capacity. The salt profile is therefore typical of a recharge soil.

Surface Soil Fertility

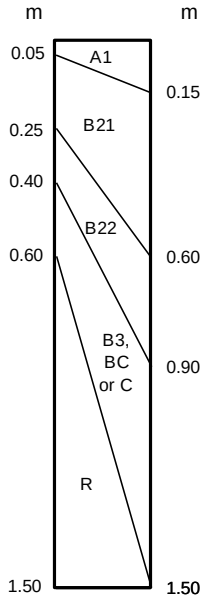
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Level	46	0.09	2.0	0.98	12	2.0
No of samples	1	1	1	1	1	1
Rating	Very high	Low	Moderate	Moderate	Moderate	Moderate

The surface soil fertility for the Cooper soil was measured only from the one site. This shows that Cooper has a moderate surface soil fertility as it has a very high phosphorous level of 46 mg/kg, but only a low total nitrogen content of 0.09%. All other nutrients are at moderate levels.

Cottonham (Ch)

Concept: Cottonham is a moderately deep to deep (0.6-1.5 m), very fine self-mulching, red or brown cracking clay soil with an alkaline soil reaction trend that is formed on folded, Permian mudstones.
Geology: Little weathered, folded, Permian mudstones of the Back Creek Group (Pb and Puf), the Gyranda Formation (Puy) and Rannes Beds (Pw) of the Bowen Basin.
Aust Class: Red or Brown Vertosol
PPF: Ug5.32, Ug5.37
Landform: Crests and hillslopes of gently undulating to undulating rises formed on the folded, Permian sedimentary rocks with slopes of 1 to 4% and a relief of 10 to 20 m. Cottenham is found mainly between the Fairview road and Banana-Baralaba roads to the north and north-west of the Banana township.
Vegetation: Tall (12-20 m), open brigalow or brigalow-belah forest or woodland.
Runoff: Moderately rapid
Permeability: Slowly permeable
Drainage: Moderately well drained
Surface cond: Very fine self-mulching (peds <1 mm) and periodic cracking, with <2-50%, gravels and cobbles of mudstone and quartz

Profile Description



A1: Dark red-brown or dark brown (5YR 3/2; 7.5YR3/2, 3/3; 10YR 3/3); light to medium clay; weak to strong, 2 to 5 mm, granular or subangular blocky structure parting to very fine (<1 mm), granular peds; loose dry consistence; <2-20%, quartz or mudstone gravels, 2-20 mm; pH of 6.5 to 8.5. Abrupt to -

B21: Dark red-brown, red-brown or dark brown (5YR 3/3, 3/4, 4/4; 7.5YR 3/4, 4/4); light medium or medium clay; strong, 2-5 mm, lenticular structure; very firm or strong dry consistence; <2-10%, quartz or mudstone gravels, 2-20 mm; sometimes 2-10%, calcareous nodules, 2-6 mm or calcareous; pH 6.5 to 8.5. Clear or gradual to -

B22: Similar to B21, except always calcareous with <2-20%, soft or nodular carbonate segregations, <2-6 mm; strong, 2 to 10 mm, lenticular structure; pH 8.0 to 8.5. Clear or gradual to -

B3, BC or C: The B3 horizon is a yellow-red or strong brown (5YR 4/6; 7.5YR 4/6, 5/6), light clay while the BC is usually a yellow-brown (10YR 6/4), light clay, both horizons have 20-90%, weathered mudstone fragments; and 2-50%, soft or nodular, carbonate segregations. The C horizon consists entirely of a calcareous, weathered mudstone.

R: Hard, unweathered mudstone.

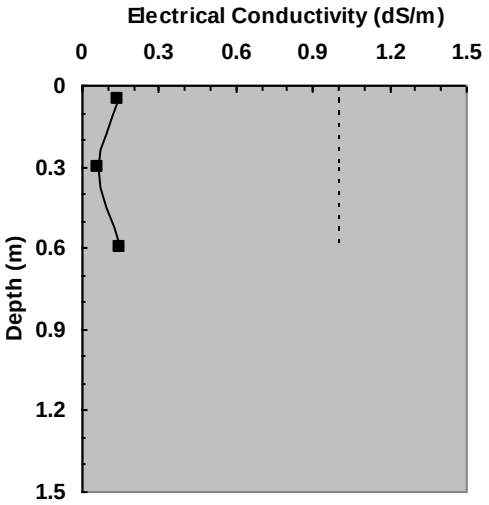
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.05	7.7	.14	.002	10	27	19	43	29	20	4.0	.13	2.6	5.0	0.4	.28	.67
B_{21}	0.3	7.9	.06	.001	5	21	17	60	29	20	4.4	.30	.90	4.5	1	.33	.48
B_{22}	0.6	8.8	.15	.001	16	20	23	45	21[2]	14	5.3	.71	.30	2.6	3	.38	.47

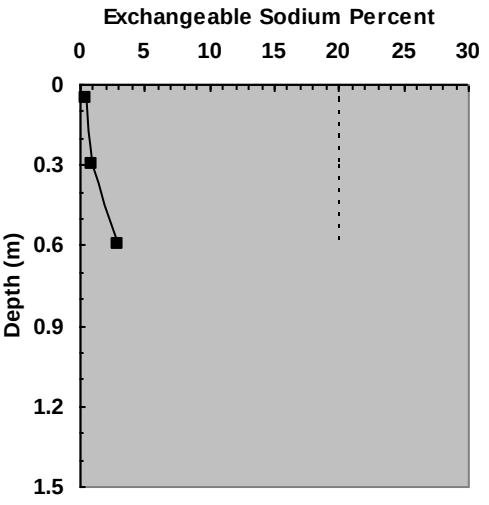
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Cottonham has a high to very high clay content (43-60%), but only a moderate CEC of 21-29 cmol[+] kg^{-1}, indicating a moderately weathered soil. The calcium content is high (14-20 cmol[+] kg^{-1}) and is strongly dominant over magnesium with Ca/Mg ratios of 2.6 to 5. The subsoil is also non-sodic (ESP 1-3), and is therefore structurally stable and well drained as indicated by the low soluble salt content (0.06-0.15 dS/m) and low dispersion ratios (0.28-0.38). The CEC:clay ratios of 0.5-0.7 indicate a mixed clay mineralogy that is smectite dominant.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Cottonham has a rooting depth range that varies from 0.6 to 1.5 m, that is limited only by hard, unweathered bedrock as subsoil salinity and sodicity are low and not limiting (see above graphs). These rooting depths result in a PAWC that varies from 75 mm to 135 mm. The salt graph shows also that there is significant deep drainage below the soil profile, as soluble salts have not accumulated in the subsoil (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	64	0.23	2.8	1.8	4	24	5.1
Range	32-161	.18-.28	2.2-3.2	1.8-1.8	4-5	19-31	3.9-7.9
No of samples	4	4	4	2	2	3	3
Rating	Very high	Very high	High	High	Low	High	Moderate

The above table shows that Cottonham has a very high surface soil fertility as the mean phosphorous and total nitrogen contents are both at very high levels of 64 mg/kg and 0.23% respectively. The phosphorous results are variable, with a wide range, however all the results are in the high to very high range so that the mean is representative. Organic carbon levels are also high, which again demonstrates the effect of the higher biomass of brigalow or softwood scrub vegetation on the accumulation of organic matter and nitrogen in the topsoil. The other nutrients are mainly high except for sulfur which is low, but it was only measured from two sites.

Desdemona (Dd)

Concept: Desdemona is a very deep (>1.5 m), brown, sodic duplex soil with a thick to very thick (0.4-0.9 m), sandy topsoil that has a sporadically bleached A2 horizon. The topsoil overlies a brown, sometimes mottled, fine sandy light or light medium clay subsoil with a coarse prismatic structure. Desdemona has a neutral soil reaction trend.

Geology: Unconsolidated, Cainozoic, alluvial or colluvial sediments (Cza)

Aust Class: Brown Sodosol

PPF: Db4.32, Dy4.32

Landform: Gently undulating plains and rises formed on alluvial-colluvial outwash from the erosion of the Tertiary land surface, with slopes of 0.5 to 3%, and a relief of 5 to 15 m. Desdemona occurs mainly to the north of Jambin, on the eastern side of the Callide Creek floodplain.

Vegetation: Tall (12-20 m), narrow-leaved ironbark woodland, sometimes with gum-topped box and poplar box as associated species. The understorey consists of close to widely spaced low trees (3-6 m) and shrubs (<3 m) of soap bush, quinine berry, currant bush and wait-a-while. The native grass pastures consist of white spear grass, other wire grasses (*Aristida spp.*), barbed wire grass with a minor component of black spear grass.

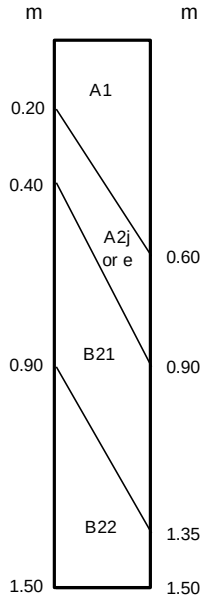
Runoff: Slow

Permeability: Slowly permeable

Drainage: Imperfectlt drained

Surface cond: Usually firm, or occasionally hard setting for some sandy loam topsoils, with <2-10%, gravels of quartz and ferruginous siltstones

Profile Description



A1: Dark brown (7.5YR 3/4; 10YR 3/3, 3/4); fine sand, sand or fine sandy loam texture; massive or weak, 5 to 10 mm, platy structure; very weak to firm dry consistence; occasionally <2-10%, quartz or ferruginous siltstone gravels, 2-20 mm; pH 6.0 to 7.0. Clear to -

A2,j or e: Dark yellow-brown or yellow-brown (10YR 4/4, 5/4), with a very pale brown or white (10YR 7/4, 8/1, 8/2), dry colour; course sand, fine sandy loam or fine sandy clay loam texture; massive structure; firm dry consistence; sometimes 2-20%, quartz or ferruginous siltstone gravels 2-20 mm and <2-50%, ferruginous, manganiferous or ferromanganiferous nodules, 2-20 mm, often in a band directly overlying the subsoil; pH 6.5 to 7.5. Sharp or abrupt to -

B21: Dark brown, yellow-brown or grey-brown (7.5YR4/4, 4/6; 10YR 5/6; 2.5Y 6/2), sometimes with 2-50%, brown, grey or dark mottles, <5-15 mm; fine sandy light or light medium clay texture; strong, 50 to 100 mm, prismatic structure; parting to strong 10 to 20 mm, angular blocky primary peds; very firm or strong dry consistence; occasionally <2-10%, quartz or ironstone gravels, 2-20 mm; usually <2-10%, ferruginous nodules or soft manganiferous segregations, <2-6 mm; pH 7.0 to 8.0. Gradual to -

B22: Yellow-brown or grey-brown (10YR5/4, 5/6, 5/8; 2.5Y 6/2), with 10-50%, red, brown or grey mottles, 5-30 mm; light medium clay, or coarse sandy light or light medium clay texture; strong, 20-50 mm, prismatic structure parting to strong, 10-50 mm, angular or subangular blocky primary peds; very firm or strong dry consistence; 2-20%, soft calcium carbonate or manganiferous segregations, <2-6 mm; pH 6.5 to 8.0.

Soil Chemistry

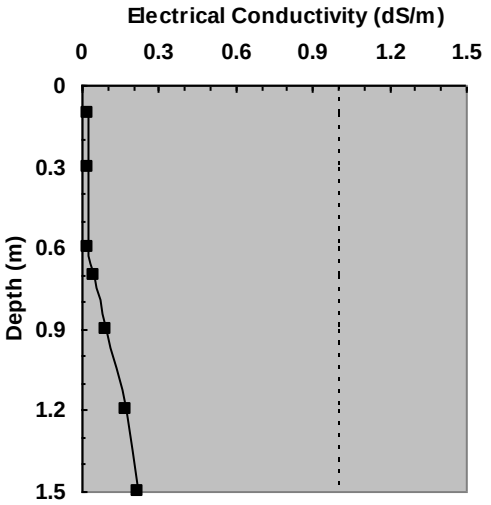
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.6	.02	.001	34	40	10	16	4[2]	3.2	.93	.01	.16	3.4	na	.na	n/a
A_1	0.3	7.2	.02	.002	33	39	13	16	5[2]	4.1	.86	.01	.05	4.8	na	.na	n/a
A_{2j}	0.6	7.5	.02	.001	33	40	13	17	3[2]	1.5	1.1	.03	.02	1.4	na	.na	n/a
B_{21}	0.7	8.1	.05	.003	22	26	10	43	8	2.3	3.2	.76	.05	0.7	10	.35	.19
B_{21}	0.9	8.1	.09	.007	20	20	7	54	13	5.4	4.9	1.6	.18	1.1	12	.56	.24
B_{21}	1.2	7.4	.17	.014	37	9	3	50	12	3.5	4.8	2.1	.04	0.7	18	-	.24
B_{22}	1.5	6.4	.22	.019													

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

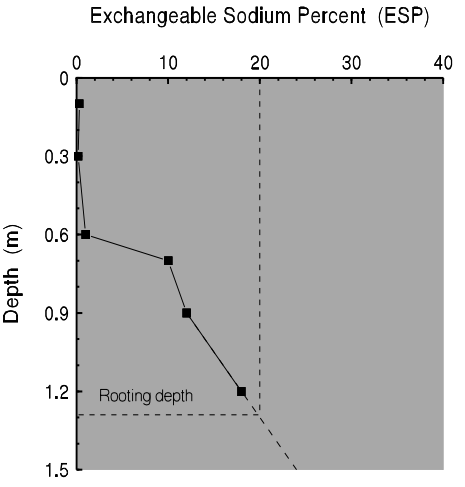
The topsoil is very sandy with a clay content of 16 to 17 %, with a large increase in clay in the subsoils to 43 to 54%, showing the strong texture contrast. The surface soil CEC is only 3 to 5 cmol[+] kg^{-1}) due to the low clay content, while the subsoil CEC is only 8 to 13 cmol[+] kg^{-1} as this soil is derived from highly weathered source material. Surface soil calcium and magnesium contents are low, while magnesium (3.2-4.8 cmol[+] kg^{-1}) is either dominant or co-dominant with calcium (2.3-5.4 cmol[+] kg^{-1}) in the subsoil, giving Ca/Mg ratios of 0.7 to 1.1.

Subsoil calcium levels are also mainly low (2.3-5.4 cmol[+] kg^{-1}), and is sodic to strongly sodic (ESP 10-18). It is therefore dispersive with impeded drainage, though not indicated by the dispersion ratios. The subsoil salt content is low (0.05-0.22 dS/m) due to loss of salts through subsurface drainage. The CEC:clay ratio 0.19 to 0.24 indicates a kaolinite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Desdemona has a rooting depth of 1.3 m that is limited by subsoil sodicity with an ESP of 20 at 1.3 m (extrapolated from the ESP curve). Total soluble salts are low and do not affect the rooting depth (see above graphs). The PAWC varies slightly depending on the thickness of the sandy topsoil. This results in a PAWC of 85 mm for a soil with a 0.9 m thick topsoil, that increases to 105 mm for a 0.4 m thick topsoil (proportionally more contribution from the clay subsoil which has a higher water holding capacity). The salt graph shows also that significant deep drainage below the soil profile occurs as subsoil salt contents are low and only reach equilibrium at low concentrations despite the strongly sodic subsoil (i.e. only a small "salt bulge" is present due to the leaching of salts by deep drainage).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	13	0.05	0.93	0.31	3	3.2	0.93
Range	6-36	.04-.06	.84-1.1	.31-.41	3-5	-	-
No of samples	5	5	5	4	5	1	1
Rating	Moderate	Low	Low	Low	Very low	Low	Low

The Desdemona soil has a low surface soil fertility as phosphorous levels are usually low to moderate with a mean of 13 mg/kg, while total nitrogen is always low with a mean of only 0.05%. The mean organic carbon is also low (0.93%) as it breaks down quicker in the sandy topsoil, thus resulting in the low levels of total nitrogen. Mobile nutrients are also readily leached in these thick sandy topsoils as demonstrated by the very low mean sulphate-sulphur content. All other nutrients measured are low which tends to indicate an overall low fertility

Drumberle (Db)

Concept: Drumberle is a hard setting, moderately deep (0.5-0.9 m), black, grey-brown or dark brown, sodic duplex soil with a moderately thick (0.1-0.3 m), clay loamy topsoil that has a sporadically bleached A2 horizon. The topsoil overlies a medium clay subsoil that has a coarse prismatic or columnar structure and is sometimes mottled. Drumberle has a neutral to alkaline soil reaction trend and is formed on acid volcanic rocks.

Geology: Little weathered, trachy-andesite and andesitic tuffs of the Torsdale beds (Ct), Camboon andesites (Pln) and undifferentiated Devonian volcanic rocks (Du).

Aust Class: Black, Brown or Grey Sodosol

PPF: Dd1.33, Db1.33, Dy3.42

Landform: Undulating rises to rolling low hills formed on the acid volcanic rocks and tuffs of the Torsdale beds. Slopes range from 3 to 10% on the rises, and up to 20% on the low hills. The steeper low hills are usually strongly dissected. Drumberle is found mainly on the rises and low hills to the east and north of the Banana Range, in the southern part of the study area.

Vegetation: Mid high to tall (6-20 m), narrow-leaved ironbark open forest or woodland, occasionally with currajong, silver-leaved ironbark or gum-topped bloodwood as associated species. The mid-stratum consists of well separated, low trees of mainly wattles (pretty wattle, dead finish, corkwood wattle), myrtle tree, cassia, and occasionally false sandalwood. The native pastures vary from forest blue grass – black spear grass dominant pastures, to wire grass – black spear grass dominant pastures in response to surface soil fertility.

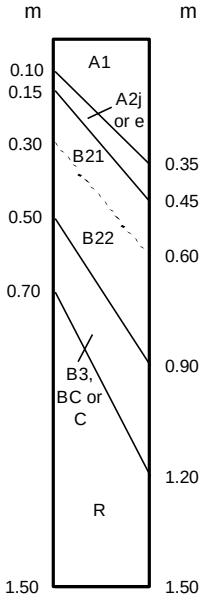
Runoff: Moderately rapid to rapid

Permeability: Slowly permeable

Drainage: Imperfectly drained

Surface cond: Hard setting, with 10-50%, surface gravels, cobbles and stones, 6-600mm, and <2% of rock outcrop

Profile Description



A1: Black, very dark grey, grey-brown or dark brown (10YR 2/1, 3/1, 3/2, 3/3); sandy clay loam to clay loam, fine sandy texture; weak or moderate, 2 to 10 mm, subangular blocky or platy structure; firm or very firm dry consistence; 10-50%, acid volcanic rocks, 2-200 mm; pH 6.0 to 7.0. Abrupt or clear to –

A2j or e: Dark grey-brown, grey-brown or brown (10YR 4/2, 5/2, 5/3), with a light grey or white, dry bleach colour (10YR 7/1, 7/2, 8/1); fine sandy clay loam to clay loam sandy texture; massive, weak or moderate, 2 to 10 mm, subangular blocky structure; firm or very firm dry consistence; 20-90%, acid volcanic rocks and quartz; 2-60 mm that are often present in a band overlying the subsoil; pH 6.5 to 7.5. Sharp or abrupt to –

B21: Black, very dark grey or grey-brown, dark grey or dark brown (2.5Y 5/2; 10YR 2/1, 3/1, 3/3, 4/1, 4/3), sometimes with 2-50%, yellow, brown or dark mottles, <5-15 mm; light medium to medium clay texture; strong, 50-200mm, prismatic or columnar structure parting to a strong, 10 to 50 mm, angular or subangular blocky primary peds; strong dry consistence; <2-20%, acid volcanic rock gravels, 2-60 mm; pH 7.0 to 8.0. Either abrupt to weathered substrate or clear or gradual to the B22 –

B22: (when present) Similar to B21 except that a strong, 5 to 20 mm, lenticular structure with slickensides, and the deeper subsoils are either calcareous or have 2-20%, soft or nodular calcium carbonate segregations, <2-6 mm; pH 7.5 to 8.5. Clear or gradual to –

B3, BC or C: The B3 and BC horizons are grey-brown or yellow-brown (2.5Y 4/2, 4/3, 5/4; 10YR 5/3, 5/4, 6/6), sometimes with 2-50%, dark, yellow or brown mottles, <5-15 mm; sandy light or light medium clay texture; massive to strong, 2 to 10 mm subangular blocky structure; 20-90%, weathered substrate fragments; sometimes 2-20%, soft calcium carbonate segregations, 2-20 mm. The C horizons are composed entirely of weathered acid volcanic rocks and can also be calcareous.

R: Hard, unweathered acid volcanic rocks.

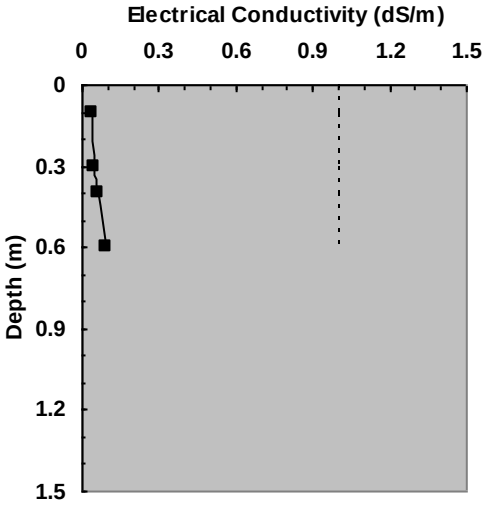
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	CEC cmol[+] kg^{-1}	Exchangeable Cations[1] Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.9	.04	.001	28	27	23	20	11[2]	6.0	4.0	.07	.80	1.5			
B_{21}	0.3	7.7	.05	.001	11	18	15	54	17[2]	6.0	9.2	1.4	.20	0.7	8	.68	.31
B_{21}	0.4	8.0	.06	.001	11	19	17	52	18[2]	6.5	9.9	1.8	.19	0.7	10	.71	.35
B_{22}	0.6	8.6	.09	.001	21	15	13	49	22	5.9	11	2.0	.18	0.5	9	.80	.45

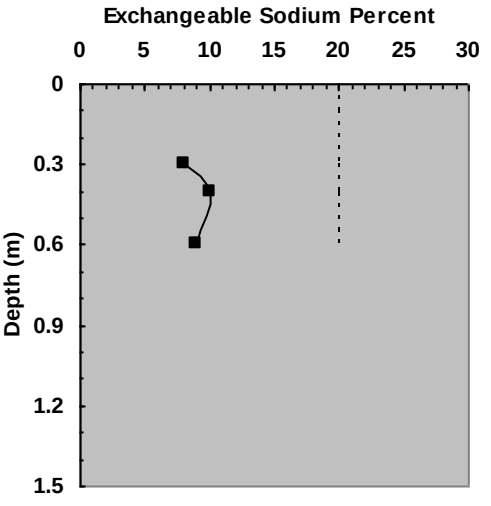
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

The surface soil has a moderate clay content (20%) that increases to 54% in the upper subsoil, showing the strong texture contrast. The high proportion of fine sand (27%) and silt (23%) in the topsoil makes it prone to hard setting, crusting and surface sealing. The subsoil CEC is 17 to 22 cmol[+] kg^{-1} indicating a moderately weathered soil. Calcium (5.9-6.5 cmol[+] kg^{-1}) and magnesium (9.2-11 cmol[+] kg^{-1}) are at moderate levels, with magnesium is the dominant subsoil cation resulting in Ca/Mg ratios of 0.5 to 0.7. The subsoil is also sodic (ESP 8-10) and therefore dispersive and restricts water movement. This is only evident in the profiles with deeper subsoils that have high salt contents. The high subsoil dispersion ratios (0.68-0.8) also indicate dispersive clay materials. The CEC:clay ratios of 0.3-0.45 indicate a mixed kaolinite-illite clay mineralogy. The high total potassium levels present in this soil (0.65-3.4%) also indicate illite clay minerals.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Drumberle has a rooting depth range of 0.7 to 1.2 m, that is limited by only hard, unweathered bedrock as subsoil salinity and sodicity are low to moderate and not limiting (see above graphs). The PAWC varies from 70 to 95 mm for these rooting depths. The salt graph shows that for the deeper profiles, soluble salts increase to moderate levels as the slowly permeable subsoil restricts deep drainage and leaching of salts.

Surface Soil Fertility

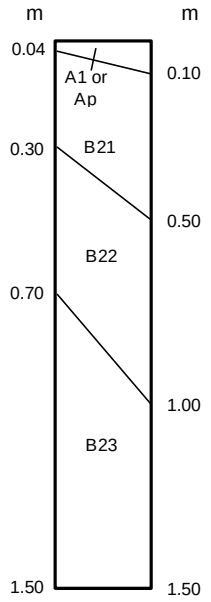
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	10	0.10	1.7	1.1	4	5.8	4.3
Range	7-17	.06-.16	1.1-2.5	.88-1.3	3-7	5.0-6.5	3.4-6.0
No of samples	8	8	8	2	6	4	4
Rating	Moderate	Low	Moderate	High	Low	Moderate	Moderate

Drumberle has a low fertility as the mean phosphorous content of 10 mg/kg is only moderate, while total nitrogen levels ane mainly low with a mean of 0.1%. Organic carbon levels are also moderate (1.7%) while potassium contents are high due to the acid volcanic rock parent material. The mean sulphate-sulphur content is also low which could affect seca stylo productivity and persistence.

Earlsfield (Ef)

Concept: Earlsfield is a very deep (>1.5 m), black, dark brown or grey, cracking clay soil with a very fine self-mulching topsoil. The subsoil is strongly sodic (ESP>15), with high levels of soluble salts (EC >0.8 dS/m) below 0.8 m. It has a predominantly acid soil reaction trend and is formed on unconsolidated, alluvial-colluvial sediments.
Geology: Unconsolidated, Cainozoic, alluvial-colluvial clay sediments (Cza)
Aust Class: Black, Brown or Grey Vertosol
PPF: Ug5.15, Ug5.16, Ug5.34, Ug5.24
Landform: Extensive level plains and gently undulating rises formed on unconsolidated Cainozoic clay sediments, which have slopes of 0 to 5% and a relief of 5 to 20 m. Earlsfield is found throughout the Callide Valley, and also occurs on the clay sheets to the north and west of Banana in the western area of the study area.
Vegetation: Mid high to tall (6-20 m), brigalow – belah or brigalow open forest or woodlands, with associates such as red or white flowered bauhinia and narrow and broad-leaved bottle trees. Wilga, lime bush and holly bush are the dominant understorey species while sparse grasses such as brigalow grass (*Paspalidium spp.*) and curly windmill grass, along with low prostrate shrubs such as currant bush are found in the ground layer.
Microrelief: Occasionally widely spaced melonhole gilgai – vertical interval: 0.3-0.5 m; horizontal interval: 10-15 m
Runoff: Slow
Permeability: Slowly permeable
Drainage: Imperfectly drained
Surface cond: Very fine self-mulching and seasonally cracking, usually <2-10%, quartz or ferruginous siltstone gravels (ironstone), 6-20 mm

Profile Description



Ap or A1: Black, very dark grey, grey-brown, or dark brown (10YR 2/1, 3/1, 3/2, 3/3; 7.5YR 3/3); light medium or medium clay; strong, <1 m, granular structure; loose dry consistence; occasionally <2%, calcium carbonate nodules, <2 mm, and/or quartz or ironstones, 2-20 mm; pH 6.5 to 8.5. Abrupt to -

B21: Black, very dark grey, dark grey or dark brown (2.5Y 3/2; 10YR 2/1, 3/1, 3/2, 3/3, 4/1, 4/2, 4/3); medium clay or medium heavy clay; strong, 2 to 5 mm, lenticular or 10 to 20 mm, angular blocky structure that parts to a strong, 2 to 5 mm, lenticular primary structure; very firm or strong dry consistence; 2-20%, soft or nodular calcium carbonate segregations, <2-6 mm; occasionally <2-10%, quartz or ironstone gravels, 2-20 mm; pH 7.5 to 8.5. Gradual or diffuse to -

B22: As above, except sometimes with <2-20%, grey, brown or dark mottles, <5-15 mm; and the structure is always strong, 2 to 5 mm, lenticular with few (2-10%), slickensides; pH usually between 8.0 and 9.0. Clear or gradual to -

B23: Dark grey, dark grey brown, dark brown or yellow brown (10YR 4/1, 4/2, 4/3, 4/4, 5/3, 5/6; 7.5YR 4/4, 4/6), usually 2-50%, dark, grey or brown mottles, <5-30 mm; medium or medium heavy clay; strong, 5 to 10 mm, lenticular structure with few (2-10%) slickensides; usually 2-20%, calcium carbonate segregations in the alkaline profiles, or occasionally <2-20%, gypsum crystals, 2-6 mm, in the acid to neutral subsoils, and <2-20%, soft manganese segregations, <2 mm; pH usually 7.5 to 5.5, but also remains alkaline (8.0-9.0) for a significant number (20%) of profiles.

Soil Chemistry

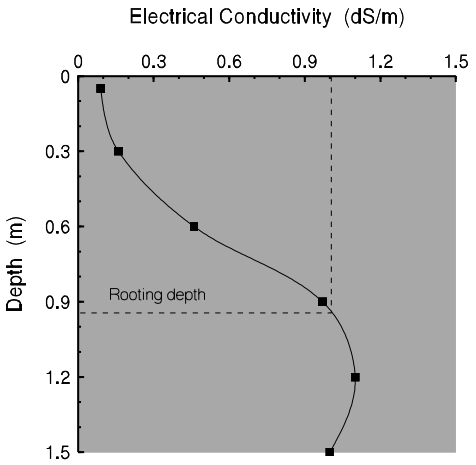
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_p	0.1	8.6	.13	.003	14	18	12	55	44[2]	32	9.2	1.5	.90	3.5	3	.60	.80
B_{21}	0.3	8.8	.19	.005	15	15	18	53	48	27	12	3.5	.50	2.3	7	.60	.91
B_{22}	0.6	8.6	.56	.057	13	18	13	58	49	25	14	6.5	.57	1.8	13	.87	.84
B_{23}	0.9	8.4	1.1	.111	12	17	12	60	45	20	15	8.0	.64	1.3	18	.91	.75
B_{23}	1.2	7.6	1.0[3]	.102	13	16	15	56	40	18	13	7.5	.52	1.4	19	.82	.71
B_{23}	1.5	5.7	.97	.089	16	19	14	54	31[2]	15	10	6.1	.45	1.5	20	.97	.57

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC [3] Cl^- used to estimate the EC

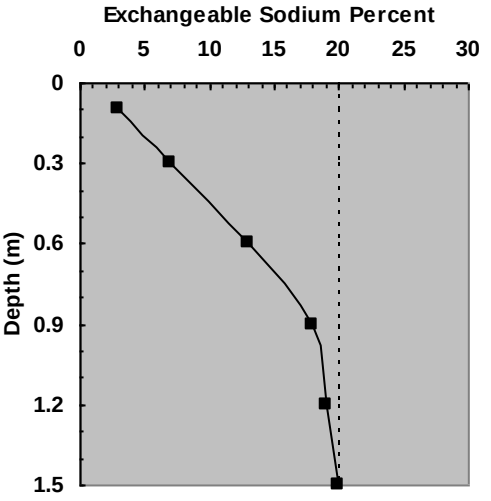
Earlsfield has a uniform, high clay content (53-64%) throughout the profile. The CEC is also high (31-49 cmol[+] kg^{-1}) throughout, with high levels of calcium that decrease significantly with depth (15-32 cmol[+] kg^{-1}). Calcium is dominant cation resulting in favourable Ca/Mg ratios of 3.5 to 1.3 (magnesium contents of only 9.2-15 cmol[+] kg^{-1}).

The subsoil is strongly sodic by 0.9 m (ESP 18) and is therefore dispersive with impeded drainage as indicated by the high levels of soluble salts (1.0-1.1 dS/m). The high dispersion ratios from 0.6 m (0.82-0.97) also indicate a dispersive lower subsoil. The CEC:clay ratios of 0.7 to 0.9 indicate a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Earlsfield has a rooting depth of 0.95 m that is limited by the very high subsoil salt content (≥1.0 dS/m), while subsoil sodicity only becomes limiting at 1.5 m (see above graphs). A rooting depth of 0.95 m results in a PAWC of 140 mm. Earlsfield has a high water holding capacity per unit depth of soil due to its very high clay content. The salt graph shows also that the salt concentration reaches equilibrium at 1.0 m, due to the impeded subsoil drainage, which indicates the long-term average depth of wetting and water extraction by plants.

Surface Soil Fertility

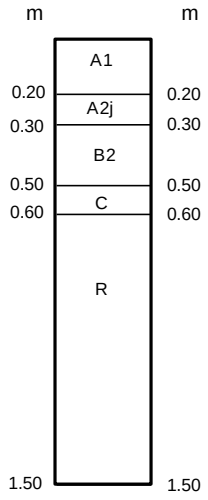
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	38	0.16	1.9	0.70	6	33	8.0
Range	15-76	.09-.28	1.1-3.1	.53-1.0	3-13	28-41	6.6-11
No of samples	10	10	10	3	9	5	5
Rating	Very high	High	Moderate	Moderate	Low	High	High

Earlsfield has a high surface soil fertility due to its very high mean phosphorous (44 mg/kg) and high mean total nitrogen (0.15%) contents. The mean organic carbon content however is only moderate (1.9%). The results for total nitrogen and organic carbon are quite variable as even though samples were taken from pasture paddocks and occasionally areas of remnant scrub, it is most likely that the pasture areas were previously cultivated, thus resulting in the low nitrogen and carbon levels, e.g. virgin brigalow-belah forest near Jambin has organic carbon and total nitrogen levels of 3.1% and 0.28% respectively. Of the other nutrients, sulphate-sulphur is again mainly low with a mean of 6 mg/kg.

Eugene (Eg)

Concept: Eugene is a hard setting, moderately deep (0.5 m), strongly sodic, grey, duplex soil with a 0.3m thick sandy loam topsoil, that has a sporadically bleached A2 horizon. The topsoil overlies a grey-brown, mottled, columnar structured sandy light clay subsoil. Eugene has neutral soil reaction trend and is formed on granite.
Geology: Little weathered, Permian granite of the Mt Gerard complex (PRf).
Aust Class: Grey Sodosol
PPF: Dy3.32
Landform: Gently undulating to undulating rises with slopes of 0.5 to 5 %, and a relief 10 to 15 m. Eugene is a minor soil type that was mapped in only one map unit, just to the west of the Boundary Hill coal mine on the central-eastern margin of the Banana study area.
Vegetation: Coowarra box – brigalow open forest, with an understorey of wilga, holly bush and currant bush. The ground layer comprises sparse native grasses such as slender panic and windmill grass.
Runoff: Slow
Permeability: Slowly permeable
Drainage: Imperfectly drained
Surface cond: Hard setting, with 2-10%, granite and quartz gravels, 2-60 mm

Profile Description



A1: Very dark brown (10YR 2/2); sandy loam; massive structure; 2-10%, granite gravels, 2-20 mm; firm dry consistence; pH 6.0. Clear to -
A2j: Dark grey-brown (10YR 4/2), white, dry, bleach colour (10YR 8/1); sandy loam texture; massive structure; 10-20%, granite gravels, 2-20 mm; firm dry consistence; pH 7.0. Sharp to -
B2: Dark grey-brown (10YR 4/2), 20-50%, distinct, brown mottles, 5-15 mm; sandy light clay texture; strong, 50-100 mm, columnar structure, parting to moderate, 10 to 20 mm, angular blocky primary peds; strong dry consistence; 2-10%, granite gravels , 6-20 mm; pH 7.5. Abrupt to -
C: Weathered granite. Sharp to.
R: Hard, unweathered granite.

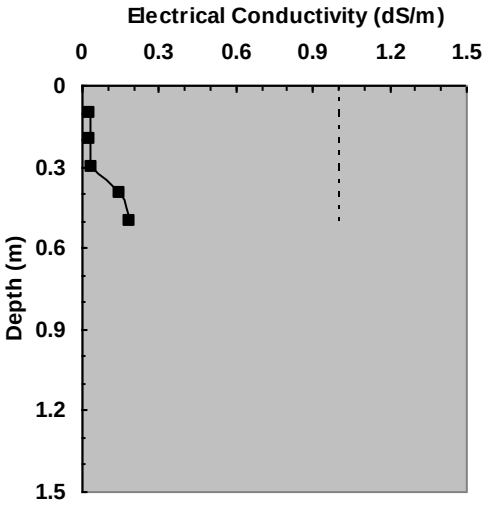
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.9	.03	.001	39	36	9	17	10[2]	8.0	1.5	.11	.21	5.3			
A_{2j}	0.2	7.3	.03	.001													
A_{2j}	0.3	7.5	.04	.001	45	34	9	12	7[2]	4.6	1.9	.37	.11	2.4	5	.75	
B_2	0.4	7.4	.15	.005	35	25	9	29	19	5.4	9.2	3.0	.09	0.6	16	.93	.62
B_2	0.5	7.8	.19	.006	30	29	9	30	20	5.1	11	3.8	.09	0.5	19	.99	.67

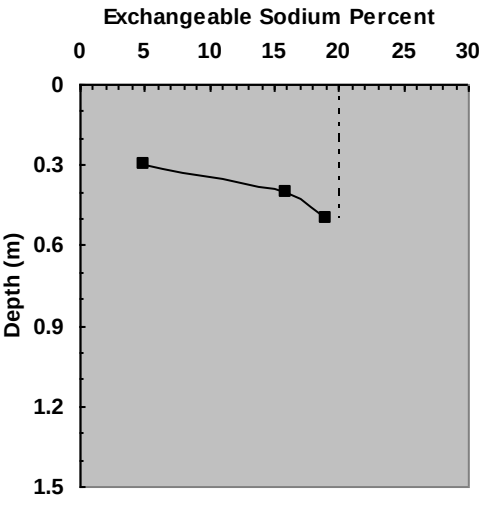
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Eugene has a sandy topsoil that has only a low clay content of 12 to 17%, that increases significantly in the clay subsoil to 30% (under estimated by the particle size analysis), showing the strong texture contrast between the A and B horizons. The topsoil has a low CEC due to its low clay content, which is dominated by calcium (4.6-8.0 cmol[+] kg^{-1}). Magnesium levels are low (1.5-1.9 cmol[+] kg^{-1}) however. The subsoil has a moderate CEC (19-20 cmol[+] kg^{-1}) indicating a weathered soil. Magnesium is the dominant cation at high levels (9.2-11 cmol[+] kg^{-1}), with only moderate calcium concentrations (5.1-5.4 cmol[+] kg^{-1}), resulting in Ca/Mg ratios of 0.5 to 0.6. The subsoil is also strongly sodic (ESP 16-19) and is therefore strongly dispersive (dispersion ratios of 0.93-0.99), due to its low calcium content and Ca/Mg ratios, and impedes water movement. The subsoil is too shallow to accumulate salts. The CEC:clay ratios are also overestimated due to the low clay content.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Although not indicated by the analytical data, Eugene has a rooting depth of only 0.3 m, as it is limited to the topsoil only due to the dense, sodic subsoil. Eugene therefore has a PAWC of only 30 mm. The salt graph shows that soluble salts increase only to low concentrations in the subsoil, as it is not thick enough to restrict deep drainage.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Nutrient level	30	0.14	1.7	0.8	4	8.0	1.5
No of samples	1	1	1	1	1	1	1
Rating	High	Moderate	Moderate	Moderate	Low	Moderate	Low

The surface soil fertility was measured at only one site due to its limited occurrence. However the fertility data, which is shown in the above table is typical for a Coowarra box – brigalow, duplex soil and is therefore considered to be representative (see Ferguson, Kokotungo and Police Camp).

Eugene has a high surface soil fertility as typically, phosphorous is very high (30 mg/kg), but there is only a moderate total nitrogen content (0.14%). Organic carbon is also at a moderate level (1.7%), as organic matter would tend to break down quicker in the sandy topsoil thus resulting in the lower organic carbon and total nitrogen levels. Nitrates could also be easily leached from the sandy topsoil because of its low CEC and clay content, and there is also the potential for denitrification to occur when the topsoil becomes waterlogged in the wetter years. The remaining nutrients are at moderate or low contents.

Fairview (Fv)

Concept: Fairview is a moderately deep to very deep (0.6->1.5 m), black or dark brown, cracking clay soil with a very fine self-mulching topsoil. It is strongly sodic (ESP>15) in the upper subsoil with a moderate to high (0.7-1.2 dS/m) salt content in the lower subsoil below 0.5m. Fairview has an alkaline soil reaction trend and is formed on mudstones.

Geology: Little weathered, folded, Permian mudstones of the Back Creek Group (Pb, Puy, Puf) of the Bowen Basin sedimentary rocks.

Aust Class: Black or Brown Vertosol

PPF: Ug5.12, Ug5.13, Ug5.15, Ug5.32, Ug5.14

Landform: Level to gently undulating plains, and crests and hill slopes of gently undulating to undulating rises. The plains and rises have slopes of 0 to 4%, with a low relief of 5 to 20 m. Fairview occurs to the north and south of the Banana village in the south-western area of the study area. Fairview also occurs as the dominant soil in soil complexes mainly with the Neimen and Police Camp soils, and occasionally with the Cottenham and Kianga soils.

Vegetation: Mid-high to tall (6-20 m), brigalow open forest or woodlands with associates such as narrow and broad-leaved bottle trees, red and white flowered bauhinia and occasionally belah. Wilga, false sandalwood, lime bush and whitewood are the dominant understorey species, while sparse grasses such as brigalow grass (*Paspalidium spp*) and curly windmill grass, along with prostrate shrubs such as currant bush are found in the ground layer.

Microrelief: Normal or linear gilgai - vertical interval: 0.1 to 0.3 m; horizontal interval: 3 to 5 m

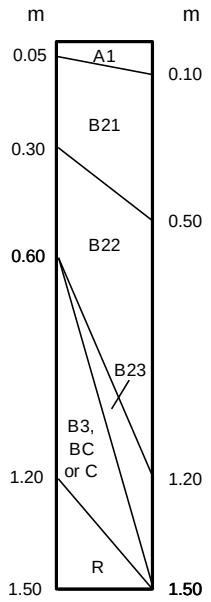
Runoff: Slow

Permeability: Slowly permeable

Drainage: Imperfectly drained

Surface cond: Very fine self-mulching topsoil, with <2-10, mudstone gravels, 2-60 mm

Profile Description



Ap or A1: Black, very dark brown or dark brown (10YR 2/1, 2/2, 3/1, 3/2, 3/3); light medium or medium clay texture; weak to strong, 2 to 5 mm, subangular blocky structure parting to strong, <1 mm, granular, angular or subangular blocky primary peds; loose dry consistence; <2-10%, quartz or mudstone gravels, 2-20 mm; rarely <2%, calcium carbonate nodules, <2 mm; pH 6.5 to 8.5. Abrupt to -

B21: Black, very dark grey to dark brown (10YR 2/1, 3/1, 3/2, 3/3, 4/3; 2.5Y 3/2); rarely <2-10%, distinct, brown or dark mottles, <5-15 mm; medium or medium heavy clay texture; strong, 2 to 5 mm, lenticular or strong, 5 to 20 mm, subangular blocky structure parting to strong, <2 mm, lenticular primary peds; very firm dry consistence; <2-10%, quartz and mudstone gravels, 2-20 mm; occasionally <2-10%, nodular or soft calcium carbonate segregations, <2-6 mm; pH .5 to 9.0. Gradual or diffuse to -

B22: As above except that the structure is moderate to strong, 5 to 20 mm, lenticular with 2-10% slickensides; 2-20%, nodular or soft calcium carbonate segregations, <2-6 mm; pH 8.0 and 8.5. Clear or gradual to -

B23: (when present) Very dark grey, dark brown, dark yellow-brown or brown (7.5YR 4/6; 10YR 3/1, 3/2, 3/3, 4/3, 4/4, 5/3); usually 2-50%, dark, brown or yellow mottles, <5-15 mm; medium or medium heavy clay texture; moderate or strong, 5 to 20 mm, lenticular structure with 2-10% slickensides; strong dry consistence; <2-20%, nodular or soft calcium carbonate segregations, <2-6 mm; occasionally <2-20%, soft, manganese segregations, <2-6 mm; pH 7.0 to 8.5. Abrupt or clear to –

B3 or BC: Dark grey-brown to yellow-brown (10YR 3/1, 4/3, 5/3, 5/4, 6/6); 2-50%, dark or brown mottles, <5-15 mm; light to medium clay; massive or weak to strong, 2 to 10 mm, subangular blocky structure; 20-90%, weathered mudstone fragments; 2-50%, soft or nodular calcium carbonate segregations, 2-20 mm; pH 7.0 to 8.5. Clear or gradual to -

C: Weathered mudstones, sometimes with 2-20%, soft carbonate segregations. Sharp abrupt to –

R: Hard, unweathered mudstone.

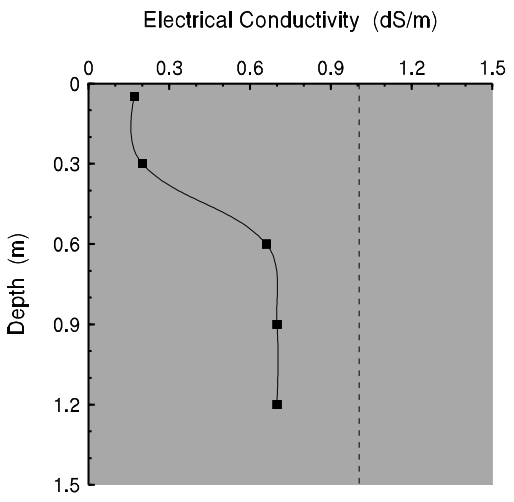
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	CEC	Exchangeable Cations[1] Ca cmol[+] kg^{-1}	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.05	8.0	.18	.002	8	24	23	47	40	34	4.0	.19	1.6	8.5	.5	.28	.85
B_{22}	0.3	8.7	.50	.040	4	18	20	61	38	22	13	4.0	.30	1.7	11	.53	.62
B_{22}	0.6	8.7	1.1	.138	5	18	20	60	36	16	13	7.7	.20	1.2	21	.76	.60
B_{23}	0.9	7.4	1.0	.159	2	18	22	60	35	12	13	8.5	.26	0.9	24	.97	.58
B_{23}	1.2	5.0	.99	.160	2	14	27	60	28[2]	9.0	11	7.7	.23	0.8	27		.47
C	1.5	5.4	.87	.114													

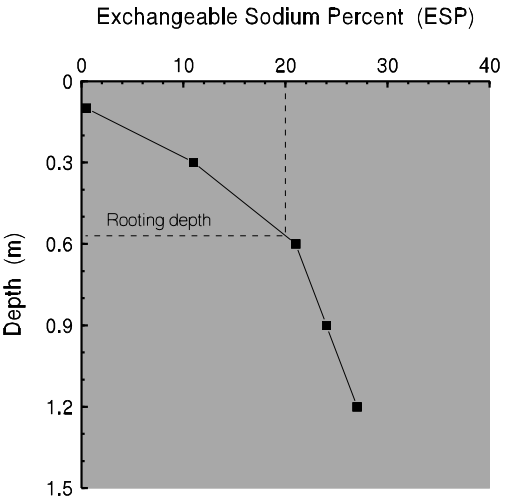
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Fairview has a uniform, high clay content of 47 to 61% throughout the profile, and corresponding high CEC (28-40 cmol[+] kg^{-1}). Calcium is high in the upper subsoil but decreases with depth (34-9.0 cmol[+] kg^{-1}), while magnesium levels increase with depth (4.0-13 cmol[+] kg^{-1}). As a result the Ca/Mg ratio decreases from 8.5 in the surface to 0.8 in the lower subsoil. The subsoil is also sodic to strongly sodic throughout (ESP 11-27), and is therefore dispersive with impeded drainage, as indicated by the high subsoil soluble salt content (0.5-1.1 dS/m). Lower subsoil dispersion ratios are also high to very high (0.76-0.97). The lower subsoil strongly acid pH is atypical for Fairview and the salt content is also higher than average. The CEC:clay ratios indicate a smectite dominant clay mineralogy in the upper profile to a mixed illite-smectite clay mineralogy in the lower subsoil.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Fairview has a rooting depth of 0.6 m that is limited by the very high subsoil sodicity (ESP ≥20). The soluble salt content is only moderate and therefore not limiting (see above graphs). A rooting depth a rooting depth of 0.6 m results in a PAWC of 100 mm. However the representative profile is more sodic and salty than average and most profiles have a rooting depth of 0.9 m, which gives Fairview a PAWC of 130 mm. The salt graph shows also that the salt concentration reaches equilibrium at 0.6 m, due to impeded subsoil drainage, which indicates the long-term average depth of wetting and water extraction by plants.

Surface Soil Fertility

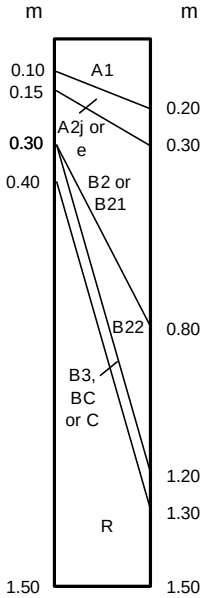
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	18	0.19	2.3	1.0	4	35	6.4
Range	6-81	.09-.28	1.3-2.8		3-7	28-53	2.6-15
No of samples	7	7	7	1	6	6	6
Rating	High	High	Moderate	Moderate	Low	High	High

Fairview has a high surface soil fertility due to its high mean phosphorous (18 mg/kg) and total nitrogen (0.19%) contents. The organic carbon content is moderate to high with a moderate mean level of 2.3%. These higher levels of nitrogen and organic carbon are typical of brigalow scrub, cracking clay soils, compared to eucalypt woodland, clay soils, (e.g., Banana) and are thought to be due to the higher biomass of the scrub vegetation. The other nutrients are high or moderate except for sulphate- sulphur which is mainly at low levels with a mean content of 4 mg/kg.

Ferguson (Fg)

Concept: Ferguson is a stony, hard setting, shallow to deep (0.3-1.2 m), black, brown or grey-brown, sodic duplex soil with moderately thick (0.1-0.3 m), clay loamy topsoil that has a sporadically bleached A2 horizon. The topsoil overlies a light medium to medium clay subsoil that has a coarse prismatic structure. Ferguson has an alkaline soil reaction trend, and is formed on acid volcanic rocks.
Geology: Little weathered, acid volcanic rocks of the Torsdale beds (Ct) and undifferentiated Devonian tuffs (Du).
Aust Class: Brown or Black Sodosol
PPF: Db1.33, Dd1.33
Landform: Undulating rises and low hills that have slopes of 2 to 8% and a relief of 15 to 50 m. Ferguson is found mainly in the central and southern parts of the Banana study area where Ferguson often adjoins the more hilly landforms with the Bertha soil.
Vegetation: Coowarra box – brigalow mid-high to tall (6-20 m) open forest. Unable to be described further as all areas of Ferguson are cleared.
Runoff: Moderately rapid
Permeability: Slowly permeable
Drainage: Moderately well drained
Surface cond: Hard setting, with 10 to 50%, gravels and cobbles of acid volcanic rocks and quartz, 6-200mm

Profile Description



A1: Very dark brown, very dark grey-brown or dark brown (10YR 2/2, 3/2, 3/3); fine sandy clay loam to clay loam, fine sandy texture; massive, or weak, 2 to 10 mm, platy structure; weak to very firm dry consistence; 10-50%, acid volcanic rocks and quartz, 2-60 mm; pH 6.5 to 7.0. Clear to -
A2j or e: Dark grey-brown, grey-brown or brown (10YR 4/2, 5/2, 5/3), with a light grey or white dry bleach colour (10YR 7/1, 7/2, 8/1, 8/2); fine sandy clay loam to clay loam, fine sandy texture; massive or weak, 2 to 10 mm, platy structure; weak to very firm consistence; 10-50%, acid volcanic rocks and quartz, 2-60 mm; pH 6.5 to 7.0. Sharp or abrupt to -
B2 or B21: Very dark grey, dark brown or olive-brown (10YR 3/1, 3/2, 3/3, 4/4; 2.5Y 5/3, 5/4), 2-50%, dark or brown mottles, <5-30 mm; light medium or medium clay texture; strong, 50-100 mm, prismatic structure often parting to strong, 10 to 50 mm, angular or subangular blocky primary peds; strong consistence; 2-20%, acid volcanic rocks and quartz, 2-60 mm; pH 7.0 to 8.0. Gradual to –
B22: (when present) Very dark grey-brown, dark brown or olive-brown (10YR 3/2, 4/3; 2.5Y 5/4), 2-50%, dark or brown mottles, <5-30 mm; light medium or medium clay texture; strong, 5 to 50 mm, lenticular or subangular blocky structure; strong dry consistence; 2-20%, acid volcanic rocks and quartz, 2-60 mm; <2-10%, soft calcium carbonate segregations, <2-6 mm; pH of 8.5 to 9.5. Abrupt or clear to –
B3 or BC: Very dark grey, dark brown, dark grey-brown or yellow-brown (10YR 3/1, 3/3, 4/2, 4/4, 6/8), rarely 10-20%, grey or dark mottles, 5-15 mm; sandy light to light medium clay; massive, or weak to moderate, 2 to 10 mm, subangular blocky structure; 50-90%, weathered acid volcanic rock fragments; usually 10-20%, soft calcium carbonate segregations, 2-6 mm; pH 8.5 and 9.0. Clear to –
C: Weathered acid volcanic rocks, sometimes 2-10%, soft, calcium carbonate segregations, 6-20 mm. Sharp or abrupt to –
R: Hard, unweathered bedrock

Soil Chemistry

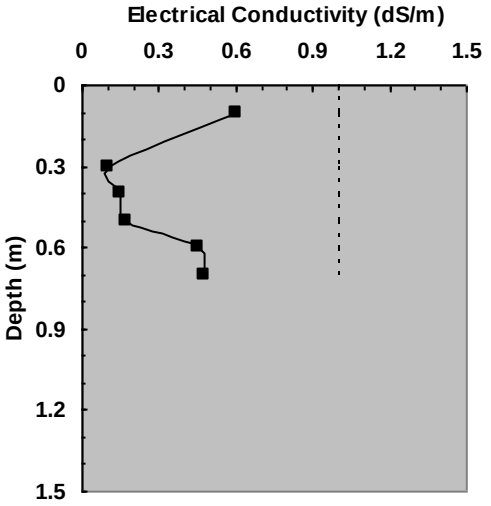
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.0	.06	.001	38	28	15	19	10[2]	6.0	2.9	.15	.99	2.1			
B_{21}	0.3	7.4	.10	.005	16	16	11	55	23[2]	8.2	12	2.2	.39	0.7	10	.84	.42
B_{21}	0.4	8.0	.15	.012	13	19	11	55	26[2]	9.1	14	2.7	.30	0.7	10	.86	.47
B_{22}	0.5	8.3	.17	.011													
B_{23}	0.6	8.9	.45	.029	13	19	13	52	30	10	16	4.4	.26	0.6	15	.88	.58
B_{23}	0.7	9.2	.48	.033													

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

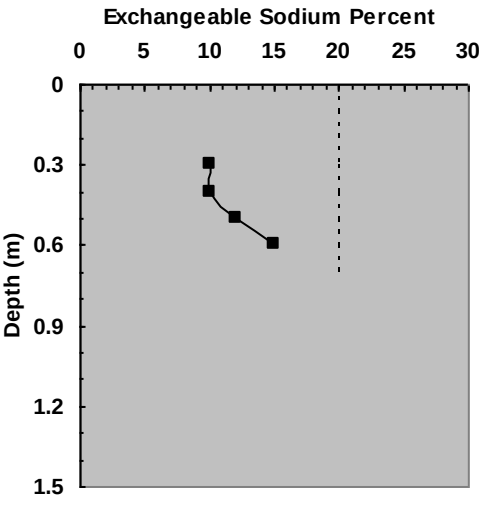
Ferguson has a low surface soil clay content of 19%, that increases to 55% in the subsoil showing the strong texture contrast. The high proportion of fine sand (28%) and silt (15%) makes the surface soil prone to surface sealing, crusting and hard setting. The CEC of the subsoil is moderate (23-30 cmol[+] kg^{-1}) with a moderate calcium content (8-10 cmol[+] kg^{-1}). However magnesium is the dominant subsoil cation (12-16 cmol[+] kg^{-1}), resulting in low Ca/Mg ratios of 0.6 to 0.7.

The subsoil is also sodic (ESP 10-15) and is therefore dispersive as indicated by the high dispersion ratios of 0.84 to 0.88. The subsoil CEC:clay ratios of 0.42 to 0.58 indicate a mixed illite-kaolinite clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Ferguson has a wide rooting depth range of 0.4 to 1.3 m, that is limited only by hard, unweathered bedrock as subsoil salinity and sodicity are moderate and not limiting (see above graphs). The PAWC varies from 45 mm to 105 mm for these rooting depths. The salt graph shows also that for the deeper profiles, soluble salts increase to moderate levels as the slowly permeable subsoil restricts deep drainage and leaching of salts.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	22	0.10	1.9	1.6	4	6.0	2.9
Range	17-36	.07-.12	1.6-2.3		3-6		
No of samples	3	3	3	1	2	1	1
Rating	High	Low	Moderate	Moderate	Low	Moderate	Moderate

Although limited by the low number of samples, the data indicates that Ferguson has a moderate surface soil fertility as it has a high mean phosphorous content (22 mg/kg). However the mean total nitrogen content is only low (0.1%), which is typical for coowarra box (Dawson gum) – brigalow, sodic duplex soils, while the mean organic carbon content is moderate (1.9%). These soils have lower organic carbon and total nitrogen levels than the brigalow clay soils, as the organic matter breaks down quicker on the lighter textured surface soils. Sulphate-sulphur levels are again consistently low, which appeasr to be typical for these sandy-surfaced, sodic duplex soils and could affect productivity and persistence of seca stylo. The other nutrients measured are all at moderate concentrations.

Flat Top (Ft)

Concept: Flat Top is a shallow (0.05-0.35 m), stony, uniform sand to clay loam soil, with a surface soil that either directly overlies weathered sandstone, or overlies a sporadically or conspicuously bleached A2 horizon that overlies weathered sandstone.

Geology: Little weathered, folded, Permian, lithic and feldspathic sandstones of the Rannes Beds (Pw), and Back Creek Group (Purc, Pb) of the Bowen Basin sedimentary rocks.

Aust Class: Leptic Rudosol or Bleached-Leptic or Leptic Tenosol

PPF: Uc1.43, Uc2.12, Um2.12, Um3.12

Landform: Undulating rises to strongly dissected low hills and strike ridges with slopes of 3 to 20% and a relief of 20 to 40m. Flat Top often occurs in soil complexes or as a minor soil in association with other soils such as Neimen and Benn on these landforms. It occurs mainly on the rises and low hills in the north-western area of the study area, and as part of soil complexes or associations, it is found throughout the western area of the study area where the Permian sedimentary rocks outcrop.

Vegetation: The dominant vegetation association is a tall (12-20 m) open forest or woodland of narrow-leaved ironbark. Minor associations are mid-high (6-12 m) woodlands of silver-leaved ironbark or mixed silver-leaved ironbark – narrow-leaved ironbark woodlands. The sparse understorey is made up of species such as myrtle tree, dead finish, pretty wattle, currant bush, and Leichhardt bean. The low quality native pastures are dominated by wire grasses (*Aristida spp*.), with a minor component of pitted blue grass, curly windmill grass and various annual grasses eg. *Enneapogon spp.*

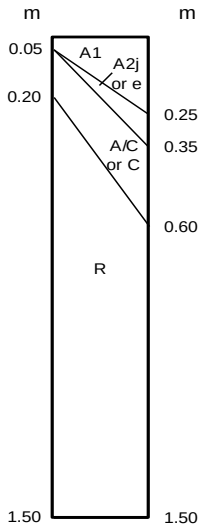
Runoff: Moderately rapid to rapid

Permeability: Highly permeable

Drainage: Well drained

Surface cond: Hard setting, with 20-90%, sandstone gravels and cobbles, 6-200 mm and <2-10% rock outcrop

Profile Description



A1: Very dark grey-brown, dark grey-brown or dark brown (10YR 3/2, 3/3, 4/2, 4/3); coarse sand, sandy loam, sandy clay loam or occasionally clay loam texture; massive or weak, 2 to 5 mm, subangular blocky or platy structure; weak to very firm dry consistence; 20-90%, sandstone gravels and cobbles, 2-200 mm; pH 6.0 to 7.0. The surface soil either directly overlies weathered sandstone, or a bleached A2 horizon. Abrupt or clear to -

A2j or e: (when present) Dark grey-brown, brown or light brown (10YR 4/2, 5/3, 6/2), light grey or white dry bleach colour (10YR 7/2, 8/1); sandy loam, sandy clay loam or clay loam, sandy texture; massive structure; weak to very firm dry consistence; 20-90%, sandstone gravels to cobbles, 2-200 mm; pH 6.0 to 7.5. Abrupt to -

A/C: 50-90%, weathered sandstone fragments with sandy loam or sandy clay loam topsoil between rock fragments, occasionally very dark grey, very dark grey-brown, dark brown or brown (10YR 31, 3/2, 3/3, 5/3), light clay fragments have also formed between rock fissures.

C: The C horizons are composed entirely of weathered sandstone fragments.

R: Hard, unweathered sandstone

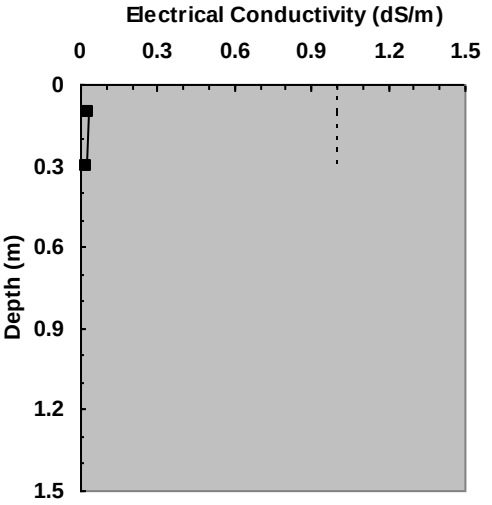
Soil Chemistry

Horizon	Depth (m)	pH EC Cl^- dS/m % 1:5, soil:water	Particle Size CS FS S C %	Exchangeable Cations[(1)] ECEC Ca Mg Na K cmol[+] kg^{-1}	Ca/Mg ratio
A_1	0.1	6.5 .03 <.001	36 18 18 26	11 4.2 6.0 .13 .30	0.7
A_{2e}	0.3	6.9 .02 <.001	46 15 16 22	10 2.3 7.3 .27 .10	0.3

[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 ECEC= Ca + Mg + Na +K

Flat Top has a moderate clay content (22-26%), and the texture is dominated by coarse sand (36-46%). As a result it is freely draining with only a moderate CEC (10-11 cmol[+] kg^{-1}), and negligible soluble salts (0.02-0.03dS/m). Magnesium is the dominant cation (Ca/Mg ratios 0.3-0.7) and calcium (2.3-4.2 cmol[+] kg^{-1})and magnesium (6.0-7.3 cmol[+] kg^{-1}) are at moderate levels. The ESP, dispersion and CEC:clay ratios are not relevant at these clay contents.

Plant Available Water Capacity



Mean profile salt graph

Flat Top has a rooting depth range of only 0.2 to 0.6 m, that is limited only by hard, unweathered bedrock, as soil salinity and sodicity are negligible (see above graph). The PAWC varies from 15 to 25mm for these rooting depths. The water holding capacity is also significantly reduced by the high sand and stone content. The very low salt level throughout the profile indicates that nearly all water that infiltrates this soil is lost to deep drainage as it is freely draining with a low water holding capacity. The salt profile is therefore typical for a recharge soil.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	10	0.10	1.7	0.50	5	4.3	6.0
Range	5-20	.08-.13	1.2-2.0		4-8		
No of samples	4	4	4	1	3	1	1
Rating	Moderate	Low	Low	Moderate	Low	Moderate	High

Although limited by the small number of samples, the data indicates that Flat Top has a low surface soil fertility as the mean phosphorous and total nitrogen contents are moderate and low (10 mg/kg and 0.10% respectively). Flat Top has also a low organic carbon content (1.7%) due to the lower accumulation of organic matter in the topsoil under eucalypt woodlands, and as organic matter breaks down quicker in sandy surfaced soils. Sulphate-sulphur levels are also low.

Foster (Fs)

Concept: Foster is a shallow to moderately deep (0.2-0.8 m), stony, brown or red, uniform non-cracking clay or gradational soil, with a thin to moderately thick (0.05-0.2 m) clay loam, light or light medium clay topsoil that overlies a structured light medium or medium clay subsoil. Foster has a neutral or alkaline soil reaction trend, and is formed on siltstone.

Geology: Little weathered, folded Permian siltstones of the Rannes Beds (Pw) of the Bowen Basin sedimentary rocks. Low grade contact metamorphism of the siltstones to meta-sediments has occurred where the Rannes Beds join the Camboon andesites.

Aust Class: Brown or Red Dermosol

PPF: Uf6.31, Gn3.22, Gn3.12

Landform: Undulating rises, low hills and occasionally rolling low hills with slopes of 3 to 15% and a relief of 20 to 50 m. The soils on the crests and upper slopes are often shallower than the mid and lower slope soils. Foster occurs only to the north, west and south-east of Rannes.

Vegetation: Silver-leaved ironbark – gum-topped bloodwood mid-high (6-12 m) woodlands or open woodlands, with ghost gum as an associated species only in the Rannes area. There is a sparse understorey of isolated low tress (3-6 m) of myrtle tree and *Cassia tomentella*, while the native grass pastures are composed mainly of black spear grass and forest blue grass. Corkwood wattle and dead finish often become a minor regrowth problem following excessive tree clearing.

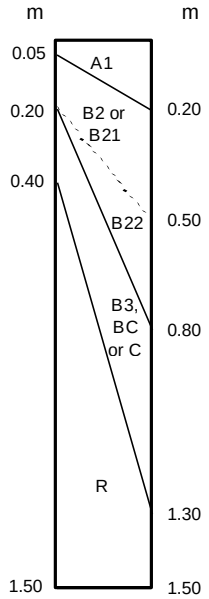
Runoff: Moderately rapid to rapid

Permeability: Moderately permeable

Drainage: Well drained

Surface cond: Firm, hard setting only where the topsoil has been eroded; with 10-50%, siltstone and meta-sediment gravels and cobbles, 2-200 mm, and <2-10% rock outcrop

Profile Description



A1: Dark brown, very dark brown or very dark grey-brown (7.5YR 3/2, 3/3; 10YR 2/2, 3/2); clay loam, clay loam fine sandy, light or light medium clay texture; moderate or strong, 2 to 10 mm, subangular blocky structure; firm dry consistence; 2-50%, siltstone and quartz gravels to cobbles, 2-200 mm; pH 6.0 and 7.0. Clear or gradual to -

B2 or B21: Dark red-brown, dark brown or very dark brown (2.5YR 3/4; 5YR 3/4; 7.5YR3/4; 10YR 2/2, 3/3); light to medium clay texture; moderate or strong, 2 to 20 mm, subangular blocky structure; firm or very firm dry consistence; 2-50%, siltstone and quartz gravels, 2-60 mm; pH 6.5 to 7.5. Gradual to -

B22: (when present) Dark red-brown or dark brown (2.5YR 3/4; 5YR 3/4; 7.5YR 4/4), usually 2-10%, dark, brown or red mottles, <5-15 mm; light medium or medium clay texture; moderate or strong, 2 to 20 mm, lenticular or subangular blocky structure; firm or very firm dry consistence; 2-20%, siltstone and quartz gravels, 2-20 mm; pH 7.5 to 8.0. Clear to -

B3 or BC: Dark red-brown, dark brown or grey-brown (5YR 4/4; 7.5YR 3/4; 2.5Y 4/2, 5/2), occasionally 2-10%, red or brown mottles, <5-15 mm; light or light medium clay texture; weak or moderate, 2 to 5 mm, subangular blocky structure; 20-90%, weathered siltstone or meta-sediment fragments; sometimes 2-10%, soft or nodular calcium carbonate segregations, 2-20 mm; pH 7.5 and 8.5. Abrupt to -

C: The C horizons are composed entirely of weathered siltstone or meta-sediments and sometimes contain 2-20%, soft calcium carbonate segregations, 6-20 mm.

R: Hard, unweathered bedrock

Soil Chemistry

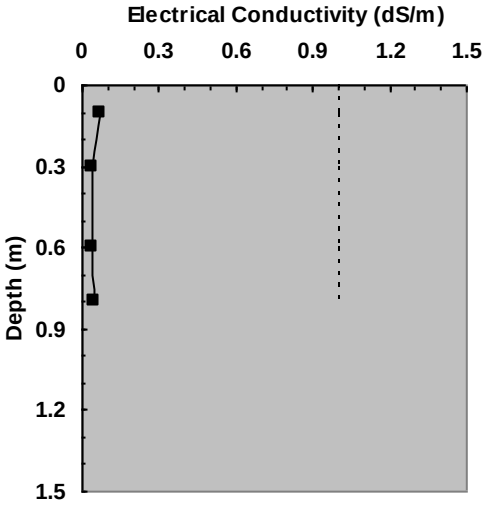
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.5	.07	.001	17	14	32	35	13	8.4	4.7	.10	.58	1.8	0.8		.37
B_{21}	0.3	6.9	.04	.001	17	14	20	47	13	7.7	5.6	.18	.20	1.4	1		.28
B_{22}	0.6	7.4	.04	.001	11	6	14	70	18	8.4	8.6	.44	.22	1.0	2	.34	.26
B_{22}	0.8	7.5	.05	.002	12	8	14	65	19	8.8	9.2	.60	.20	1.0	3	.29	.29

[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0

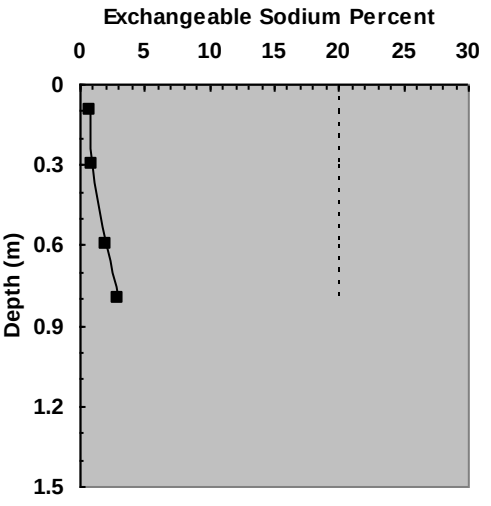
Foster has a clay content that increases with depth (35-70%), with a very high clay content in the subsoil. However the subsoil CEC is only 13 to 19 cmol[+] kg^{-1}, indicating a moderately weathered soil as it is freely draining. Calcium is also at moderate levels (7.7-8.8 cmol[+] kg^{-1}) and is either dominant or codominant with magnesium (Ca/Mg ratios 1.8-1.0). The subsoil is non-sodic with an ESP of only 1 to 3, and is therefore structurally stable and well drained as indicated by the very low soluble salt content (0.04-0.07 dS/m) and low dispersion ratios (0.29-0.34).

The CEC:clay ratios of 0.29-0.37 indicate a mixed kaolinite – illite clay mineralogy. Total potassium concentration are also high (0.93-1.2%), which is an indicator also of the presence of illite.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Foster has a rooting depth range of 0.4 to 1.3 m, that is limited only by hard, unweathered bedrock, as subsoil salinity and sodicity are very low and not limiting (see above graphs). These rooting depths result in a PAWC that varies from 40 mm to 95 mm. The salt graph shows also that significant deep drainage occurs as soluble salts have not accumulated in the subsoil (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	40	0.13	1.8	0.71	6	11	6.9
Range	25-61	.09-.17	1.5-2.1		3-12	8.2-14	4.6-10
No of samples	6	6	6	1	5	4	4
Rating	High	Moderate	Moderate	Moderate	Low	Moderate	High

Although Foster has a high mean phosphorous content of 40 mg/kg, it is rated as having moderate fertility as the mean total nitrogen and organic carbon contents are only moderate (0.13 and 1.8% respectively), which is typical for soils with eucalypt woodland vegetation. The high phosphorous levels are from the weathering of the parent material. All other nutrients are moderate or high, except for sulphate-sulphur which is low.

Garden (Gd)

Concept: Garden is a hard setting, shallow (0.2-0.4 m), stony, uniform clay loamy soil, with a surface soil that either directly overlies weathered shale, or overlies a sporadically or conspicuously bleached A2 horizon that overlies weathered shale.

Geology: Little weathered, folded, Permian shales of the Rannes Beds (Pw) of the Bowen Basin.

Aust Class: Bleached-Leptic or Leptic Tenosol, or Leptic Rudosol

PPF: Um3.12, Um2.12, Um1.44

Landform: Strongly dissected undulating rises, low hills and rolling low hills with slopes of 3 to 15% and a relief of 20 to 50 m. Garden is found mainly to the south and north-west of Rannes while another small area of Garden with softwood scrub vegetation also occurs on the upper slopes of a low hill to the west of Banana.

Vegetation: Mid-high or tall (6-20 m), narrow-leaved ironbark woodland with a low to mid-high (3-12 m), closely spaced understorey of rosewood. Leichhardt bean, red and white-flowered bauhinia, wallaby apple and holly bush also occur in the mid-stratum, while wire grasses (*Aristida spp.*) and black spear grass are the main grasses that occur in the ground layer along with prostrate shrubs such as currant bush. One area of the Garden soil to the west of Banana has a closed forest of softwood scrub that is made up of narrow and broad-leaved bottle trees, white-flowered bauhinia, wilga and whitewood. Rosewood can become a severe regrowth problem following complete clearing.

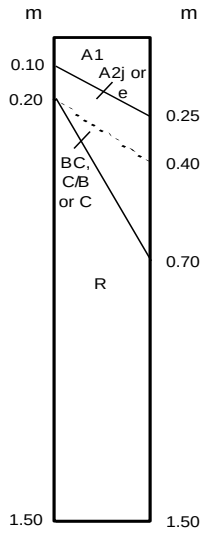
Runoff: Moderately rapid to rapid

Permeability: Moderately permeable

Drainage: Well drained

Surface cond: Hard setting, with 20-90%, gravels and cobbles of shale, 2-200mm, and <2-10% rock outcrop

Profile Description



A1: Very dark grey-brown, dark grey-brown or dark brown (7.5YR 3/2, 3/4, 4/4; 10YR 3/2, 3/3, 4/2); sandy clay loam or clay loam texture; massive or weak, 2 to 5 mm, subangular blocky structure; firm or very firm dry consistence; 20-90%, shale gravel and cobbles, 2-200 mm; pH 6.0 to 7.0. The surface soil either directly overlies weathered shale, or a bleached A2 horizon. Abrupt or clear to -

A2j or e: (when present) Dark grey-brown, dark brown, brown or light yellow-brown (10YR 4/2, 4/3, 5/3, 6/4), and light grey or white dry bleach colour (10YR7/2, 8/2); sandy clay loam, clay loam sandy or clay loam fine sandy texture; massive or weak, 2 to 5 mm subangular blocky structure; firm or very firm dry consistence; 20-90%, shale gravels, 2-60 mm; pH 6.0 to 7.5. Abrupt or clear to -

BC or C/B: (when present) Very dark brown, dark brown, dark red-brown or red-brown (5YR 3/4, 4/4; 7.5YR 3/3; 10YR 2/2, 3/3, 4/3); sandy light clay or sandy light medium clay texture;.massive, or weak to moderate, 2 to 10 mm, subangular blocky structure; 50-90%, weathered, shale fragments; pH 6.5 and 7.0. Abrupt to -

C: The C horizons are composed entirely of weathered shale.

R: Hard, unweathered shale.

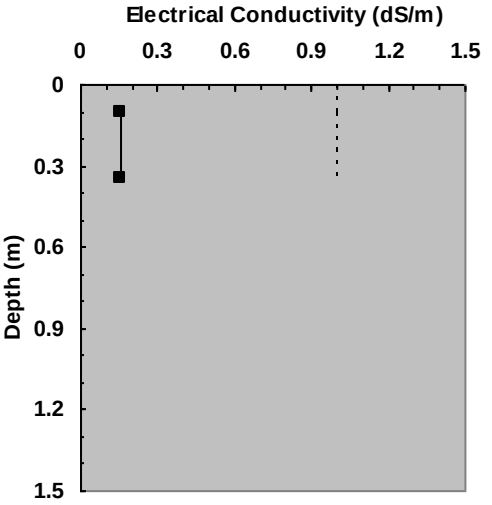
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio
A_1	0.1	7.0	.16	.001	36	18	14	32	12	6.0	5.6	.16	.39	1.1
A_{2e}	0.35	7.1	.16	.001	36	17	12	34	10	1.2	8.7	.53	.10	.14

[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 ECEC= Ca + Mg + Na +K

Garden has a uniform, moderate clay content of 32 to 34% throughout the profile. Coarse sand levels are also high (36%), and the profile is freely draining as indicated by the low salt content (0.16%), most of which is made up of plant nutrients as it has a high fertility. The CEC is moderate also (10-12 cmol[+] kg^{-1}), due to its clay content, and is dominated by calcium in the surface soil and magnesium in the bleached A2 horizon. The subsurface calcium content is low (1.2 cmol[+] kg^{-1}) and Ca/Mg ratios decrease significantly with depth, 1.1 to 0.14. The ESP, dispersion and CEC:clay ratios are not presented as they are not relevant at these clay contents.

Plant Available Water Capacity



Mean profile salt graph

Garden has a rooting depth range that varies from 0.2 to 0.7 m, which is limited only by hard, unweathered bedrock, as subsoil salinity and sodicity are very low and not limiting (see above graph). The PAWC varies from 20 mm to 40 mm for these rooting depths, and is also significantly reduced by the high profile stone content. The very low salt level throughout the profile indicates that nearly all water that infiltrates this soil is lost to deep drainage as it is freely draining with a low water holding capacity. The salt profile is therefore typical of a recharge soil.

Surface Soil Fertility

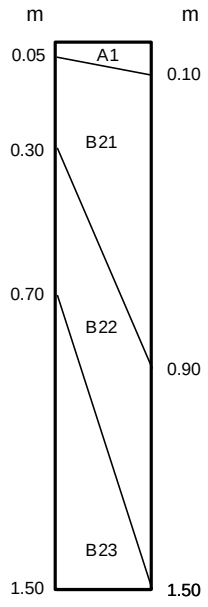
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	31	0.24	2.9	0.73	11	6.0	5.6
Range	13-55	.18-.30	2.2-3.5		8-15		
No of samples	3	3	3	1	2	1	1
Rating	High	Very high	High	Moderate	High	Moderate	High

Although limited by the small number of samples, the data indicates that Garden has a high surface soil fertility as it has a high mean phosphorous (31 mg/kg) and a very high mean total nitrogen (0.24%) content. The high nitrogen levels are most likely due to the nitrogen-fixing rosewood understorey. Garden has also a high mean organic carbon content of 2.9%, with the total nitrogen and organic carbon contents showing strong correlation. All other nutrients are moderate to high.

Goovigen (Gv)

Concept: Goovigen is a very deep (>1.5 m), black cracking clay soil with a firm, pedal surface soil and an alkaline soil reaction trend. The subsoil is strongly sodic (ESP >20), with high to very high levels of soluble salts (EC 0.8-1.5 dS/m) between depths of 0.3 to 1.0 m. Goovigen has well developed melonhole gilgai microrelief and is formed on Quaternary alluvium.
Geology: Unconsolidated, Quaternary, alluvial sediments (Qa).
Aust Class: **Mound:** Black Vertosol **Depression:** Black Vertosol
PPF: **Mound:** Ug5.1, Ug5.15, Ug5.24 **Depression:** Ug5.1, Ug5.24
Landform: Backplains of the alluvial plains and valley flats of the river and creek systems. These landforms have slopes less than 0.5% and a very low relief, usually less than 2 m.
Vegetation: Mid-high to tall (6-20 m), brigalow open forests or woodlands. Coolibah commonly occurs as an emergent, and the understorey is made up of species such as red bauhinia, wilga, lime bush and holly bush.
Microrelief: Melonhole gilgai – vertical interval: 0.5 to 1.5 m; horizontal interval: 15 to 30 m
Runoff: No runoff or very slow
Permeability: Very slowly permeable
Drainage: Poorly drained
Surface cond: Firm, pedal topsoil with a surface flake, seasonally cracking, or occasionally non-cracking on the mounds, occasionally <2-10%, quartz or ferruginous siltstone gravels, 6-20 mm

Profile Description **(mounds and depressions)**



A1: Black, very dark brown, very dark grey or very dark grey-brown (10YR 2/1, 2/2, 3/1, 3/2); light medium clay, silty light medium clay or medium clay texture; moderate or strong, 2 to 5 mm, subangular blocky structure; weak dry consistence; <2-10%, rounded quartz gravels, 2-20 mm; pH 6.5 to 7.5. Abrupt to -

B21: Black, very dark brown, very dark grey, very dark grey-brown and occasionally dark grey-brown (10YR 2/1, 2/2, 3/1, 3/2, 4/2); light medium or medium clay texture; strong, 5-20 mm, subangular blocky or strong, 2 to 5 mm, lenticular structure; strong or very strong dry consistence; sometimes 2-20%, soft or nodular calcium carbonate segregations, <2-6 mm; <2-10%, rounded quartz or siltstone gravels, 2-20 mm; pH 7.5 to 9.5. Clear or gradual to -

B22: Very dark grey, very dark grey-brown, dark grey or dark grey-brown (10YR 3/1, 3/2, 4/1, 4/2), occasionally 2-20%, distinct brown or yellow mottles, 5-15 mm (depressions only); light medium or medium clay texture; moderate 2 to 10 mm, lenticular structure; 2-20%, soft or nodular, calcium carbonate segregations, 2-20 mm; 2-20%, gypsum crystals, 2-6 mm occasionally in mounds; sometimes <2-10%, quartz or siltstone gravels, 2-20 mm; pH 8.5 and 9.5. Gradual to –

B23: Very dark grey, very dark grey-brown, dark brown, dark grey-brown or grey (10YR 3/1, 3/2, 3/3, 4/2, 4/3, 5/1), sometimes 20-50%, brown or yellow mottles, 5-30 mm; medium clay texture; weak or moderate, 2 to 10 mm lenticular, or rarely strong, 20-50 mm, prismatic structure parting to moderate, 2 to 5 mm, lenticular primary peds; strong or very strong dry consistence; 2-20%, soft or nodular, calcium carbonate segregations, 2-6 mm and rarely <2%, gypsum crystals, <2 mm in mounds; sometimes <2-10%, quartz gravels, 2-20 mm; pH 8.5 and 9.0.

Soil Chemistry
(a) mound

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.5	.09	.002	15	20	23	43	34[2]	22	9.7	1.0	1.7	2.3	3	.46	.80
B_{21}	0.3	9.1	.42	.023	23	17	19	45	34[2]	14	13	6.2	.41	1.1	18	.84	.76
B_{21}	0.6	8.6	1.2[3]	.076	13	21	24	47	38[2]	12	15	11	.37	0.8	29	.90	.81
B_{22}	0.9	8.4	1.7[3]	.111	5	16	17	62	48[2]	12	20	15	.50	0.6	31	.93	.77
B_{23}	1.2	9.2	1.7	.112	5	23	22	55	41[2]	8.4	17	15	.74	0.5	37	.97	.75
B_{23}	1.5	9.3	1.5	.108	6	23	21	52	37[2]	8.1	15	13	.59	0.5	35	.99	.71

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC [3] Cl used to estimate the EC

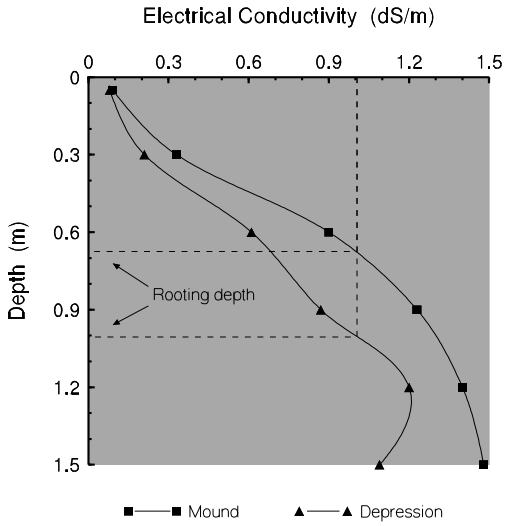
(b) depression

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.05	7.0	.07	.001	5	12	28	57	40	27	11	.50	2.0	2.5	1	.53	.70
B_{21}	0.3	8.7	.17	.010	8	15	21	61	48[2]	33	11	3.0	.89	3.0	6	.68	.79
B_{21}	0.6	9.2	.50	.030	19	16	20	51	40[2]	19	13	7.2	.72	1.5	18	.89	.78
B_{22}	0.9	9.3	.86	.061	13	19	18	52	42[2]	15	15	11	.53	1.0	26	.98	.81
B_{22}	1.2	8.9	1.3[3]	.078	13	21	17	50	40[2]	12	15	12	.51	0.8	30	.98	.80
B_{23}	1.5	9.2	1.3	.080	11	23	19	48	35[2]	9.9	14	11	.36	0.7	31	.98	.73

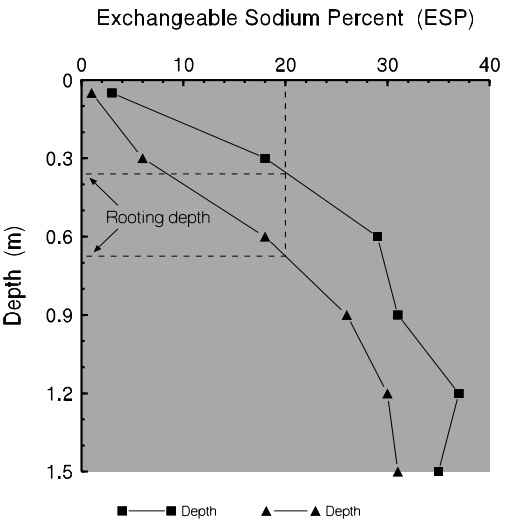
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC [3] Cl used to estimate the EC

Goovigen has a high to very high clay content (43-62%), that is higher in the surface soil and upper subsoil of the depression due to sheet wash. The CEC is high on both mound and depression (34-48 cmol[+] kg^{-1}), and calcium decreases significantly from the surface soil and upper subsoil to only moderate levels in the lower subsoil, while the magnesium content increases with depth. The Ca/Mg ratios therefore decrease from favourable ratios in the surface (1.1-3.0) to 0.5 to 0.8 in the lower subsoil. The subsoil is sodic to strongly sodic throughout (ESP 6-37). As a result the subsoil is highly dispersive with impeded drainage, which is also indicated by the high subsoil soluble salt levels (0.8-1.7 dS/m). Subsoil dispersion ratios are also very high (0.9-0.99). The soil properties therefore change considerably a favourable surface soil with high calcium and low sodicity and salinity, to a strongly sodic and saline subsoil with low calcium levels and Ca/Mg ratios less that 1.0. The effect of the seasonally ponded water in the depressions has been to leach the soluble salts and exchangeable sodium around 0.3 m lower in the profile than the mounds. The CEC:clay ratios of 0.7 to 0.81 indicate a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Goovigen has a rooting depth of 0.35 m on the mounds and 0.7 m in the depressions due to the very high subsoil sodicity (ESP ≥20). The subsoil salinity is also high but not as limiting as sodicity (see above graphs). The rooting depth for the mound is used as it is the most limiting. Goovigen therefore has a rooting depth of 0.35 m, which results in a PAWC of 60 mm. The salt graphs show also that the salt concentration reaches equilibrium at around 0.9 m for the mound and 1.2 m for the depression, due to the impeded subsoil drainage. The equilibrium point indicates the average depth of wetting for these two components of the gilgai, with the depression significantly deeper due to seasonal ponding of water and therefore significantly more deep drainage.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	82	0.15	1.9	1.2	24	8.2
Range	51-133	.14-.15	1.8-2.0	1.1-1.4	24-24	8.0-8.4
No of samples	2	2	2	2	2	2
Rating	Very high	Moderate	Moderate	High	High	High

Although only sampled on a mound and depression at the one site, the data is representative of brigalow clay soils. These data show that Goovigen has a high surface soil fertility as it has a very high mean phosphorous (82 mg/kg) and a moderate mean total nitrogen (0.15%) content. Typically for gilgai clay soils, the phosphorous content of the mound (51 mg/kg) is significantly lower than for the depression (133 mg/kg) due to the movement of topsoil by erosion from the mounds into the depression. Goovigen has a moderate mean organic carbon level (1.9%), while the other nutrients measured (K, Ca and Mg) are all high.

Granville (Gn)

Concept: Granville is a moderately deep to deep (0.7-1.3 m), hard setting, brown or grey, sodic duplex soil with a moderately thick to thick (0.15-0.4 m), fine sandy loam or fine sandy clay loam topsoil that has a sporadically bleached A2 horizon. The topsoil overlies a fine sandy light medium clay to medium clay subsoil with a prismatic or columnar structure. Granville has a neutral to alkaline soil reaction trend and is formed on deeply weathered sandstone or siltstone.

Geology: Deeply weathered, Tertiary sandstones and siltstones (Ta).

Aust Class: Brown or Grey Sodosol

PPF: Db1.33, Db3.32, Dy5.33

Landform: Residual, undulating rises formed on the eroded remnants of deeply weathered Tertiary sedimentary rocks. These rises have slopes of up to 8% with a relief of 15 to 25 m. Granville occurs mainly in the southern parts of the Callide Valley, to the north-west of Biloela, often either adjoining or in close proximity to the Tertiary sandstone plateaus.

Vegetation: Coowarra box (Dawson gum) – brigalow, tall (12-20 m), open forest with coowarra box as an emergent above an upper stratum of brigalow and narrow and broad-leaved bottle trees. As all areas of Granville are cleared, it was not possible to describe the vegetation in any further detail.

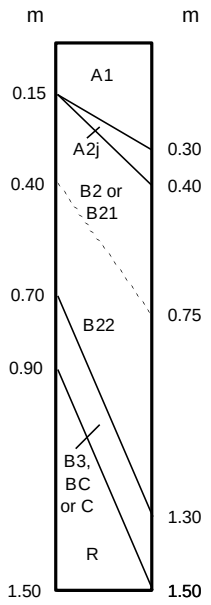
Runoff: Slow to moderately rapid

Permeability: Slowly permeable

Drainage: Moderately well drained

Surface cond: Predominantly a hard setting topsoil, occasionally firm-surfaced for the sand and sandy loam topsoils, sometimes with 2 to 20%, sandstone and ferruginous siltstones (ironstone) gravels, 2-60 mm.

Profile Description



A1: Very dark brown, very dark grey-brown or dark brown (7.5YR 3/3; 10YR 2/2, 3/2, 3/3); fine sand, fine sandy loam to fine sandy clay loam or clay loam, fine sandy texture; massive, or weak to moderate, 2 to 10 mm, subangular blocky or platy structure; very weak to firm dry consistence; <2-10%, sandstone, ironstone or quartz gravels, 2-20 mm; pH 6.0 to 7.0. Abrupt or clear to -

A2j: Dark brown, yellow-brown or pale brown (10YR 3/3, 4/3, 5/4, 6/3), light grey or white (10YR 7/2, 8/2) dry bleach colour; fine sandy loam, fine sandy clay loam or clay loam fine sandy texture; massive structure; very weak to firm dry consistence; 2-20%, sandstone, ironstone or quartz gravels, 2-20 mm; pH 6.0 to 7.0. Sharp or abrupt to -

B2 or B21: Dark brown, dark grey-brown or dark yellow-brown (7.5YR 3/4; 10YR 3/3, 4/2, 4/3, 4/4), sometimes 2-50%, brown or dark mottles, <5-15 mm; fine sandy light medium or medium clay texture; strong, 20-100 mm, prismatic or >100 mm, columnar structure, often parting to strong, 10 to 50 mm, subangular blocky primary peds; strong dry consistence; <2-20%, sandstone, ironstone or quartz gravels, 2-20 mm; pH 6.5 to 7.5. Gradual to the B22, or abrupt or clear to a B3, BC or C -

B22: (when present) Strong brown, dark yellow-brown, yellow-brown, or grey-brown (7.5YR 4/6; 10YR 4/4, 5/4; 2.5Y 5/2), usually 2-20%, brown, grey or dark mottles, <5-15 mm; fine sandy light medium or medium clay texture; strong, 10 to 100 mm, prismatic structure, often parting to strong, 5 to 20 mm, subangular blocky primary peds, or a strong, 5 to 20 mm, lenticular structure; <2%, sandstone or ironstone gravels, 2-20 mm; sometimes <2-20%, soft or nodular calcium carbonate or soft manganese segregations, <2-20 mm; pH 7.5 and 9.0. Abrupt or clear to -

B3 or BC: Dark brown, dark or light yellow-brown, light brown-grey or olive-yellow (7.5YR 4/4; 10YR 4/4, 6/4; 2.5Y 6/2, 6/6), 2-50%, grey, pale or brown mottles, <5-30 mm; clay loam fine sandy to sandy light medium clay texture; weak or moderate, 2 to 10 mm, subangular blocky structure; 20-90%, weathered sandstone fragments; sometimes 2-50%, soft calcareous or manganese segregations present, <2 mm; pH 7.5 to 9.0. Abrupt to -

C: The C horizons are composed entirely of weathered sandstone or siltstone, sometimes with <2-10%, soft calcareous segregations, 2-6 mm.

R: Hard, unweathered sandstone or siltstone.

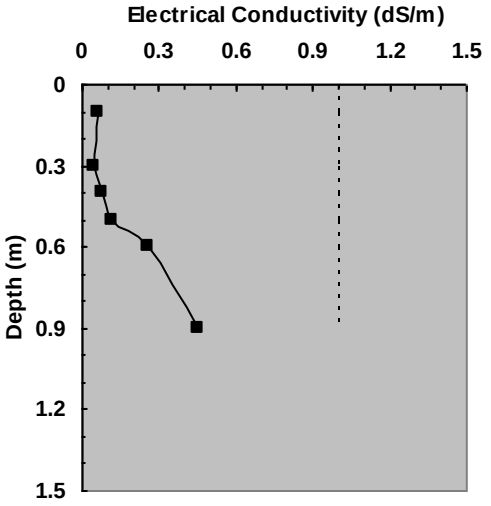
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl⁻ %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg⁻¹	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A1	0.1	6.8	.06	.004	15	63	7	13	9.1[2]	6.8	1.5	.10	.74	4.5			
A2j	0.3	7.6	.05	.002	16	60	9	15	9.2[2]	6.5	1.7	.60	.36	3.8			
B21	0.4	7.4	.08	.002	14	35	9	43	14[2]	5.4	6.2	2.5	.20	0.9	18	.93	.33
B21	0.5	7.7	.12	.004	10	40	10	41	19[2]	5.4	9.5	3.6	.20	0.6	19	1.0	.46
B22	0.6	9.1	.26	.008	8	43	10	40	23	6.4	11	4.3	.17	0.6	19	.95	.57
B22	0.9	9.5	.45	.026	8	44	7	42	16	3.7	8.0	3.7	.15	0.5	23	.97	.38

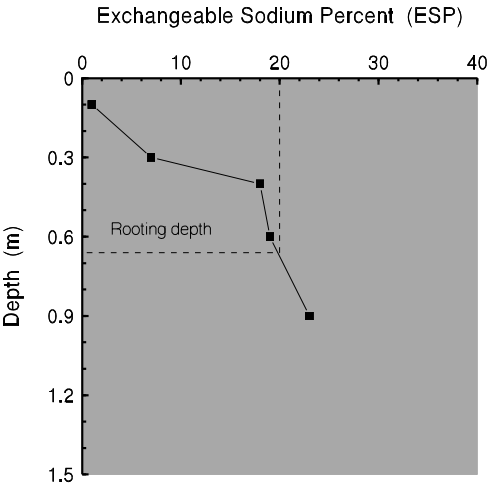
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Granville has only a low clay content in the topsoil (13-15%), which is dominated by fine sand (60-63%). The high fine sand content makes it prone to surface sealing and crusting. There is a large increase in the clay content of the subsoil (40-43%), showing the strong texture contrast. The topsoil has only a low CEC (9 cmol[+] kg^{-1}), due to its low clay content, that is calcium dominant with only a low magnesium content (1.5-1.7 cmol[+] kg^{-1}). The subsoil CEC is only moderate (16-23 cmol[+] kg^{-1}), and is magnesium dominant (Ca/Mg ratios 0.9-0.5), with only low to moderate levels of calcium (3.7-6.4 cmol[+] kg^{-1}). The subsoil is also strongly sodic (ESP 18-23) and as a result it is highly dispersive, which is also indicated by the very high dispersion ratios of 0.9 to 1.0. Although it therefore has restricted, slow drainage, subsoil salts have only built up to moderate levels (0.26-0.45 dS/m) as there is still sufficient deep drainage to leach soluble salts below the profile due to the thinness of the subsoil. The CEC:clay ratios of 0.33 to 0.57 indicates a mixed, kaolinite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Granville has a rooting depth of 0.65m, that is limited by the very high subsoil sodicity with an ESP of 20 at 0.65m. Subsoil soluble salt levels are moderate and do not limit the rooting depth (see above graphs). A rooting depth of 0.65 m results in a PAWC of 70 mm. The salt graph shows also that, despite the strongly sodic subsoil, there is still some deep drainage as the salt concentration reaches equilibrium at moderate salt levels with a smaller "salt bulge" at 0.9 m, which indicates the long-term average depth of wetting and water uptake.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	38	0.11	1.8	1.1	5	5.0	1.4
Range	14-81	.06-.17	1.3-2.8	.78-1.6	3-11	3.7-6.7	1.4-1.5
No of samples	7	7	7	2	5	2	2
Rating	High	Moderate	Moderate	High	Low	Moderate	Low

Granville has a moderate surface soil fertility as it has a high mean phosphorous content (38 mg/kg), but only a moderate mean total nitrogen level of 0.11%. The mean organic carbon content is also moderate (1.8%), and these total nitrogen and organic carbon levels are typical for coowarra box – brigalow, sodic duplex soils compared to the higher levels of the brigalow clay soils. The organic matter breaks down quicker in these lighter textured, surface soils, thus leading to lower levels of total nitrogen and organic carbon. Of the other nutrients measured, both sulphate-sulphur and magnesium are consistently low, although this interpretation is limited by the low number of samples.

Grevillea (Gr)

Concept: Grevillea is a very deep (>1.5 m), black, strongly sodic, duplex or weakly cracking clay soil with a thin (< 0.15 m) silty clay loam or silty light clay topsoil that has a very thin (≤ 0.05 m), sporadically bleached A2 horizon. The topsoil overlies a prismatic structured, clay subsoil that is strongly sodic (ESP >15) with high levels of soluble salts (EC >1.0 dS/m). Grevillea has an alkaline soil reaction trend and is formed on Quaternary alluvium.

Geology: Unconsolidated, Quaternary, alluvial sediments (Qa).

Aust Class: Black Sodosol, Black Vertosol or Black Dermosol

PPF: Dd3.33, Uf3, Dd1.33

Landform: Low-lying, flood prone backplains of the Callide Valley floodplain, and on the valley flats of some of the tributaries of the Callide and Kroombit creeks. It occurs usually in small areas of less than 50 ha, and is mainly found in the Lake Victoria area of the Callide floodplain, and also on the southern parts of the Callide floodplain immediately to the west and north of Biloela.

Vegetation: Tall (12-20 m), poplar box or poplar box – coolibah woodlands. The understorey is a low to mid-high (3-12 m), woodland of sally wattle with false sandalwood, lime bush or rams horn wattle as minor associates. The native grasses are variable and consist mainly of forest blue grass and windmill grass with pitted blue grass, slender rats tail, button and love grasses.

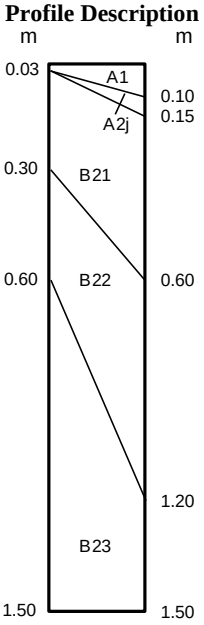
Runoff: Very slow

Permeability: Very slowly permeable

Drainage: Poorly drained

Surface cond: Usually firm surfaced, often with a thin surface flake, hard setting only when compacted, occasionally weakly cracking.

Profile Description



A1: Black, very dark brown, very dark grey, very dark grey-brown or dark grey (10YR 2/1, 2/2, 3/1, 3/2, 4/1); silty clay loam or silty light clay texture; massive, or weak to strong, 2 to 10 mm, subangular blocky or platy structure; weak to very firm dry consistence; pH 6.0 to 7.0. Abrupt to either an A2j or B21 -

A2j: (when present) Very dark grey, very dark grey-brown, dark grey or dark grey-brown (10YR 3/1, 3/2, 4/1, 4/2), light grey or white (10YR 7/1, 7/2, 8/1) dry bleach colour; silty clay loam or silty light clay texture; massive, or weak or moderate, 2 to 10 mm, subangular blocky structure; weak to very firm dry consistence; pH 6.0 to 7.5. Abrupt to -

B21: Black, very dark brown or very dark grey (10YR 2/1, 2/2, 3/1); light medium or medium clay texture; strong, 5 to 50 mm, prismatic or subangular blocky structure parting to strong, 5 to 20 mm, subangular blocky peds, sometimes also parting to strong, 2 to 10 mm, lenticular primary structure; very firm dry consistence; pH 7.5 to 8.5. Gradual to -

B22: As above except also 2-20%, concretionary or soft calcareous segregations, 2-20 mm; and structure usually weak, 2 to 10 mm lenticular or occasionally 20 to 100 mm, prismatic, occasionally parting to weak, 5-20 mm subangular blocky primary peds; pH 8.5 to 9.0. Gradual to -

B23: Very dark brown, very dark grey-brown, dark brown or dark grey (10YR 2/1, 2/2, 3/1, 3/2, 3/3, 4/1, 4/3), sometimes 2-20%, brown or dark mottles, <5-15 mm; light medium or medium clay texture; weak 2 to 10 mm, lenticular structure or occasionally 20 to 100 mm, prismatic structure, occasionally parting to weak, 2-10 mm, lenticular or subangular blocky primary peds; 2-20%, concretionary calcareous segregations, 2-20 mm; pH 8.5 to 9.0.

Soil Chemistry

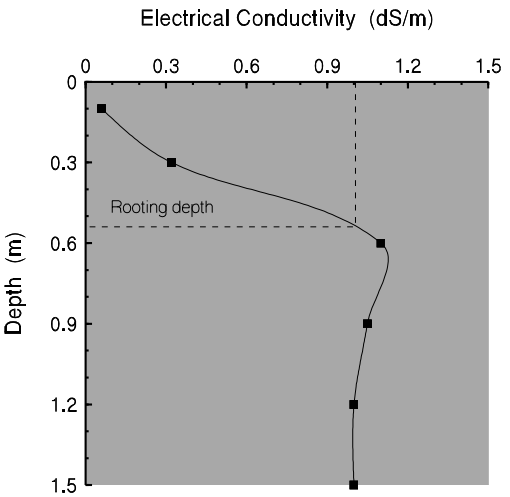
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
$A_{1,2j}$	0.1	6.6	.08	.004	4	32	36	30	18[2]	7.7	8.4	1.4	.50	0.9	8	.68	.60
B_{21}	0.2	7.3	.34	.039					35	14	14	5.9	.20	1.0	17		
B_{21}	0.3	7.9	.74	.091	3	22	27	52	41	13	17	9.3	.20	0.8	23	.79	.79
B_{22}	0.6	8.7	1.6	.206	3	17	25	60	44	13	19	14	.25	0.7	32	.93	.73
B_{22}	0.9	8.8	1.7	.213	4	20	21	58	40	10	18	13	.30	0.6	33	.98	.69
B_{23}	1.2	8.9	1.5	.179	3	20	22	55	36	9.2	16	11	.35	0.6	31		.65
B_{23}	1.5	8.9	1.4	.175													

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

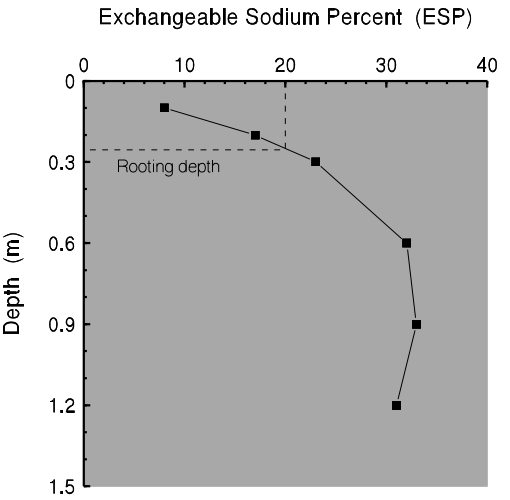
The particle size data shows the high silt content of this soil, and in general the Callide alluvial soils have significantly higher silt contents than the other soils of this study area. The silt content is very high in the surface soil and decreases with depth, whereas the clay content increases significantly in the subsoil.

The high silt and fine sand content of the surface soil also makes it susceptible to hard setting, crusting and surface sealing when cultivated. The surface soil has a moderate CEC (18 cmol[+] kg^{-1}) that increases to high levels in the subsoil (35-44 cmol[+] kg^{-1}). However cation chemistry is particularly unfavourable with the exchange capacity dominated by magnesium and sodium both of which exceed calcium over most of the subsoil. Ca/Mg ratios are low (1.0-0.6) and the subsoil is strongly sodic throughout (ESP 17-33). The subsoil is therefore highly dispersive, indicated by the very high dispersion ratios of 0.79 to 0.98, with restricted drainage. This causes soluble salts to accumulate in the subsoil, which are at very high levels below 0.3 m (1.4-1.6 dS/m). The surface soil is sodic (ESP 8) and magnesium dominant also, which would make it prone to slaking and dispersion if cultivated. The CEC:clay ratios of 0.65-0.79 indicate a mixed, smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Grevillea has a rooting depth of 0.25 m, that is limited by the very high subsoil sodicity with an ESP of 20 at 0.25 m. The subsoil salt content is also very high, but limits the rooting depth at the lower depth of 0.55 m (see above graphs). Grevillea therefore has a shallow rooting depth of 0.25 m, which results in a PAWC of 50 mm. The salt graph shows also that the salt concentration reaches equilibrium at 0.6 m, due to impeded subsoil drainage, which indicates the long-term average depth of wetting.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	56	0.16	2.5	0.37	11	12	9.4
Range	36-150	.12-.24	2.0-3.8		4-18	7.5-19	8.1-11
No of samples	6	6	6	1	6	6	6
Rating	Very high	High	Moderate	Low	High	Moderate	High

Grevillea has a high surface soil fertility as, typically for alluvial soils, it has a very high mean phosphorous content (56 mg/kg). The mean total nitrogen content is also high (0.16%), which is slightly higher than for most alluvial soils. Organic carbon levels are moderate to high, with a mean of 2.5%. Grevillea is one of the few soils with a high mean sulphate-sulphur content (11 mg/kg). Calcium and magnesium concentrations are also consistently moderate to high, while only potassium is low (but only one sample).

Greycliffe (Gc)

Concept: Greycliffe is a very deep (>1.5 m), grey or brown cracking clay soil with a pedal to coarse self-mulching topsoil and an acid soil reaction trend. The upper subsoil is strongly sodic (ESP >15), with high to very levels of soluble salts (0.8 to 2.5 dS/m). Greycliffe has widely spaced, melonhole gilgai separated by inter-gilgai flats up to 50 m in width.

Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza).

Aust Class: Grey, Brown and occasionally Black Vertosol

PPF: Ug5.24, Ug5.16, Ug5.34, Ug5.25, Ug5.28, Ug5.35

Landform: Level to gently undulating plains and occasionally gently undulating rises, with slopes of up to 3% and a relief less than 15 m. The widely spaced melonholes occur as irregular shaped depressions across the landscape separated by inter-gilgai flats up to 50 m in width.

Vegetation: Mid-high (6-12 m), brigalow forest, often referred to as whip stick brigalow. It was not possible to further describe the vegetation as Greycliffe has been almost totally cleared and sown to introduced grass pastures. Only isolated clumps of brigalow have been kept for shade. Brigalow regrowth is a common problem, requiring blade ploughing.

Microrelief: Sparse, widely spaced (10-50 m), melonhole gilgai – vertical interval: 0.2-1.0 m; horizontal interval: 10- 30 m

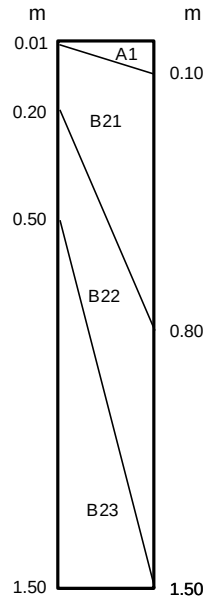
Runoff: Very slow

Permeability: Very slowly permeable

Drainage: Poorly drained

Surface cond: Firm pedal to coarse self-mulching; with <2-20% of quartz and ironstone gravels and occasional silcrete cobbles, 2-200 mm..

Profile Description **(mounds, depressions and intergilgai flats)**



A1: Very dark brown, very dark grey, very dark grey-brown to dark grey-brown (10YR 2/2, 3/1, 3/2, 3/3, 4/1, 4/2), depressions only-2-20%, orange mottles, <5 mm;. light or light medium clay texture; weak or moderate, 2 to 5 mm, subangular blocky structure, or occasionally self-mulching with a moderate 1 to 2 mm, subangular blocky or granular structure (mounds only); loose to firm consistence; <2-20%, ironstone or quartz gravels present, 2-20 mm; pH 6.0 and 7.5. Abrupt or clear to -

B21: Very dark grey, very dark grey-brown or dark grey to grey-brown (10YR 3/1, 3/2, 4/1, 4/2, 4/3, 4/4, 5/2; 2.5Y 4/2), sometimes <2-50%, dark, brown or yellow mottles, <%-30 mm; light medium or medium clay texture; moderate or strong, 5 to 20 mm, subangular blocky structure that parts to 2 to 20 mm lenticular primary peds; strong or very strong dry consistence; <2-20%, ironstone and quartz gravels, 2-20 mm; occasionally <2-10%, soft or nodular calcareous segregations, <2-20 mm; pH 5.5 to 9.0. Gradual or diffuse to -

B22: Dark grey to grey-brown, or dark brown (10YR 4/1, 4/2, 4/3, 5/2; 2.5Y 4/2; 7.5YR 4/6), usually 2-50%, grey, brown or red mottles, <5-30 mm; light medium or medium clay texture; weak or moderate, 2 to 20 mm, lenticular structure, occasionally <2% slickensides; strong or very strong dry consistence; <2-10%, ironstone or quartz gravels, 2-20 mm; occasionally <2-10%, soft or nodular calcareous, and sometimes manganese or iron-manganese segregations, <2-20 mm; pH 5.5 to 9.0. Gradual or diffuse to –

B23: (when present) The lower subsoil becomes paler in colour and is grey-brown, brown, light brown-grey or dark brown (10YR 5/2, 5/3, 5/4, 6/2; 2.5Y 5/4; 7.5YR 4/4), usually 2-50%, grey, red or brown mottles, 5->30 mm; light medium or medium clay texture; massive or weak lenticular or occasionally prismatic structure; strong or very strong dry consistence; sometimes <2-10%, ironstone or quartz gravels, 2-20 mm; <2-10%, soft or nodular calcareous, manganese or iron-manganese segregations, <2-20 mm; pH 5.0 to 8.0.

Soil Chemistry

(a) mound

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Al	Exch Acid	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A1/B21	0.1	6.4	.42	.053	21	20	16	46	22	8.7	12	1.2	.44	-	-	.73	5	.57	.48
B22	0.3	5.8	.60	.080	21	21	15	47	21	4.8	13	2.3	.27	.20	.20	.37	11	.89	.43
B22	0.6	4.9	1.3	.164	18	19	14	50	24	2.9	15	5.4	.27	.50	.50	.19	23	1.0	.48
B23	0.9	4.6	1.7	.274	11	14	17	58	26	2.3	17	5.3	.30	.40	.60	.14	21	1.0	.43
B23	1.2	4.5	2.0	.307	9	13	18	60	27	2.0	17	7.4	.33	.50	.70	.12	27	1.0	.45
B23	1.5	4.5	2.2	.340	7	14	15	64	31	2.0	18	10	.39	.50	.60	.11	34	1.0	.48

(1) Cations extracted with aqueous 1M NH_4Cl at pH 7.0, and exchangeable sodium adjusted for soluble salts

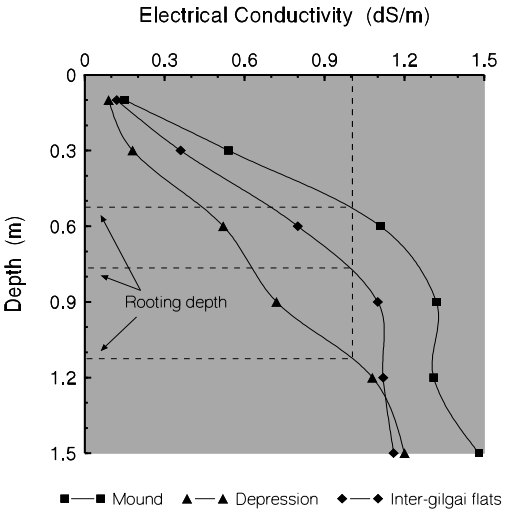
(b) depression

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	ECEC	Exchangeable Cations[1] Ca cmol[+] kg^{-1}	Mg cmol[+] kg^{-1}	Na cmol[+] kg^{-1}	K cmol[+] kg^{-1}	Al cmol[+] kg^{-1}	Exch Acid cmol[+] kg^{-1}	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	6.3	.16	.016	20	18	19	46	23	7.0	12	1.9	.48	-	-	.58	8	.65	.50
B_{21}	0.3	5.6	.48	.066	23	19	19	42	20	4.5	12	3.4	.25	.20	.20	.38	17	.88	.48
B_{22}	0.6	4.7	1.3	.203	17	19	14	50	21	2.4	13	4.3	.29	.40	.50	.18	20	.98	.42
B_{22}	0.9	4.6	1.7	.246	14	21	15	53	22	2.0	14	5.1	.33	.30	.50	.14	23	.98	.42
B_{22}	1.2	4.6	1.9	.289	9	17	16	58	26	1.9	16	6.9	.33	.40	.60	.12	27	1.0	.45
B_{22}	1.5	4.6	2.0	.338	6	16	18	60	29	1.9	17	9.5	.46	.30	.50	.11	33	1.0	.48

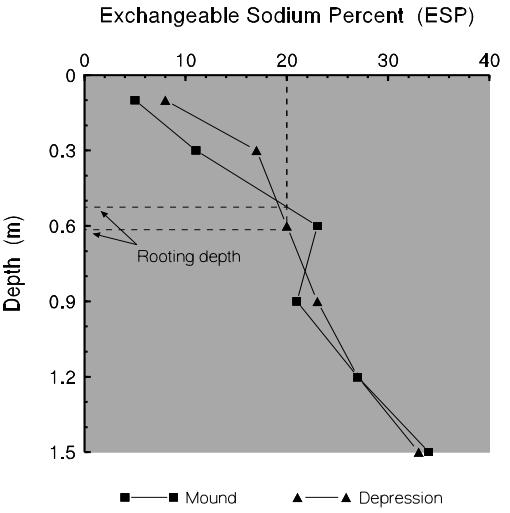
[1] Cations extracted with aqueous 1M NH_4Cl at pH 7.0, and exchangeable sodium adjusted for soluble salts

One of the main features of the Greycliffe soil is that it is often strongly acidic (pH 4.5-5.5) in the lower subsoil. The clay content is high to very high throughout the profile. The CEC is mainly moderate (20-31 cmol[+] kg^{-1}), however cation chemistry is particularly unfavourable with the exchange capacity dominated by magnesium and sodium, both of which exceed calcium over most of the subsoil. Ca/Mg ratios are therefore low to very low (0.7-0.1), and the subsoil is strongly sodic throughout (ESP 17-34). The subsoil is therefore highly dispersive, indicated by the very high dispersion ratios of 0.9 to 1.0, with restricted drainage. This causes soluble salts to accumulate in the subsoil, which are at very high levels below 0.3 m (1.3-2.2 dS/m). There is also a small amount of exchangeable aluminium and acidity due to the low pH. At this site, the melonhole depression for some reason does not show the leaching effect of the ponded water, which is evident in the below salt graph, which is derived from the mean of many sites. This shows that the peak salt and sodicity concentrations have been moved lower in the profile. The CEC:clay ratios of 0.42 to 0.5 indicate a mixed clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Greycliffe has a rooting depth that is limited by the very high subsoil sodicity (ESP ≥ 20), which occurs at depths of 0.5 m and 0.6 m in the mounds and depressions respectively. The very high levels of subsoil soluble salts also limits the rooting depth, however this occurs below 0.5 m, so that sodicity is more limiting. The Greycliffe soil therefore has a rooting depth of 0.5 m, which results in a PAWC of 70 mm. The salt graph shows also the effect of the slow subsoil drainage with the salt concentration reaching equilibrium at 0.9 m on the mounds and intergilgai flats, as very little deep drainage occurs. Compare this to the equilibrium point of 1.2 m in the depressions where there is significantly more deep drainage as water can pond in the depressions for up to three months during the summer, thus leaching the salts lower in the profile.

Surface Soil Fertility (data is combined mounds and depressions)

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	53	0.16	2.0	0.87	10	13	9.4
Range	12-117	.10-.31	1.2-3.7	.69-1.1	6-17	7.0-23	6.9-12
No of samples	13	13	13	4	9	4	4
Rating	Very high	High	Moderate	Moderate	High	Moderate	High

Greycliffe has high surface soil fertility due to its very high mean phosphorous content (53 mg/kg), and high mean level of total nitrogen (0.16%). The mean organic carbon content while only moderate (2.0%) is still significantly higher than for eucalypt woodland clay soils, as the greater biomass of brigalow scrub results in higher levels of organic carbon and total nitrogen in the surface soil. It is also one of the few soils with a high mean sulphur content (10 mg/kg). The other nutrients measured are moderate or high.

Greycliffe, melonhole phase (GcMp)

Concept: Greycliffe melonhole phase is a very deep (>1.5 m), grey cracking clay with well developed melonhole gilgai. It is strongly sodic (ESP >15) with high levels of soluble salts ($EC_{1:5}$ >0.8dS/m) in the upper 0.3 to 0.5 m of the subsoil, and has mainly an acid soil reaction trend.

Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza), derived mainly from the weathering of the Tertiary land surface.

Aust Class: **Mounds and depressions:** Grey or Brown Vertosol

PPF: **Mounds and depressions:** Ug5.24, Ug5.28, Ug5.34

Landform: Level to gently undulating plains and occasional rises formed on the unconsolidated, Cainozoic, alluvial-colluvial fans and outwash plains, surrounding the remnants of the Tertiary sandstone plateaus. Greycliffe melonhole phase is one of the more extensive soil types and is found in association with Greycliffe throughout the Callide and Dawson Valleys.

Vegetation: Mid-high or occasionally tall (6-20 m), open forest of brigalow, occasionally with coowarra box and yapunyah as emergents. Yapunyah occurs only to the west Banana, where the Greycliffe melonhole phase soil has a strongly acid subsoil. The understorey is made up mainly of wilga, holly bush, sandalwood and lime bush with brigalow grasses, slender panic, windmill grass, love grasses and low shrubs such as currant bush in the ground layer.

Microrelief: Strongly developed melonhole gilgai – vertical interval: 0.5-1.6 m; horizontal interval: 20-60 m

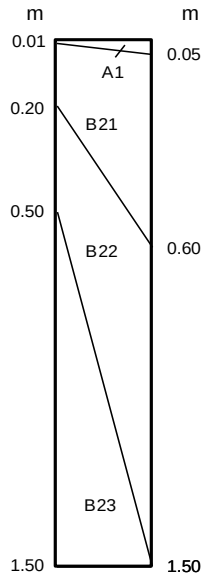
Runoff: Very slow

Permeability: Very slowly permeable

Drainage: Poorly drained

Surface cond: Mounds are usually coarse self-mulching with a surface flake or crust, and the depressions are firm with a crust. There are often 2 to 20%, ironstone (ferruginous siltstone) and quartz gravels, 2-20 mm, on the mounds

Profile Description **(mounds and depressions)**



A1: Very dark grey, very dark grey-brown, dark brown to dark grey-brown (10YR 3/1, 3/2, 3/3, 4/1, 4/2), 2-20%, orange mottles, <5 mm (depressions only); light, light medium or medium clay texture; strong, <2 to 5 mm, subangular blocky or granular structure (mounds), moderate or strong, 2 to 10 mm subangular blocky structure (depressions); loose to firm dry consistence; <2-20%, quartz, ironstone or silcrete gravels (2-20 mm); rarely <2%, nodular calcareous segregations, <2 mm (mounds); pH 6.0 to 8.5. Abrupt to -

B21: Dark grey to grey-brown, or dark brown (10YR 3/3, 4/1, 4/2, 4/3, 5/3, 5/3), occasionally 2-20%, dark, brown or orange mottles, <5-15 mm; light medium to medium heavy clay texture; strong, 5 to 20 mm subangular blocky structure sometimes parting to lenticular primary peds, or moderate or strong, 2 to 10mm lenticular structure; very firm or strong dry consistence; <2-10%, ironstone, silcrete or quartz gravels, 2-20 mm; sometimes <2-20%, soft or nodular calcareous segregations, <2-6 mm (mounds); 2-20%, soft or nodular manganese segregations, <2-6 mm (depressions); pH 6.5 to8.5. Gradual or diffuse to –

B22: The lower subsoil becomes paler in colour to dark grey-brown, dark brown, grey-brown to light grey-brown (2.5Y 5/2; 10YR 4/2, 4/4, 5/2, 5/3, 5/4, 6/2), sometimes 2-50%, orange, grey or brown mottles, <5-15 mm; light medium to medium heavy clay texture; weak or moderate lenticular structure; strong or very strong dry consistence; occasionally <2-10%, quartz or ironstone gravels, 2-20 mm; sometimes <2-10%, soft or nodular calcareous segregations, <2-6 mm (mounds) and <2-10%, soft or concretionary manganese segregations, 2-6 mm (depressions); pH usually 5.0 to 6.5, sometimes alkaline, pH 7.5 to 8.5, for those few profiles with calcareous segregations. Gradual or diffuse to -

B23: (when present) as above except structure is massive to weak, lenticular; calcareous segregations only very occasionally present in the mounds, and sometimes <2-20%, soft or concretionary manganese segregations, <2-6 mm (mounds and depressions).

Soil Chemistry

(a) mound

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	6.7	.15	.006	12	23	17	46	29	18	9.0	.68	1.4	2.0	2	.42	.63
B_{21}	0.3	6.7	.55	.065	6	17	20	56	32	13	14	4.1	.60	.93	13	.79	.57
B_{22}	0.6	5.2	1.2	.173	3	16	20	60	29	9.8	14	5.1	.37	.70	18	.90	.48
B_{23}	0.9	4.8	1.2	.189	2	14	21	61	26	7.4	13	5.7	.35	.57	22	.96	.43
B_{23}	1.2	4.7	1.2	.191	2	16	20	61	26	6.4	13	6.6	.36	.49	25		.43
B_{23}	1.5	4.7	1.3	.207													

[1] Cations extracted with aqueous 1M NH_4Cl at pH 7.0

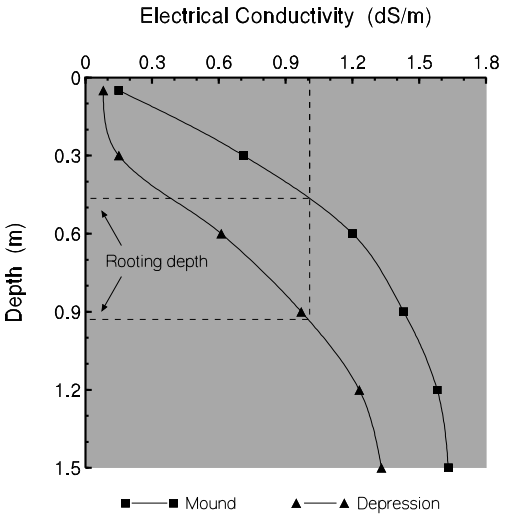
(b) depression

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	7.0	.10	.006	8	18	19	53	32	20	10	.93	.80	2.0	3	.81	.60
B_{21}	0.3	7.8	.18	.019	8	17	20	56	34	21	9.7	2.5	.60	2.2	7	.70	.61
B_{22}	0.6	8.4	.36	.040	13	22	17	48	29	15	9.6	3.8	.35	1.6	13	.87	.60
B_{23}	0.9	7.6	.46	.061	15	24	18	44	24	9.1	10	4.8	.27	.91	20	.93	.55
B_{23}	1.2	5.8	.66	.096	13	24	19	44	21	6.0	9.9	4.6	.25	.61	22		.48
B_{23}	1.5	5.6	.76	.112													

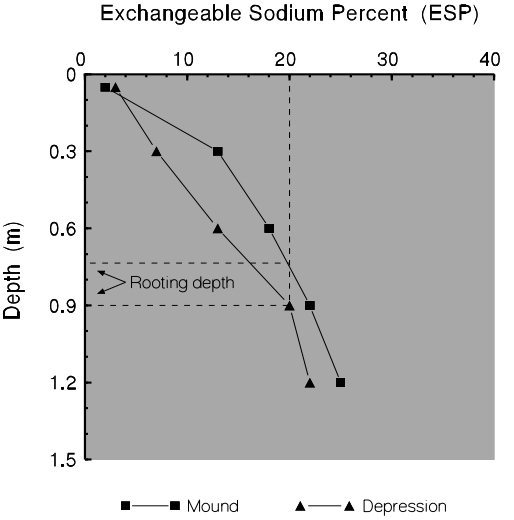
(1) Cations extracted with aqueous 1M NH_4Cl at pH 7.0

The above data is similar to that of Greycliffe, with a strongly acid mound profile, while the depression is an example of those profiles with an alkaline upper subsoil and strongly acid lower subsoil. Clay contents are high to very high (44-61%). Calcium is also at much higher levels than in the Greycliffe profile (6-20 cmol[+] kg^{-1}), but on the mound magnesium is still the dominant cation throughout the subsoil (Ca/Mg ratios 0.9-0.5). The subsoil is sodic to strongly sodic (ESP 7-25) and highly dispersive (dispersion ratios 0.8-0.96), and as a result is very slowly drained as indicated by the very high levels of soluble salts (1.2-1.3 dS/m) below 0.3 m on the mound. The depression data shows the effect of ponded water with significantly lower levels of soluble salts (0.18-0.76 dS/m). Exchangeable sodium has also been moved lower in the profile (see ESP graph below). The CEC:clay ratios of 0.43 to 0.63 indicate a mixed, smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Greycliffe melonhole phase has a rooting depth of 0.45 m on the mounds and 0.9 m in the depressions due to the very high subsoil salt content (≥1.0 dS/m) and high subsoil sodicity (ESP ≥20) (see above graphs). The rooting depth for the mound is used to determine the overall PAWC, as it is the most limiting. Greycliffe melonhole phase therefore has a rooting depth of 0.45 m, which results in a PAWC of 75 mm. The salt graph shows also the effect of the very slow subsoil drainage, with the salt concentration reaching equilibrium on the mounds at 0.6 m. Compare this to the equilibrium point of 1.2 m in the depressions, where water can be ponded for up to three months over the summers, and therefore significantly more deep drainage occurs leaching the salts lower in the profile.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	48	0.16	1.9	1.1	16	13	10
Range	16-128	.10-.25	1.1-3.3	.73-1.5	11-27	7.2-19	8.4-12
No of samples	12	12	12	7	7	7	7
Rating	Very high	High	Moderate	High	Very high	Moderate	High

Greycliffe melonhole phase has a high surface soil fertility* due to its very high mean phosphorous content (48 mg/kg) and high mean level of total nitrogen (0.16%). The mean organic carbon content is only moderate (1.9%), which is low for a brigalow clay soil. However, organic carbon and total nitrogen levels are still significantly higher than for eucalypt clay soils. Greycliffe melonhole phase is also one of the very few soils that has a very high mean sulphur content (16 mg/kg). Mean potassium content is also high (1.1 meq%). * Data is combined mounds and depressions

Harris (Hr)

Concept: Harris is a moderately deep to very deep (0.8->1.5 m), black or brown, cracking clay soil with a fine self-mulching topsoil and an alkaline soil reaction trend, that is formed on intermediate to basic volcanic rocks. The subsoil is sodic (ESP 10-12), with high levels of soluble salts (EC >0.7 dS/m) below 0.5 m.

Geology: Little weathered, Permian, intermediate to basic volcanic rocks of the Camboon andesites (Pln).

Aust Class: Black or Brown Vertosol

PPF: Ug5.15, Ug5.13, Ug5.32

Landform: Footslopes and mid-slopes of undulating rises and low hills that have gradients of 1 to 7%, and relief of 25 to 80 m. Some of the areas of low hills can be strongly dissected. Harris occurs as small pockets of a brigalow clay soil, 1 to 30 ha in size, within larger areas of the Santo soil, which has a silver-leaved ironbark – gum-topped bloodwood vegetation.

Vegetation: Mid-high to tall (6-20 m), brigalow open forest or woodlands, with associated species such as narrow and broad-leaved bottle trees, red and white-flowered bauhinia and occasionally belah. Wilga, false sandalwood, lime bush and whitewood are the dominant understorey species, while sparse grasses such as brigalow grass (*Paspalidium spp*) and curly windmill grass, along with prostrate shrubs such as currant bush are found in the ground layer.

Microrelief: Normal gilgai very occasionally – vertical interval: 0.3 m; horizontal interval: 3-6 m

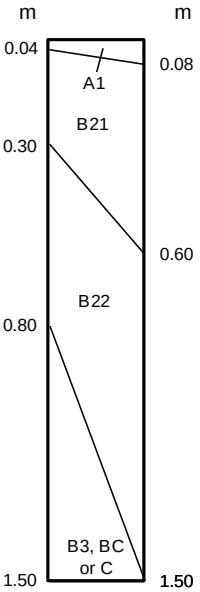
Runoff: Slow to moderately rapid

Permeability: Slowly permeable

Drainage: Imperfectly drained

Surface cond: Fine self-mulching topsoil (peds 1-2 mm), periodic cracking; with <2-20% gravels and cobbles,2-200 mm of andesite

Profile Description



A1: Black to very dark grey-brown or dark brown (10YR 2/1, 2/2, 3/1, 3/2; 7.5YR 3/2); light medium or medium clay texture; strong, 1-2 mm, granular structure; loose dry consistence; <2-10%, quartz or volcanic rocks, 2-20 mm; pH 6.5 to 7.5. Abrupt to -

B21: Black, very dark brown, very dark grey or dark brown (10YR 2/1, 2/2, 3/1, 3/3; 7.5YR 3/4); light medium, medium or medium heavy clay texture; strong, 5 to 50 mm, subangular blocky, or strong, 2 to 10 mm, lenticular structure; very firm or strong dry consistence; sometimes <2-10%, soft or nodular calcareous segregations, <2-20 mm; <2-10%, quartz or volcanic rock gravels, 2-20 mm; pH of 8.5 to 9.0. Gradual to -

B22: Very dark grey, very dark grey-brown or dark brown (10YR 3/1, 3/2, 3/3, 4/3; 2.5Y 3/2; 7.5YR 4/4), sometimes (2-50%, dark or brown mottles, <5-15 mm; light medium or medium clay texture; strong, 2 to 20 mm, lenticular structure, sometimes 2-10% slickensides; strong dry consistence; <2-20%, soft or nodular calcareous segregations, <2-20 mm; <2-10%, quartz or volcanic rock gravels, 2-20 mm; occasionally 2-50%, gypsum crystals, <2-6 mm; pH 8.5 to 9.0. Abrupt or clear to -

B3 or BC: Yellow-brown, light olive-brown to light yellow-brown and sometimes white (2.5Y 5/6, 6/4; 10YR 5/6, 8/1), 10-50%, red, brown or pale mottles, 5->30 mm; fine sandy light or light clay texture; 20-90%, fragments of weathered volcanic rock; 2-20%, soft or nodular calcareous segregations, 2-60 mm; rarely, 2-10%, gypsum crystals, <2-6 mm; pH 6.0 to 8.5. Abrupt to -

C: The C horizons are composed entirely of weathered volcanic rock, sometimes 2-50%, soft calcareous segregations, 6-20 mm.

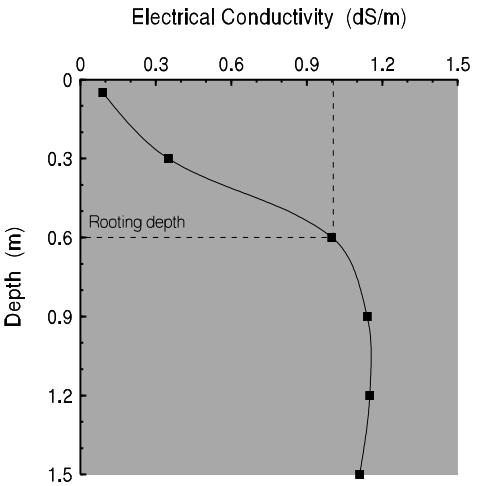
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	7.2	.18	.003	17	12	14	59	40[2]	35	4.0	.40	.63	8.7	1	.46	.68
B_{21}	0.3	7.4	.22	.020	11	11	10	69	44	33	7.1	1.9	.19	4.6	4	.42	.64
B_{22}	0.6	8.4	.74	.080	10	11	14	67	37[2]	25	8.7	3.6	.10	2.9	10	.39	.55
B_{23}	0.9	7.9	.76[3]	.083					29[2]	19	6.8	2.8	.02	2.8	10		
B_{23}	1.2	6.1	1.0[3]	.110					27[2]	16	7.5	3.1	.02	2.1	11		
BC	1.5	4.5	1.6[3]	.176					26	13	9.2	3.0	.01	1.4	12		

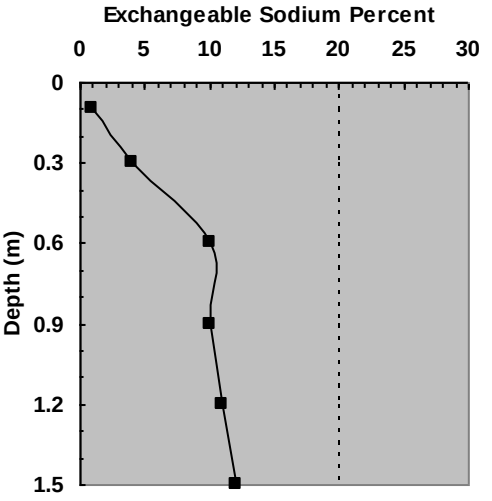
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC [3] Cl used to estimate EC

The clay content is very high (59-67%) in the upper subsoil (gypsum prevented reliable measure of the particle size and R1 dispersion ratio below 0.6 m). The CEC is also high (26-44 cmol[+] kg^{-1}), and strongly calcium dominant (Ca/Mg ratios (8.7-2.9). This is typical for soils developed on these Permian intermediate to basic volcanic rocks. The lower subsoil is sodic (ESP 10-12), and dispersive and slowly drained, despite the high calcium levels, as indicated by the high chloride content (0.08-0.176%) below 0.3 m (the electrical conductivity is affected by subsoil gypsum). The upper subsoil CEC:clay ratios of 0.55 to 0.68 indicate a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Harris has a rooting depth of 0.6 m that is limited by the high subsoil salt content (≥1.0 dS/m). Harris has only a moderately sodic subsoil (ESP 10-12) that does not limit the rooting depth (see above graphs). A rooting depth of 0.6m results in a PAWC of 105 mm. Harris has a high water holding capacity per unit depth of soil due to its very high clay content. The salt graph shows also that the profile salt content reaches equilibrium at 0.6 m, due to impeded subsoil drainage, which indicates the long-term average depth of wetting.

Surface Soil Fertility

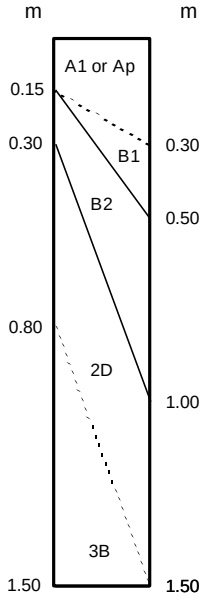
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Nutrient level	18	0.35	4.4	0.94	37	3.4
No of samples	1	1	1	1	1	1
Rating	High	Very high	Very high	Moderate	Very high	Moderate

Although sampled at only one site, the fertility data for Harris is representative of brigalow clay soils. The data shown in the above table indicates that Harris has a high surface soil fertility due to its high phosphorous content (18 mg/kg) and very high total nitrogen (0.35%) and organic carbon contents (4.4%). Harris was sampled in an uncleared area of brigalow scrub which most likely accounts for the high organic carbon and total nitrogen contents, and therefore represent pre-clearing nutrient levels. They are also significantly higher than eucalypt clay soils, due to the higher biomass of the brigalow forest. The other nutrients measured are moderate to very high.

Hodge (Hd)

Concept: Hodge is a very deep (>1.5 m), black or dark brown, gradational or uniform clay loam soil with a moderately thick to thick (0.1-0.5 m) clay loamy topsoil that overlies a massive to moderate, coarse prismatic structured, clay loam subsoil, which overlies buried soil materials between 0.3 to 1.0 m.
Geology: Unconsolidated, Quaternary, alluvial sediments (Qa)
Aust Class: Black or Brown Dermosol or Kandosol
PPF: Gn3.42, Um6, Gn2
Landform: Hodge occurs only on the active levee of the Callide Creek, for only a short distance into the Banana study area to the north of Biloela. It is more extensive on the Callide Creek to the east of the Banana study area (Shields 1989) and on the levees of the Kroombit and Kariboe Creeks to the south of Biloela. The Callide Creek levee has a gentle back slope of 0.5 to 1.5%, but falls steeply a depth of 3 to 5 m into the creek bed, and is some 200 to 300 m wide on each bank of the Callide creek.
Vegetation: Tall (12-20 m), open forests or woodlands of Moreton Bay ash and forest blue gum with an understorey of sally wattle. Apart from a thin strip of vegetation left along the creek banks and levee crest, Hodge has been completely cleared for irrigated or dryland cropping.
Runoff: Slow
Permeability: Moderately permeable
Drainage: Well drained
Surface cond: Firm, becomes hard setting and crusting when cultivated

Profile Description



A1 or Ap: Black, very dark brown, very dark grey or very dark grey-brown (10YR 2/1, 2/2, 3/1, 3/2), fine sandy loam, fine sandy clay loam or clay loam fine sandy texture; massive or weak, 2 to 5 mm, subangular blocky structure; weak or firm dry consistence; pH 6.0 to 7.0. Clear or gradual to -
B1: (when present) Black or very dark grey-brown (10YR 2/1, 3/2); 2-20%, brown mottles, 5-15 mm; a clay loam fine sandy texture; massive or weak, 5 to 10 mm, subangular blocky structure; very firm dry consistence; pH 6.5 to 7.5. Clear or gradual to -
B2: Black, very dark brown, very dark grey, very dark grey-brown or dark brown (10YR 2/1, 2/2, 3/1, 3/2, 3/3), occasionally 2-10%, brown or dark mottles, <5-15 mm; fine sandy clay loam or clay loam fine sandy texture; massive, or weak or moderate, coarse prismatic or subangular blocky structure; firm or very firm dry consistence; pH 7.0 to 8.0. Abrupt or clear to -
2D: Very dark grey-brown, dark brown or dark grey-brown (10YR 3/2, 3/3, 4/2, 4/3, 4/4); sand, sandy loam, sandy clay loam or fine sandy clay loam or clay loam fine sandy texture; single grain or massive structure; <2%, calcareous segregations, <2 mm; pH 7.0 to 8.5. Abrupt to -
3B2: (when present) Black, very dark brown, very dark grey, very dark grey-brown or dark brown (10YR 2/1, 2/2, 3/1, 3/2, 3/3); sandy light medium, light medium or medium clay texture; strong, 10 to 20 mm, prismatic structure parting to 2 to 5 mm, subangular blocky primary peds, or a strong, 2 to 10 mm, subangular blocky structure; very firm dry consistence; pH 7.0 and 8.0.

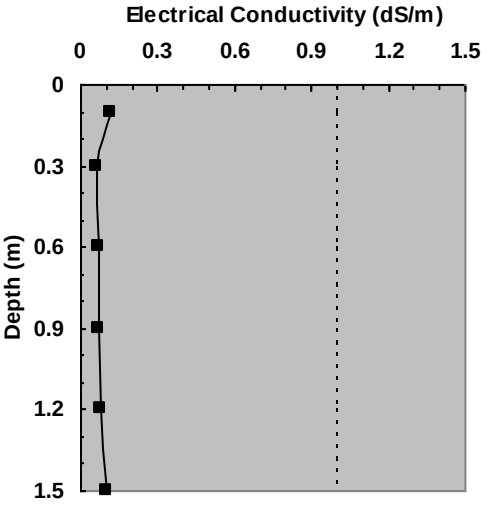
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio
A_p	0.1	6.2	.12	.001	12	63	11	16	11[2]	7.0	2.5	.06	1.3	2.8
B_1	0.3	6.9	.06	.001	5	64	14	20	17[2]	13	3.7	.05	.63	3.5
B_2	0.6	7.7	.07	.001	3	49	24	29	26	20	5.0	.15	.37	4.0
2D	0.9	8.2	.07	.002	11	68	9	13	15	11	4.0	.03	.23	2.8
2D	1.2	8.3	.08	.001	22	57	8	14	15	10	4.4	.07	.25	2.3
3D	1.5	8.3	.10	.002										

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Typically for alluvial soils Hodge has an alkaline subsoil. As it is a levee soil, the particle size is dominated by fine sand (49-64%), with only a moderate clay content (16-29%). The high fine sand content of the surface soil also makes it pone to crusting and surface sealing, which can affect water entry. The particle size data also shows the discontinuity to the buried soil materials at 0.9 m. The CEC is therefore only moderate (11-26 cmol[+] kg^{-1}), and is typically strongly calcium dominant (Ca/Mg ratios 2.8-4.0). As the profile is sandy and porous it is freely draining as indicated by the very low soluble salt content throughout the profile (0.06-0.12 dS/m). Exchangeable sodium levels are also very low as it is well drained, however the ESP, dispersion and CEC:clay ratio are not relevant at these clay contents.

Plant Available Water Capacity



Mean profile salt graph

Hodge has a rooting depth of 1.5 m, as subsoil salinity and sodicity are very low and not limiting (see above graphs). The water holding capacity is limited to some degree by sandy nature of the profile and the thick, buried sandy horizons. The PAWC therefore varies across a paddock depending on the texture and thickness of these soil horizons. The horizons of the sampled profile are typical for the Hodge soil, which has a PAWC of 100 mm. The salt graph shows also that there is significant deep drainage below the soil profile as the salt concentration is very low throughout the profile (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage). This salt profile is typical of a recharge soil.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Nutrient level	69	0.08	1.2	1.7	7	7.0	2.5
No of samples	1	1	1	1	1	1	1
Rating	Very high	Low	Low	High	Moderate	Moderate	Moderate

Although sampled at only one site due to its limited occurrence, the data is representative of alluvial soils. Hodge has a moderate surface soil fertility as it has a very high phosphorous content (69 mg/kg). However the total nitrogen and organic carbon contents are low (0.08 and 1.2% respectively), as the sampled site is from a long-term cropping paddock. Pre-clearing organic carbon and total nitrogen contents would be around the 2.0% and 0.12% mark respectively. Nitrates can also be readily leached through the profile as Hodge is so freely draining. Hodge has a high potassium content (1.7 meq%) which is also typical of alluvial soils of the Callide floodplain, while the sulphur (7 mg/kg), calcium (7.0 cmol[+] kg^{-1}) and magnesium (2.5 cmol[+] kg^{-1}) concentrations are moderate.

Jambin (Jb)

Concept: Jambin is a very deep (>1.5 m), black cracking clay soil with a fine self-mulching topsoil and an alkaline soil reaction trend. The subsoil is strongly sodic (ESP ≥15) with high to very high levels of soluble salts (0.8->1.5 dS/m) in the lower subsoil below 0.9 m. Jambin has weakly developed normal gilgai and is formed on Quaternary alluvium.

Geology: Unconsolidated, Quaternary, alluvial sediments (Qa).

Aust Class: Black Vertosol

PPF: Ug5.1, Ug5.15, Ug5.16

Landform: Level backplains of the Callide Creek floodplain, and valley flats of its tributaries in the Jambin area. It also occurs along almost the entire eastern margin of the Don and Dee River floodplain upstream from the constriction at Rannes. Slopes are typically 0.1 to 0.3% and the relief is less than 3 m.

Vegetation: Mid-high (6-12 m), brigalow open forest, with red bauhinia and white flowered bauhinia as associated species. Coowarra box and coolibah are sometimes present as emergents. The understorey comprises species such as false sandalwood, lime bush, wilga and ram's horn wattle. However very little brigalow scrub now remains as Jambin has been almost totally cleared for irrigated or dryland cropping.

Microrelief: Weakly developed normal gilgai – vertical interval: < 0.1 m, horizontal interval: 2 to 3 m

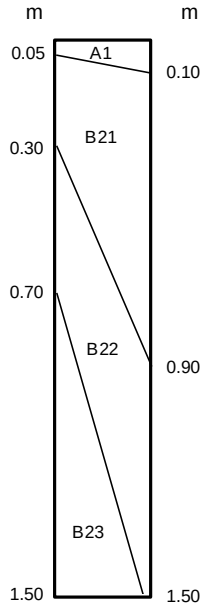
Runoff: Slow

Permeability: Slowly permeable

Drainage: Imperfectly drained

Surface cond: Fine self-mulching, periodic cracking

Profile Description



A1: Black, very dark brown, very dark grey, very dark grey-brown or occasionally dark grey (10YR 2/1, 2/2, 3/1, 3/2, 4/1); silty light medium, medium or medium heavy clay texture; weak to strong, 2 to 5 mm, subangular blocky or polyhedral structure parting to strong, 1-2 mm, granular, subangular blocky or polyhedral primary peds; loose dry consistence; occasionally <2-10%, calcareous concretions, <2-6 mm (mounds only); pH 6.5 to 8.5. Abrupt to -

B21: Black, very dark grey or very dark grey-brown (10YR 2/1, 3/1; 2.5Y 3/2); silty medium or medium heavy clay texture; strong, 10 to 50 mm, subangular blocky structure parting to 2 to 10 mm subangular blocky or lenticular primary peds, or strong, 2 to 10 mm, lenticular structure; very firm or strong dry consistence; sometimes <2-10%, soft or nodular calcareous segregation, <2-6 mm; pH 7.0 to 9.0. Clear or gradual to -

B22: Black, very dark grey, very dark grey-brown or dark brown (10YR 2/1, 3/1, 3/2, 3/3, 4/4; 2.5Y 3/2), occasionally 2-20%, dark, yellow or brown mottles, <5-15 mm; light medium, medium or medium heavy clay texture; strong, 2 to 10 mm, lenticular structure, sometimes 2-10% slickensides; strong dry consistence; <2-20%, concretionary, soft or nodular calcareous segregations, <2-20 mm; occasionally, 2-20%, gypsum crystals, <2 mm; pH 8.0 to 9.0. Clear or gradual to -

B23: (when present) Black, very dark grey, dark brown, dark grey or dark grey-brown (10YR 2/1, 3/1, 3/3, 4/1; 2.5Y 4/2), sometimes <2-20%, dark, brown or yellow mottles, <5-15 mm; light medium or medium clay texture; strong, 2 to 10 mm, lenticular or occasionally 10 to 50 mm, prismatic structure that parts to lenticular primary peds; very firm or strong dry consistence; <2-10%, nodular or concretionary calcareous segregations, or very occasionally soft manganese segregations, <2-6 mm; pH 8.0 to 9.0

Soil Chemistry

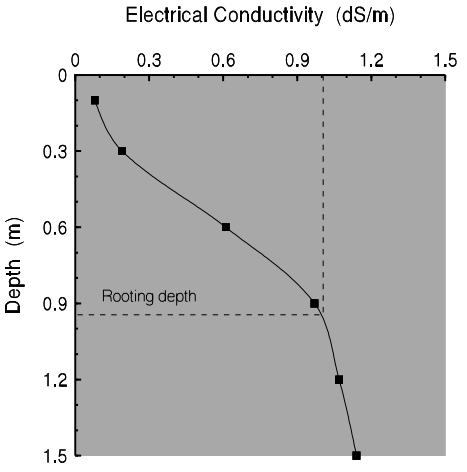
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A1/B21	0.1	7.2	.10	.004	3	12	21	64	50[2]	32	16	0.8	1.4	1.5	2	.47	.78
B21	0.3	8.4	.55	.051	3	13	19	66	52[2]	29	18	4.1	.46	1.6	8	.49	.79
B22	0.6	8.3	.78	.070	2	12	19	68	52[2]	24	21	6.8	.32	1.1	13	.65	.76
B23	0.9	8.1	.75	.094	2	12	19	66	52	21	22	7.0	.27	1.0	14	.82	.79
B24	1.2	8.0	.78	.090	2	14	21	64	52	19	22	8.0	.24	0.9	15	.88	.81
B24	1.5	8.5	.81	.100	4	16	19	66	45	16	19	6.9	.25	0.8	15	.83	.68

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

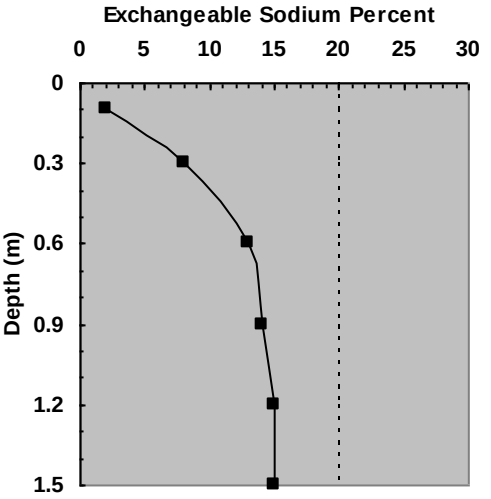
Jambin typically has an alkaline subsoil. It has a very high clay content (64-68%) as it occurs on the backplains. Silt levels are also high (19-21%) which is also typical of the Callide alluvial soils. The CEC is very high (45-52 cmol[+] kg^{-1}) and is calcium dominant in the upper subsoil which decreases with depth so that magnesium is dominant in the lower subsoil (Ca/Mg ratios 1.6-0.8). Calcium and magnesium are both at high levels.

The subsoil is sodic (ESP 8-15) and dispersive in the lower subsoil (dispersion ratios 0.82-0.88), where magnesium is dominant, and therefore slowly drained as indicated by the moderate salt content (0.75-0.8 dS/m) below 0.6 m. The CEC:clay ratios of 0.68 to 0.81 indicate a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Jambin has a rooting depth of 0.95 m that is limited by the very high profile salt content (≥1.0 dS/m). Although subsoil sodicity is moderate it does not limit the rooting depth. A rooting depth of 0.95 m results in a PAWC of 160 mm. Jambin has a high water holding capacity per unit depth of soil due to its high clay content throughout the profile. The salt graph shows also that the salt concentration reaches equilibrium at 0.9 m, due to impeded subsoil drainage, which indicates the long term depth of wetting.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	74	0.18	2.3	1.0	8	25	10
Range	28-212	.13-.34	1.7-4.7		4-16	21-28	7.3-19
No of samples	7	7	7	1	6	4	4
Rating	Very high	High	Moderate	Moderate	Moderate	High	High

Jambin has a high fertility due to its very high mean phosphorous content (74 mg/kg), which is typical for alluvial soils, and its high mean total nitrogen level of 0.18%. The maximum total nitrogen of 0.34% was obtained from an undisturbed site with brigalow scrub. The mean organic carbon content is moderate (2.3%), again demonstrating that brigalow clay soils have higher levels of organic matter and total nitrogen than eucalypt clay soils due to the higher biomass of the brigalow forest. Sulphate sulphur contents are mainly moderate, while the one sample analysed for potassium is also moderate, which is typical for the Callide alluvial soils.

Kianga (Kg)

Concept: Kianga is a shallow to deep (0.3-1.2 m), red or brown, non-cracking clay or occasionally gradational soil with a 0.05 to 0.3 m thick clay loam, light or light medium clay topsoil overlying a structured, light medium or medium clay subsoil. Kianga has an alkaline soil reaction trend and is formed on Permian sedimentary rocks.

Geology: Weathered, folded, Permian siltstone and mudstones and shale of the Rannes Beds (Pw), Back Creek Group (Pb) and Gyranda Formation (Puy) of the Bowen Basin.

Aust Class: Red or Brown Dermosol

PPF: Uf6.31, Gn3.13

Landform: Hillslopes and pediments of gently undulating or undulating rises with slopes of 1 to 7%, and relief of 10 to 30 m, formed on the folded, sedimentary rocks. Kianga occurs mainly around Rannes, to the south of Mt. Cooper and in the vicinity of Banana. Kianga also forms soil complexes with the Fairview and Police Camp soils.

Vegetation: Closed softwood scrub forest, comprising mainly narrow, and to a lesser extent, broad-leaved bottle trees, red bauhinia and white-flowered bauhinia, scrub ironbark and crows ash, occasionally with coowarra box as an emergent. As Kianga merges with the eucalypt woodlands, gum-topped bloodwood and silver-leaved ironbark are sometimes present. The shrub layer is made up mainly of currant bush, holly bush, *Cassia spp.* and wait-a-while. Most areas of Kianga have been cleared for rainfed cropping or sown to introduced grasses for cattle fattening, and very little natural vegetation now remains.

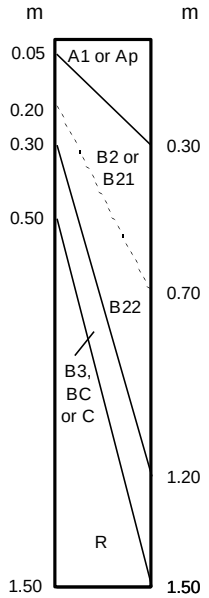
Runoff: Moderately rapid

Permeability: Moderately permeable

Drainage: Moderately well drained

Surface cond: Firm, pedal surface soil, or occasionally very fine self-mulching; with 2-50%, gravels of sedimentary rock or quartz, 2-60 mm.

Profile Description



A1 or Ap: Dark brown, red-brown or dark red-brown (5YR 3/3, 4/3; 7.5YR 3/2, 3/3, 3/4; 10YR 3/3); clay loam to light or light medium clay texture; moderate or strong, <2 to 10 mm, subangular blocky structure; loose to firm dry consistence; 2-20%, sedimentary rock or quartz gravels, 2-20 mm; pH 6.5 to 7.0. Abrupt, clear or gradual to -

B2 or B21: Dark red-brown, dark red, red-brown or dark brown (2.5YR 3/4, 3/6; 5YR 3/4, 4/4; 7.5YR 3/4, 4/4); light, light medium or medium clay texture; strong 2 to 20 mm, angular or subangular blocky or occasionally 5 to 20 mm, prismatic structure; firm or very firm dry consistence; 2-50%, sedimentary rock or quartz gravels, 2-60 mm; rarely 2-10%, soft calcareous segregations, <2-6 mm; pH 6.5 to 8.5. Gradual or diffuse to -

B22: (when present) Dark red, red, dark red-brown, yellow-red, dark or strong brown (2.5YR 3/6, 4/6; 5YR 3/4, 4/4, 4/6; 7.5YR 4/4, 4/6), occasionally <2-20%, brown mottles, 5-15 mm; light, light medium or medium clay texture; strong, 10 to 50 mm, prismatic structure parting to 2 to 10 mm, lenticular or blocky primary peds, or strong, 5 to 20 mm, lenticular, angular or subangular blocky structure; firm to strong dry consistence; 2-20%, sedimentary rock or quartz gravels, 2-20 mm; <2-50%, soft or nodular calcareous segregations, <2-20 mm, sometimes 2-20%, soft manganese segregations, <2 mm; pH 6.5 to 8.5. Abrupt or clear to -

B3 or BC: Dark red-brown, yellow-red, dark brown or yellow-brown (2.5YR 3/4; 5YR 4/6; 7.5YR 3/4; 10YR 5/4; 2.5Y 6/4), occasionally 2-20%, brown, dark or red mottles, <5-15 mm; light, light medium or sandy light clay texture; massive, or weak to moderate, 2 to 10 mm, subangular blocky structure; 20-90%, weathered siltstone, mudstone or shale fragments; 2-50%, soft or nodular calcareous segregations, <2-20 mm; pH 8.0 to 9.0. Abrupt to -

C: Weathered siltstone, mudstone or shale, sometimes 2-90%, soft or nodular calcareous segregations, 2-60 mm.

R: Hard, unweathered bedrock

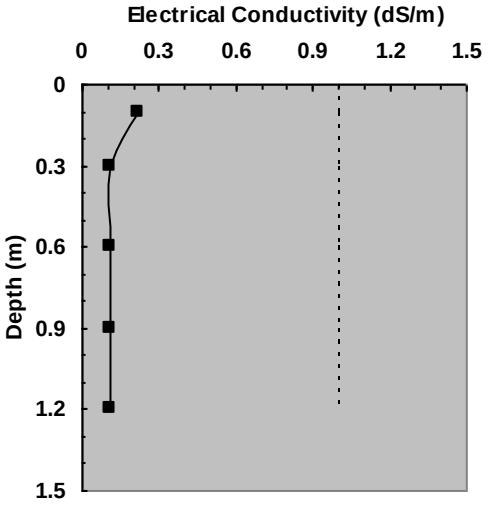
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_p	0.1	7.7	.22	.005	8	27	15	52	26	23	2.6	.52	1.3	8.8	2	.48	.50
B_{21}	0.3	8.6	.11	.001	8	21	10	62	31[2]	28	1.9	.45	.59	15	2	.38	.50
B_{22}	0.6	8.9	.11	.001	15	18	19	51	25[2]	22	2.2	.41	.34	10	2	.56	.49
B_{23}	0.9	9.1	.11	.001	14	17	21	50	25[2]	21	3.0	.49	.28	7.0	2	.58	.50
B_3	1.2	9.1	.11	.001	18	33	15	36	20[2]	16	3.0	.44	.22	5.3	2		.55

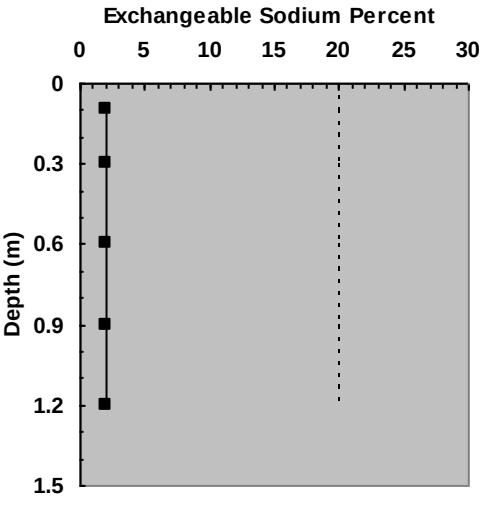
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Typically Kianga has an alkaline subsoil as shown above. It has a very high clay content (50-62%), but only a moderate CEC (25-31 cmol[+] kg^{-1}), indicating a moderately weathered soil. Calcium is the dominant cation and at high levels throughout the profile (16-28 cmol[+] kg^{-1}) while magnesium levels are only moderate (1.9-3.0 cmol[+] kg^{-1}), resulting in very high Ca/Mg ratios (5.3-15). Kianga is non-sodic (ESP 2) and is therefore structurally stable and well drained as indicated by the low to moderate dispersion ratios (0.38-0.58), and very low salt content (0.11-0.22 dS/m). The CEC:clay ratios of 0.49 to 0.55 indicate a mixed, illite dominant clay mineralogy. The high total potassium levels of 1.5 to 1.9% also indicate significant illite.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

The Kianga soil has a rooting depth range of 0.5 to 1.5 m that is limited only by bedrock, as subsoil salinity and sodicity are very low and not limiting (see above graphs). The PAWC varies from 65 mm to 135 mm for these rooting depths. The salt graph shows also that there is significant deep drainage below the soil profile as soluble salts have not accumulated in the subsoil (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage).

SurfaceSoil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	77	0.23	2.8	1.3	9	14	3.0
Range	35-173	.13-.33	1.6-4.5	1.1-1.6	5-16	7.3-22	2.3-4.4
No of samples	8	8	8	3	5	4	4
Rating	Very high	Very high	High	High	Moderate	Moderate	Moderate

As for all softwood scrub soils in the Banana district, Kianga has a very high surface soil fertility, as it has very high mean phosphorus (77 mg/kg) and total nitrogen (0.23%) contents. The mean organic carbon content of the surface soil is also high (2.8%), due to the high biomass of a softwood scrub forest. Kianga also has a high mean potassium concentration (1.3 meq%), while sulphur, calcium and magnesium levels are moderate.

Kilburnie (Kb)

Concept: Kilburnie is a very deep (>1.5 m), black, cracking clay soil with weakly developed linear gilgai. The mounds are fine self-mulching while the depressions are a firm or hard setting with a surface crust and occasionally non-cracking. The upper subsoil is strongly sodic (ESP >15), while the lower subsoil has moderate to high levels of soluble salts (0.5-1.4 dS/m).

Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza).

Aust Class: **Mound:** Black or occasionally Brown Vertosol **Depression:** Black Vertosol

PPF: **Mound:** Ug5.15, Ug5.16, Ug5.34 **Depression:** Ug5.15, Ug5.16, Uf6.32

Landform: Footslopes of the gently undulating to undulating plains and rises formed on unconsolidated Cainozoic sediments that stand just above the Quaternary alluvial floodplains or valley flats. The footslopes have gradients of only 0.5 to 1.5%.

Vegetation: Tall (12-20 m), poplar box woodlands, occasionally with silver-leaved ironbark or Moreton Bay ash as associates. Lime bush, false sandalwood, rams horn wattle and occasionally sally wattle occur in the widely-spaced, shrub understorey, while the native grass pastures consist mainly of forest and Queensland blue grass, black spear grass with a minor component of wire grasses (*Aristida spp.*).

Microrelief: Weakly developed linear gilgai – vertical interval: 0.05 to 0.1 m, horizontal interval: 5 to 8 m

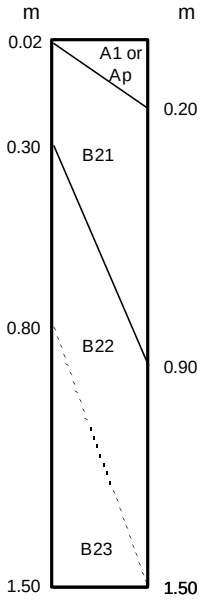
Runoff: Slow

Permeability:

Drainage: Slowly permeable

Surface cond: Mounds – fine self-mulching (peds 1-2 mm), with a surface flake, seasonally cracking; depressions – firm to hard setting, with a surface crust, cracking or non-cracking; <2-10%, quartz and silcrete gravels, 2-20 mm

Profile Description **(mounds and depressions)**



A1 or Ap: Very dark grey, very dark grey-brown, dark brown or dark grey-brown (10YR 3/1, 3/2, 3/3, 4/2), light medium or medium clay texture; mounds-strong, 1 to 2 mm, granular structure, loose dry consistence, depressions-moderate or strong, 2 to 10 mm, subangular blocky structure, very firm dry consistence; sometimes <2-20%, calcareous nodules, <2-6 mm (mounds); <2-10%, quartz or ironstone gravels, 2-20 mm; pH 6.5 to 8.5. Abrupt to -

B21: Black, very dark grey, very dark grey-brown or occasionally dark brown (10YR 2/1, 3/1, 3/2, 3/3), light medium, medium or medium heavy clay texture; strong, 2 to 10 mm, lenticular structure with <2% slickensides (mounds), lenticular or strong, 10 to 20 mm, subangular blocky or prismatic structure (depressions); strong dry consistence; <2-20%, soft or nodular calcareous segregations, <2-6 mm; <2-10%, quartz and ironstone gravels, 2-20 mm; pH 7.5 to 9.0. Gradual to -

B22: Very dark grey, very dark grey-brown, dark brown, dark yellow-brown to yellow-brown (10YR 3/1, 3/2, 4/3, 4/4, 5/6; 7.5YR 4/4), sometimes <2-20%, dark, brown or grey mottles, <5-15 mm; medium or medium heavy clay texture; moderate or strong, 2 to 10 mm, lenticular structure, with 2-10% slickensides; strong dry consistence; 2-20%, soft or nodular calcareous segregations, 2-20 mm; rarely <2-10%, gypsum crystals, <2 mm; sometimes <2-10%, quartz and ironstone gravels, 2-20 mm; pH 8.5 to 9.0. Gradual to

B23: (when present) Dark brown, brown, dark or light yellow-brown (10YR 4/3, 4/4, 5/4, 5/6, 6/4; 7.5YR 4/4, 5/6), sometimes <2-20%, dark, grey or brown mottles, <5-15 mm; light medium or medium clay texture; moderate or strong lenticular, or 10 to 50 mm, prismatic structure; sometimes <2-20%, soft or nodular, calcareous segregations, <2-6 mm; occasionally <2-10%, gypsum crystals, <2 mm; <2-10%, quartz or ironstone gravels, 2-20 mm; pH 6.0 to 8.5.

Soil Chemistry

(a) mound

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	8.5	.19	.006	16	21	14	47	37	24	10	1.8	.48	2.4	5	.53	.79
B_{21}	0.3	8.8	.48	.035	14	19	12	51	40	20	13	4.8	.27	1.5	12	.65	.78
B_{21}	0.6	8.6	.94	.086	12	18	15	52	37	16	14	6.5	.24	1.1	18	.78	.71
B_{22}	0.9	8.3	.95	.102	9	20	15	53	36	14	13	7.0	.29	1.1	19	1.0	.68
B_{22}	1.2	7.6	.72	.084	11	24	15	49	31	11	11	6.7	.28	1.0	22		.63
B_{23}	1.5	5.7	.75	.089													

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

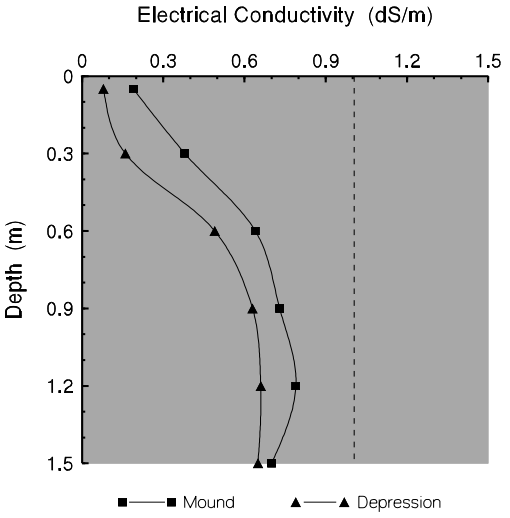
(b) depression

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.0	.13	.012	19	31	17	31	20	9.1	7.0	1.3	.50	1.6	7	.73	.65
B_{21}	0.3	7.4	.51	.060	15	22	17	44	32[2]	16	11	5.2	.25	1.5	14	.75	.72
B_{21}	0.6	8.5	1.0	.105	13	18	18	52	43	19	15	8.0	.29	1.3	19	.87	.83
B_{22}	0.9	8.5	1.1	.117	11	22	17	50	36	15	14	8.0	.34	1.1	22	.99	.72
B_{23}	1.2	7.4	.87	.089	9	28	17	47	30	11	11	6.9	.23	1.0	23		.64
B_{23}	1.5	5.6	.88	.090													

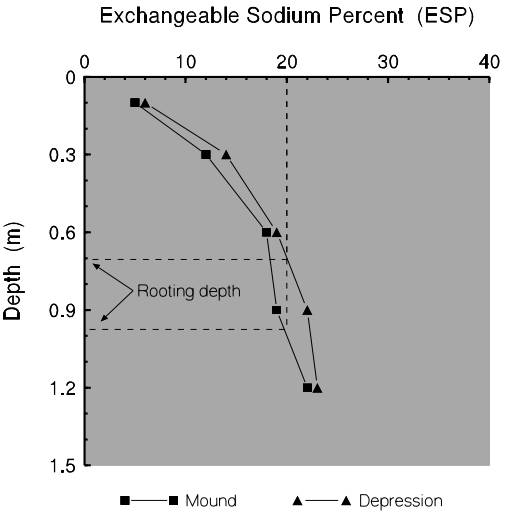
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

The pH is typically alkaline in the surface soil and upper subsoil of the mounds, becoming acid in the lower subsoil, while the the depressions have a neutral surface soil. The depressions also have a significantly lower clay and higher fine sand content in the surface soil, which accounts for its hard setting and crusting properties. The CEC is high to very high (20-43 cmol[+] kg^{-1}), and is calcium dominant or codominant (Ca/Mg ratios 2.4-1.0). Calcium is also mainly at high levels except for the depression surface soil (11-24 cmol[+] kg^{-1}). Both the mound and depression are sodic to strongly sodic (ESP 7-23), and the lower subsoil is therefore dispersive as indicated by the very high dispersion ratios (0.87-1.0). Subsoil drainage is therefore impeded as indicated by the high levels of subsoils salts (0.72-1.1 dS/m). The CEC:clay ratios of 0.6 to 0.8 indicate a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Kilburnie has a rooting depth that varies from 0.7 to 1.0 m between the mounds and depressions, that is limited by high subsoil sodicity (ESP $\geq$20). The profile salt content is only moderate, and therefore not limiting. The rooting depth of 0.7 m is used as it is most limiting and results in a PAWC of 100 mm. The salt graphs also show that the salt concentration reaches equilibrium at 0.9 m, due to impeded subsoil drainage, which indicates the long-term, average depth of wetting.

Surface Soil Fertility

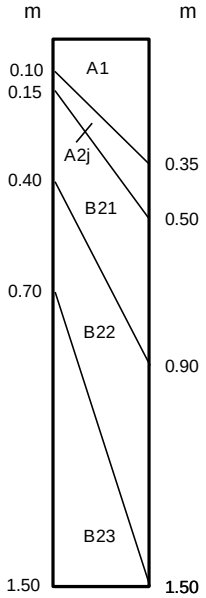
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	8	0.08	1.3	0.49	5	17	9.3
Range	2-27	.07-.11	1.1-.91	.29-.64	3-9	( )-26	4.2-15
No of samples	10	10	10	7	7	6	6
Rating	Low	Low	Low	Low	Low	High	High

Typically for poplar box woodland soils, Kilburnie has a low surface soil fertility as both mean phosphorous and total nitrogen contents are low (8 mg/kg and 0.08% respectively). The mean organic carbon level is also low (1.3%), which is also typical of eucalypt woodland soils. Potassium and sulfur levels are also low, while calcium and magnesium are the only two nutrients that are at high concentrations.

Kokotungo (Kt)

Concept: Kokotungo is a very deep (>1.5 m), brown or grey, sodic duplex soil with a moderately thick to thick (0.1-0.5 m), clay loamy topsoil that has a sporadically bleached A2 horizon, that overlies a light medium of medium clay, prismatic structured subsoil. Kokotungo has mainly an alkaline soil reaction trend and is formed on unconsolidated, alluvial-colluvial sediments..
Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza).
Aust Class: Brown or Grey Sodosol
PPF: Db1.33, Dy2.33, Db3.33, Dy3.33
Landform: Extensive level or gently undulating plains and rises formed on unconsolidated sediments in the Callide and Dawson valleys, that have slopes of 0 to 5% and a relief of 5 to 30 m.
Vegetation: Coowarra box (Dawson gum) – brigalow open forest with coowarra box as an emergent above a mid-high (6-12 m), open forest of brigalow, narrow-leaved and broad-leaved bottle trees, red bauhinia and white-flowered bauhinia. Shrubs such as bitter bark, holly bush, turkey bush and wilga, and occasionally false sandalwood occur in the understorey while currant bush is common as a low shrub in the ground layer along with sparse brigalow grasses (*Paspalidium spp.*).
Runoff: Slow to moderately rapid
Permeability: Slowly permeable
Drainage: Imperfectly drained
Surface cond: Mainly hard setting; with 2 to 20%, ironstone and quartz gravels, 2-60 mm and 2-10%, silcrete cobbles, 60-200 mm

Profile Description



A1: Black, very dark brown or grey-brown, or dark brown (7.5YR 3/2, 3/4; 10YR 2/1, 2/2, 3/2, 3/3, 4/3), fine sandy clay loam or clay loam fine sandy texture; massive, or weak to moderate, 2 to 10 mm, subangular blocky or platy structure; firm or very firm dry consistence; <2-50%, ironstone, quartz and silcrete gravels cobbles, 2-200 mm; pH 6.0 to 7.5. Clear to -
A2j: Dark brown, dark grey-brown, grey-brown, brown or yellow-brown (10YR 3/3, 4/2, 4/3, 5/2, 5/3, 5/4), light grey or white dry bleach colour (10YR 7/1, 7/2, 8/1); fine sandy clay loam, sandy clay loam, clay loam sandy or clay loam fine sandy texture; massive or weak, 2 to 10 mm, subangular blocky structure; firm or very firm dry consistence; 2-50%, ironstone, quartz and silcrete gravels, 2-60 mm; pH 5.5 to 7.5. Sharp or abrupt to -
B21: Dark brown, brown, dark yellow-brown or light olive-brown (7.5YR 3/4, 4/4, 4/6; 10YR 3/3, 4/2, 4/3, 4/4, 5/6; 2.5Y 5/4), occasionally <2-50%, dark, brown or grey mottles, <5-15 mm; fine sandy light medium, light medium or medium clay texture; strong, 20-100 mm, prismatic structure usually parting to strong, 10 to 50 mm, subangular blocky peds; very firm or strong dry consistence; occasionally <2-10%, soft or nodular, calcareous or manganese segregations, <2-6 mm; <2-20%, quartz or ironstone gravels, 2-60 mm; pH 5.5 to 8.5. Clear or gradual to –
B22: Dark grey-brown, dark brown, yellow-brown or light olive-brown (7.5YR 4/4, 4/6; 10YR 4/2, 4/3, 4/4, 5/4, 5/6; 2.5Y 5/4), usually <2-50%, grey, brown, dark or yellow mottles, <5-30 mm; fine sandy light medium, light medium or medium clay texture; strong, 10-100 mm, prismatic structure parting to strong, 5 to 20 mm, subangular blocky primary peds, or strong, 5 to 50 mm, subangular blocky or lenticular structure; very firm or strong dry consistence; 2-20%, soft or nodular, calcareous or manganese segregations, ,2-6 mm; <2-10%, quartz and ironstone gravels, 2-20 mm; pH 5.5 to 9.0. Gradual to -
B23: (when present) as above except a moderate or strong, 5 to 20 mm, lenticular structure; and 2-20%, soft or nodular, calcareous or manganese segregations, <2-20 mm.

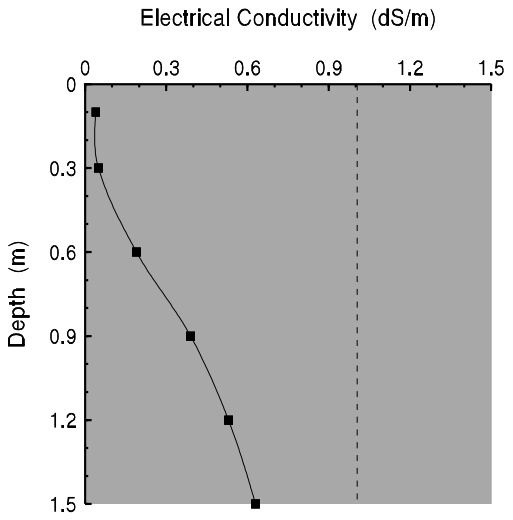
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	CEC cmol[+] kg^{-1}	Exchangeable Cations[(1)] Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.5	.09	.004	11	42	20	24	12[(2)]	9.0	2.0	.12	.80	4.5			-
B_{21}	0.3	7.2	.08	.004	9	39	20	38	11[(2)]	6.4	3.5	.89	.48	1.8	8	.70	.29
B_{21}	0.4	7.7	.13	.008	7	35	19	42	12[(2)]	6.0	4.4	1.4	.48	1.4	12	.73	.33
B_{22}	0.6	7.9	.27	.024	5	35	18	43	14	5.4	5.7	1.8	.44	0.9	13	.82	.33
B_{22}	0.9	8.1	.48	.052	12	40	12	35	11	3.9	5.0	2.3	.40	0.8	21	.92	.25
B_{23}	1.2	8.1	.82	.082	6	35	14	46	14	3.4	6.9	4.0	.59	0.5	29	1.0	.30
B_{23}	1.5	8.7	.98	.100	5	40	14	45	18[(2)]	4.6	7.4	5.3	.60	0.6	29	.98	.40

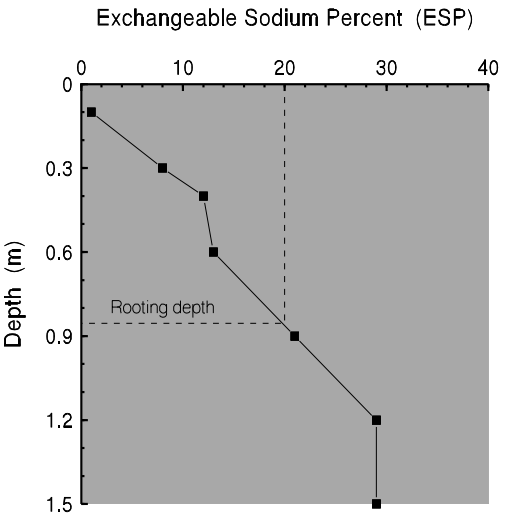
[(1)] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [(2)] ECEC used to estimate the CEC

The lower subsoil pH is variable and is mainly acidic, although the sampled soil has an alkaline subsoil. The surface soil has a moderate clay content with a high proportion of fine sand and silt, which makes it hard setting, crusting and surface sealing. There is a strong texture contrast to the subsoil, although the clay content has been underestimated. The subsoil has only a moderate CEC (11-18 cmol[+] kg^{-1}), indicating a moderately weathered soil, and is mainly magnesium dominant (Ca/Mg ratios 1.8-0.5). Calcium and magnesium contents are also at moderate levels. The subsoil is sodic to strongly sodic (ESP 8-29) and dispersive, particularly in the lower subsoil where Ca/Mg ratios are <1,as indicated by the very dispersion ratios (0.82-1.0). The subsoil is therefore has impeded drainage as indicated by the high levels of soluble salts in the lower subsoil (0.82-0.98 dS/m). The CEC:clay ratios of 0.3 to 0.4 indicate a mixed, kaolinite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Kokotungo has a rooting depth of 0.85 m that is limited by high subsoil sodicity (ESP ≥ 20). Mean subsoil salts are only moderate (0.4-0.65 dS/m) and do not restrict the rooting depth. A rooting depth of 0.85 m results in a PAWC of 90 mm. The salt graph also shows, that despite the dispersive subsoil, some deep drainage below the soil profile occurs as the salt concentration reaches equilibrium at only a moderate salt content. There is therefore a smaller, less pronounced "salt bulge" at 0.9m which indicates the long-term average depth of wetting.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	41	0.14	1.9	0.63	5	6.7	1.9
Range	9-165	.07-.31	1.3-4.5	.32-.96	2-9	5.3-8.9	1.8-2.0
No of samples	14	14	14	3	11	2	2
Rating	Very high	Moderate	Moderate	Moderate	Low	Moderate	Low

Typically for coowarra box (Dawson gum) – brigalow soils, Kokotungo has a high surface soil fertility as it has a very high mean phosphorous content (41 mg/kg), but only moderate mean total nitrogen (0.13%) and organic carbon contents (1.8%). However data from two uncleared sites, gave total nitrogen levels of 0.27 and 0.31%, and 3.2 and 4.5% of organic carbon, showing that predevelopment, coowarra box – brigalow duplex soils had very high total nitrogen and high organic matter contents. It has frequently been observed throughout central Queensland that nitrogen "runs down" faster on lighter textured surface soils than clay soils due to the more rapid breakdown of organic matter and leaching of nitrates (Bob Clem, *pers. comm*.). The other nutrients measured are at either moderate or low levels.

Kooingal (Kn)

Concept: Kooingal is a very deep (>1.5 m), grey or black cracking clay soil with a fine or very fine self-mulching topsoil that overlies a highly saline (EC >1.5 dS/m) and strongly sodic (ESP >15) subsoil. The soil reaction trend is normally neutral to acid and it is formed on basalt.

Geology: Weathered (?), Tertiary, olivine basalt (Tb).

Aust Class: Grey or Black Vertosol

PPF: Ug5.24, Ug5.16

Landform: Moderately inclined to steep escarpments of the Tertiary basalt plateaus, that occur only to the south of Biloela. The escarpment slopes are usually between 10 and 20% and become steeper on the upper slopes (40%). Sometimes a low scarp or cliff is present. The footslopes are gentler with slopes decreasing to 5 to 10%. The escarpments are very stony with many surface stones and boulders of basalt, and occasional rock outcrop.

Vegetation: Kooingal originally had a dense softwood scrub closed forest. However the areas of Kooingal on the Banana study area have been completely cleared and sown to green panic pastures for cattle fattening, and it was not possible to describe an original community. Only isolated trees of brigalow, red and white flowered bauhinia and bottle trees or brigalow thickets now remain.

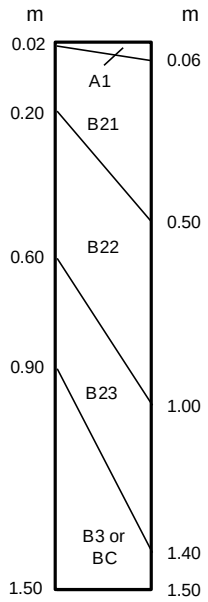
Runoff: Rapid

Permeability: Slowly permeable

Drainage: Moderately well drained

Surface cond: Fine or very fine self-mulching (peds <1-2 mm) with a thin surface flake; 20-50%, basalt cobbles, stones and boulders, 60->2 m; and 2-10% basalt outcrop

Profile Description



A1: Black, very dark brown, very dark grey or dark grey-brown (10YR 2/1, 2/2, 3/1, 4/2), medium heavy or heavy clay texture; strong, <1-2 mm, granular or subangular blocky structure; loose dry consistence; 2-50%, basalt gravels and stones, 20-600 mm; pH 6.5 to 8.5. Abrupt to -

B21: Very dark brown, very dark grey-brown or dark grey-brown (10YR 2/2, 3/2, 4/2); medium heavy or heavy clay texture; strong, 2 to 10 mm, lenticular or 5 to 20 mm, subangular blocky structure; strong dry consistence; sometimes <2-20%, soft or nodular, calcareous segregations, <2-6 mm; 2-50%, basalt gravels to stones, 20-600 mm; pH 8.5 to 9.0. Gradual to -

B22: Dark grey-brown, yellow-brown or olive-brown (10YR 4/2, 5/3, 5/4; 2.5Y 4/4), sometimes 2-10%, yellow, dark or brown mottles, <5-15 mm; medium heavy or heavy clay texture; strong, 2 to 10 mm, lenticular structure, sometimes 2-10% slickensides; very firm, moderately moist consistence; 2-20%, soft or nodular calcareous segregations, <2-20 mm; <2-10%, basalt gravels or cobbles, 20-200 mm; pH 8.5 to 9.0. Gradual to -

B23: As above except 20-50%, brown, orange or red mottles, 5-30 mm; sometimes <2-10%, soft calcareous segregations, 2-6 mm; and <2%, basalt gravels, 6-60 mm; pH 6.5 to 8.5. Clear or gradual to -

B3 or BC: The transitional horizons become paler in colour, and are grey, light olive-brown, olive-yellow or light grey (10YR 7/1; 2.5Y 5/4, 5/6; 5Y 6/1), with 10-50%, grey or brown mottles, 5-30 mm; sandy medium or medium heavy clay texture; weak lenticular or prismatic structure; pH 5.5 to 8.5.

Soil Chemistry

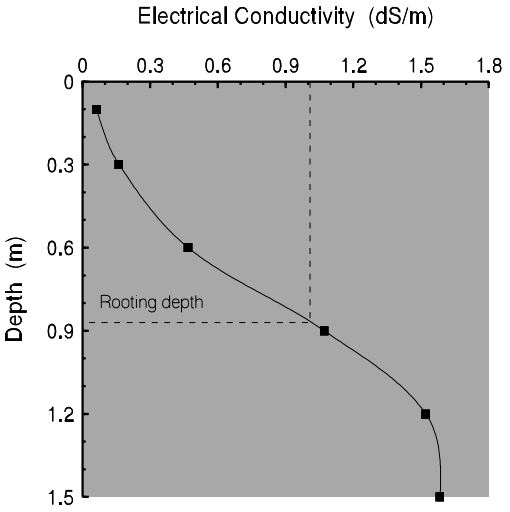
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	8.5	.24	.008	4	5	18	72	54	22	25	1.7	1.1	.88	3	.45	.75
B_{21}	0.3	8.9	.78	.081	2	5	13	77	52	13	30	6.1	.40	.43	12	.58	.68
B_{22}	0.6	8.9	1.6	.187	1	6	11	78	47	7.8	29	12	.21	.27	26	.73	.60
BC	0.9	8.9	1.9	.215	1	3	14	80	48	6.0	28	13	.23	.21	27	.71	.60
BC	1.2	8.7	1.9	.239	1	4	14	80	46	5.2	29	13	.15	.18	27	.85	.58
BC	1.5	8.7	1.8	.262	1	4	10	81	40	3.7	27	11	.07	.14	26	.87	.49

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

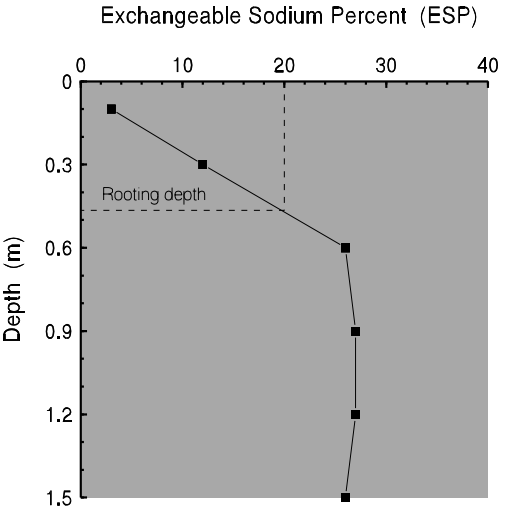
The pH is typically alkaline to strongly alkaline throughout the profile, indicating sodicity, although it is not uncommon for the weathered basalt to be moderately acid. The clay content is extremely high (72-82%), which occurs only in the basalt soils. However the CEC is only very high (40-54 cmol[+] kg^{-1}) which is significantly less than the soils formed on fresh basalt, and possible indicates a degree of weathering. Also atypically for basalt soils, magnesium and sodium are the dominant cation (Ca/Mg ratios 0.88-0.14), with only low to moderate levels of calcium in the subsoil.

The subsoil is therefore strongly sodic (ESP 12-27), and highly dispersive as indicated by the high dispersion ratios (0.7-0.87), with impeded subsoil drainage which indicated by the very high subsoil salt levels (1.6-1.9 ds/m). At that level the salt content may be flocculating the clay to some degree which could account for the dispersion ratios <0.9. It is possible that on the plateau escarpments, the soil is accumulating sodium salts from the weathering of the basalt higher in the landscape, as at these high clay contents the soil is only slowly permeable. The CEC:clay ratios of 0.6 to 0.75 are also lower that for the little weathered basalt soils, indicating that Kooingal is more weathered.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Kooingal has a rooting depth of 0.45 m that is limited by the very high subsoil sodicity with an ESP of 20 at 0.45 m. The high profile salt content also limits the rooting depth, but at a lower depth of 0.9 m. Kooingal therefore has a rooting depth of 0.45 m, which results in a PAWC of 100 mm. The salt graph also shows that the salt concentration reaches equilibrium at 1.2 m, due to impeded subsoil drainage, which indicates the long term depth of wetting.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	96	0.37	4.0	1.5	8	21	24
Range	45-211	.21-.59	2.4-5.8		7-9		
No of samples	5	5	5	1	4	1	1
Rating	Very high	Very high	Very high	High	Moderate	High	Very high

Kooingal has one of the highest fertilities for all soils of the Banana survey with very high mean phosphorous (96 mg/kg) and total nitrogen (0.37%) concentrations. The mean organic carbon (4.0%) content is also very high, which is typical for softwood scrub soils. Of the other nutrients measured only sulphate-sulphur is at less than a high or very high level.

Koorngoo (Kr)

Concept: Koorngoo is a very deep (>1.5 m), massive, red, gradational soil with a fine sandy loam to fine sandy clay loam topsoil that grades into a red, clay loam to fine sandy light medium clay subsoil. It has a neutral soil reaction trend and is formed on unconsolidated, alluvial-colluvial sediments.

Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza), derived from erosion of the Tertiary sandstone plateau surfaces.

Aust Class: Red Kandosol

PPF: Gn2.12

Landform: Either small fans lying directly downslope from the remnant tertiary sandstone plateaus surfaces, or as residual areas on the outwash plains often some distance from the remnant plateaus. Slopes range from 3 to 8% on the fans with a relief of up to 30 m, and 0.5 to 2% slopes on the plains with low relief of 5 to 15 m.

Vegetation: Softwood scrub consisting of narrow-leaved and broad-leaved bottle trees, crows ash and kurrajong, sometimes with eucalypts such as coowarra box, narrow-leaved ironbark and Moreton bay ash present as emergents. There is a dense, understorey or shrub layer comprising species such as crows apple, scrub ironbark, bitter bark, holly bush, Leichhardt bean, red bauhinia, white flowered bauhinia and wallaby apple. However, the softwood scrub has been predominantly cleared and sown to introduced grass pastures with only a few remnant trees remaining

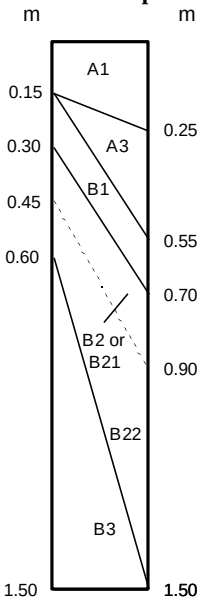
Runoff: Slow to moderately rapid

Permeability: Moderately rapid

Drainage: Well drained

Surface cond: Hard setting

Profile Description



A1: Dark brown or dark reddish-brown (5YR 3/4; 7.5YR 3/3, 3/4), fine sandy loam or fine sandy clay loam texture; massive and porous; weak or firm dry consistence; pH 6.0 7.5. Gradual or diffuse to -

A3 or B1: These transitional horizons are usually redder in colour, dark red-brown or dark red (2.5YR 3/4, 3/6; 5YR 3/3, 3/4); and/or slightly heavier in texture with a fine sandy clay loam or clay loam fine sandy texture; massive and porous; weak or firm dry consistence; pH 5.5 to 7.5. Gradual or diffuse to -

B21, 22: Dark red-brown, red or yellow-red (2.5YR 3/4, 4/6; 5YR 4/6); clay loam fine sandy, fine sandy light or light medium clay texture; massive and porous; firm or very firm dry consistence; occasionally <2%, quartz or ironstone gravels, 2-20 mm, and 2-10%, soft or nodular manganese or iron-manganese segregations, <2-6 mm; pH 6.5 and 7.5. Gradual to -

B3: (when present) The B3 becomes browner in colour than the subsoil and is yellow-red, dark brown or yellow-brown (5YR 4/6; 7.5YR 4/4; 10YR 5/6, 6/6), with 10-50%, yellow, grey or red mottles, 5-30 mm; fine sandy light or light medium clay texture; massive and porous; sometimes <2-10%, ironstone, quartz or sandstone gravels, 2-20 mm, or soft or nodular manganese, iron or iron-manganese segregations, <2-6 mm; pH 6.5 to 8.0

Soil Chemistry

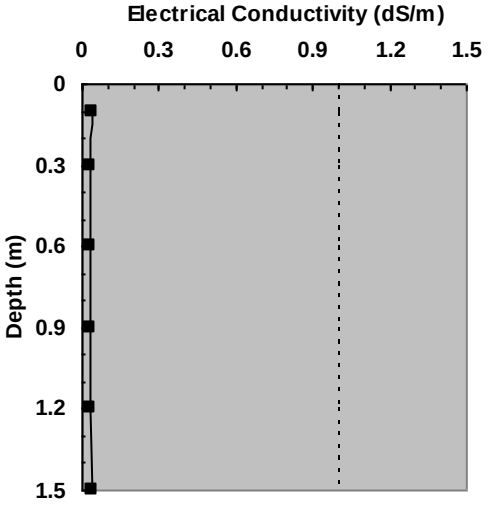
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl⁻ %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.0	.04	.001	18	52	9	20	6	3.8	1.5	.05	.42	2.5			
A_3	0.3	7.5	.03	.001	16	50	11	23	5	3.3	1.2	.05	.36	2.8			
B_1	0.6	7.8	.03	.001	13	38	10	39	7	3.1	2.8	.08	.79	1.1	1	.46	.18
B_2	0.9	7.2	.03	.001	13	38	10	39	6	2.4	3.2	.11	.54	0.8	2	.44	.15
B_2	1.2	6.6	.03	.001	14	38	10	37	6	2.2	3.1	.15	.31	0.7	3		.16
B_2	1.5	6.0	.04	.001													

[1] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 ECEC= Ca + Mg + Na +K

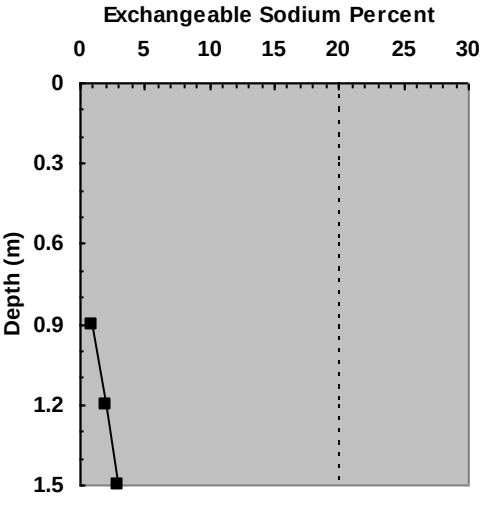
The pH is typically neutral in the surface soil becoming acid with depth. The surface soil is dominated by fine sand (50-53%) with only a moderate clay content (20-23%), which makes it prone to hard setting and surface sealing. The clay content increases gradually with depth to 39%, which is typical of these red earth soils. The CEC is low throughout the profile (5-7 cmol[+] kg^{-1}) which indicates a strongly weathered and leached soil. Calcium and magnesium contents are also low.

The profile is structurally stable, due to the iron oxides (sesquioxides) present in this weathered soil, and porous and is therefore freely draining with very low soluble salt levels throughout the profile. The ESP and dispersion ratios are also very low. The subsoil CEC:clay ratios of 0.15 to 0.18 indicate a kaolinite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Koorngoo has a very deep rooting depth of 1.5 m, as subsoil salinity and sodicity are very low and not limiting (see above graphs). A rooting depth of 1.5 m results in a PAWC of 105 mm. The PAWC for such a deep soil is low due to the high sand and only moderate clay content throughout the profile (compare to the Tognolini soil). The salt graph shows that there is significant deep drainage below the soil profile, as soluble salts are very low throughout the profile (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage). This salt profile is typical of a recharge soil.

Surface Soil Fertility

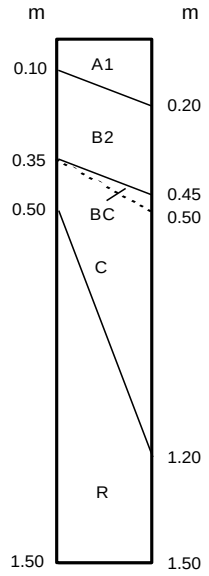
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	20	0.07	1.2	0.7	4	3.8	1.5
Range	9-53	.06-.10	1.0-1.4	.50-1.1	3-5		
No of samples	5	5	5	3	5	1	1
Rating	High	Low	Low	Moderate	Low	Low	Low

Koorngoo has at best a moderate surface soil fertility, due mainly to its high mean phosphorous content (20 mg/kg). Total nitrogen however, is consistently low for all samples, with a mean of only 0.07%. The sesquioxides in red soils can strongly adsorb or "fix" the phosphate anions thus making it unavailable to plants. However Ahern et al (1994) report minimal phosphate fixation for red earths in central Queensland. It is also not known whether these red earths exhibit significant amounts of variable charge, which could help retain anions such as SO_4^{2-} and NO_3^-. The mean organic carbon is also low (1.2%), which could be due to the more rapid breakdown of organic matter in lighter textured surface soils and correlates with the low total nitrogen concentrations. Of the remaining nutrients measured only potassium is above low levels.

Lancefield (Lf)

Concept: Lancefield is a shallow (0.35-0.45 m), stony, brown or red, duplex to non-cracking clay soil with a 0.1 to 0.2 m thick, clay loam or light clay topsoil that overlies a structured, light or light medium clay subsoil. Lancefield has a neutral soil reaction trend and is formed on folded, siltstones.
Geology: Little weathered, folded, Permian sedimentary rocks, mainly siltstones, of the Youlambie Conglomerate formation (Ply) of the Yarrol Basin.
Aust Class: Brown Dermosol or Red Chromosol
PPF: Uf6.31, Gn3.22, Dr4.12
Landform: Hillslopes of the rolling to steep low hills, with slopes of 25 to 50% and a relief of 60 to 80 m, which form the foothills of the Calliope Range to the north of the Boundary Hill coal mine.
Vegetation: Lancefield originally had a softwood scrub vegetation. However the entire area of Lancefield in the Banana study area area has been cleared and sown to green panic and buffel grass for fattening cattle. See Kianga for a description of the species in a softwood scrub forest.
Runoff: Rapid
Permeability: Moderately permeable
Drainage: Well drained
Surface cond: Firm, with 20 to 90%, gravels, cobbles and boulders, 6 mm-2 m, of sedimentary and volcanic rocks

Profile Description



A1: Dark red-brown or dark brown (5YR 3/2; 7.5YR 3/2, 3/3; 10YR 3/3); clay loam, light clay or light medium clay texture; moderate or strong, 2 to 5 mm, subangular blocky structure; weak or firm dry consistence; 50-90%, siltstone gravels and cobbles, 2-200 mm; pH 7.0 to 8.0. Abrupt or gradual to –
B2: Red-brown, dark brown or dark yellow-brown (5YR 4/4; 7.5YR 3/3; 10YR 4/4); fine sandy light medium, light medium or medium clay texture; strong, 2 to 20 mm, subangular blocky structure; very firm dry consistence; 20-90%, siltstone gravels and cobbles, 2-200mm; pH 7.5 to 8.0. Abrupt or clear to –
B/C: (when present) Dark brown (7.5YR 4/4); light medium clay; 50-90%, fragments of weathered siltstone; pH 7.5. Abrupt to –
C: Weathered siltstone.
R: Hard, unweathered siltstone

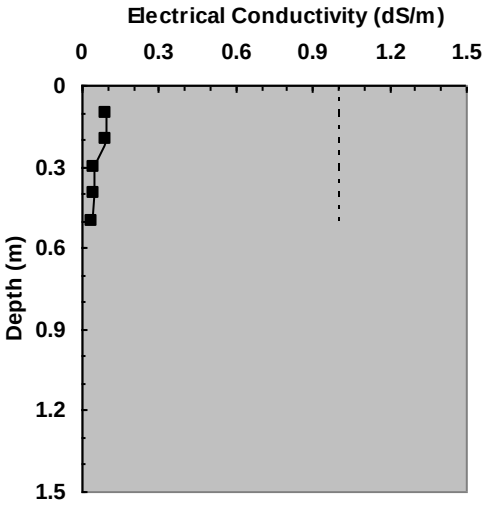
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.6	.09	.001	27	20	15	37	25	17	3.4	.09	1.3	5.0	0.4	.40	.68
B_2	0.2	7.6	.09	.002													
B_2	0.3	7.7	.05	.001	23	15	11	49	31	25	6.2	.24	.47	4.0	0.8	.58	.63
B_2/BC	0.4	7.7	.05	.001													
BC	0.5	7.7	.04	.001													

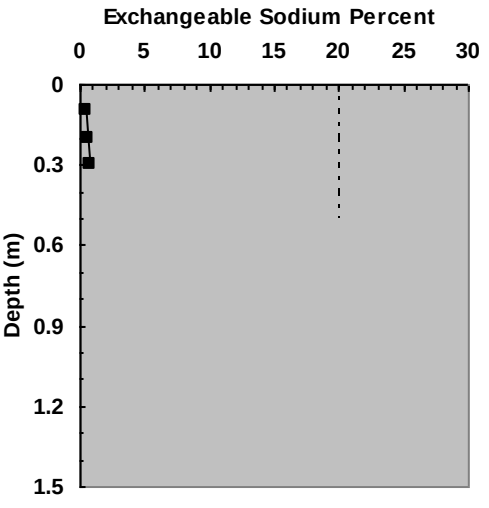
[(1)] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

The pH is typically neutral and the clay content is high throughout the profile (37-49%). The soil chemistry is favourable as the CEC is high (25-31 cmol[+] kg^{-1}) and strongly calcium dominant (Ca/Mg ratios 4-5), which is also at high levels (17-25 cmol[+] kg^{-1}). The subsoil is also non-sodic (ESP<1) and is therefore structurally stable, which is indicated by the low dispersion ratios (0.4-0.58), and therefore well drained. As there is significant deep drainage below the subsoil, profile soluble salts are very low (<0.1 dS/m). The CEC:clay ratios indicate a mixed clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Lancefield has a rooting depth range of 0.5 to 1.2 m that is limited only by the presence of hard, unweathered bedrock in the profile, as subsoil salinity and sodicity are very low and not limiting (see above graphs). The PAWC varies from 25 to 50 mm for these rooting depths. The water holding capacity is significantly reduced by the high profile stone content. The low levels of salts in the profile indicate that there is significant deep drainage, which leaches salts from the soil.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	36	0.23	2.6	1.6	10	17	3.3
Range	20-88	.18-.30	2.2-3.5	.98-2.4	7-14		
No of samples	3	3	3	3	3	1	1
Rating	High	Very high	High	High	High	High	Moderate

Although the surface soil fertility is determined from only three sites, the data is very consistent. Typically for a softwood scrub soil, the surface soil fertility is very high as it has a high mean phosphorous content (36 mg/kg) and a very high mean level of total nitrogen (0.23%). The mean organic carbon content is also high (2.6%) which is also typical of softwood scrub soils, and correlates strongly to the very high levels of total nitrogen. All other nutrients measured, except for magnesium, are also high.

Mapala (Mp)

Concept: Mapala is a moderately deep to deep (0.9-1.5 m), red, duplex soil with a 0.1 to 0.5 m thick, fine sandy loam to clay loam fine sandy topsoil that usually has either a pale or sporadically bleached A2 horizon, that overlies a prismatic structured, fine sandy light medium clay subsoil. Mapala has a neutral or alkaline soil reaction trend and is formed on Tertiary sandstone.

Geology: Deeply weathered, Tertiary sandstones (Ta) on residual rises.

Aust Class: Red or occasionally Brown Chromosol

PPF: Dr4.32, Dr4.22, Dr4.13, Db3.32

Landform: Crests and hillslopes of residual rises formed on deeply weathered Tertiary sandstones, that have slopes of only 1 to 6% and a relief of 10 to 20 m.

Vegetation: Mapala had originally a softwood scrub vegetation. However all areas of Mapala in the study area have been cleared and sown to introduced grasses for fattening cattle, with only a few remnant trees remaining, which consist of narrow and broad-leaved bottle trees, red bauhinia, white flowered bauhinia, crow's ash, brigalow, scrub ironbark and occasionally coowarra box (Dawson gum).

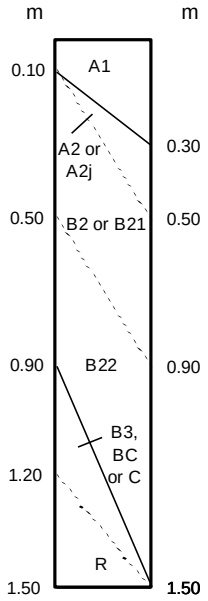
Runoff: Moderately rapid

Permeability: Moderately permeable

Drainage: Moderately well drained

Surface cond: Firm; usually with <2 to 20%, haematitic siltstone (ironstone) and sandstone gravels and cobbles, 2-200 mm

Profile Description



A1: Dark red-brown, red-brown or dark brown (5YR 3/4, 4/3; 7.5YR 3/2, 4/4); fine sandy loam, fine sandy clay loam or clay loam fine sandy texture; massive structure; weak to very firm dry consistence; sometimes <2-10%, quartz, ironstone or sandstone gravels, 2-20 mm; pH 6.0 to 7.5. Clear to -

A2 or A2j: (when present) Dark brown, dark yellow-brown or yellow-brown (7.5YR 3/4, 4/4; 10YR 4/4, 5/4); fine sandy loam, fine sandy clay loam or clay loam fine sandy texture; massive structure; weak or firm dry consistence; sometimes <2-10%, quartz or ironstone gravels, 2-20 mm; pH 6.0 to 7.0. Sharp or abrupt to -

B2 or B21: Dark red-brown, dark red, red-brown, yellow-red or occasionally dark brown (2.5YR 3/4, 3/6; 5YR 4/4, 4/6; 7.5YR 4/4), occasionally 2-20%, brown, grey or dark mottles, <5 mm; fine sandy light or light medium clay texture; strong, 10 to 20 mm, prismatic structure, parting to strong, 5 to 20 mm, subangular blocky primary peds; very firm or strong dry consistence; sometimes <2-10%, ironstone or quartz gravels, 2-20 mm; pH 6.0 to 8.0. Clear or gradual to -

B22: (when present) Dark brown or yellow-brown (7.5YR 4/4, 4/6, 5/6; 10YR 5/4, 5/6), occasionally 2-20%, dark, grey or red mottles, 5-30 mm; fine sandy light medium clay texture; strong, 50-100mm, prismatic structure parting to blocky primary peds, or a moderate or strong, 5 to 20 mm, subangular blocky structure; 2-50%, soft or nodular calcareous segregations, 2-20 mm, or rarely <2%, soft manganese segregations, <2 mm; pH 7.0 to 9.0. Abrupt or clear to -

B3 or BC: Yellow-red, dark brown, yellow-brown or brownish-yellow (5YR 4/6; 7.5YR 4/6; 10YR 5/4, 5/8, 6/6), 2-50%, grey or red mottles, 5-30 mm; fine sandy light clay texture; massive or weakly structured; 20-90%, weathered rock fragments; sometimes 2-20%, soft calcareous segregations, 2-20 mm; pH 6.5 and 8.5. Abrupt to -

C: The C horizons are composed entirely of weathered sandstone.

R: Hard, unweathered sandstone

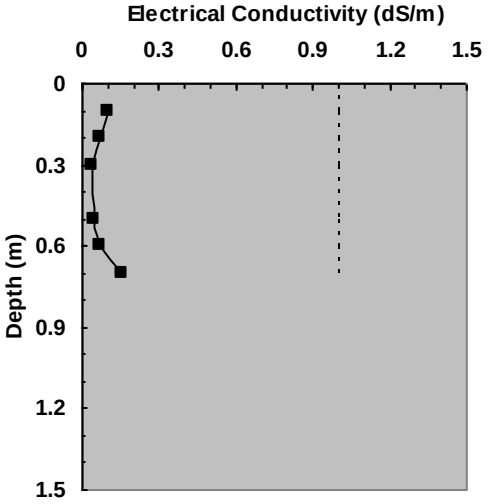
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.3	.10	.004	15	52	8	24	13	10	2.0	.12	1.1	5.0			
A_2	0.2	7.3	.07	.003													
A_2	0.3	7.5	.04	.001	14	52	9	25	10	7.7	1.7	.16	.28	4.5			
B_2	0.5	6.4	.05	.003	12	43	10	35								.56	
B_2	0.6	6.5	.07	.003	14	39	9	38	22	13	6.9	.59	.52	1.9	3	.52	.58
B_2	0.7	8.3	.16	.004													

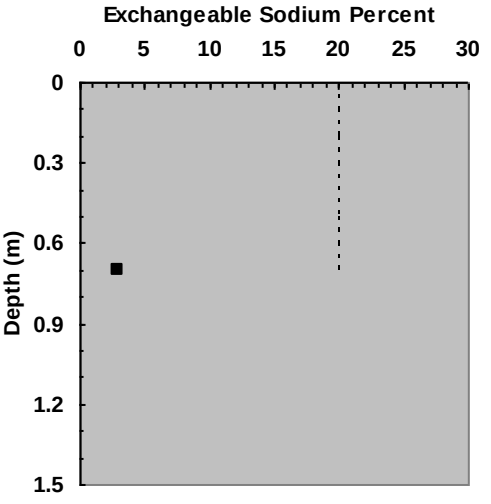
[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0

Mapala typically has a neutral topsoil with the subsoil becoming alkaline. The topsoil has a moderate clay content (25%) and very high level of fine sand (52%) which makes it prone to surface sealing and crusting. The subsoil clay content is underestimated (35-38%) and does not show the strong texture contrast. More realistically it would be around 45%. The surface soil has a moderate CEC (10-13 cmol[+] kg^{-1}) that is strongly calcium dominant, but with only low levels of magnesium (1.7-2.0 cmol[+] kg^{-1}). The CEC increases to 22 cmol[+] kg^{-1} in the subsoil in line with the increase in clay and is also calcium dominant (Ca/Mg ratio 1.9), which is at a moderate level (13 cmol[+] kg^{-1}). The subsoil is non-sodic (ESP 3) and is therefore structurally stable and well drained as indicated by the low dispersion ratios (0.52-0.58) and soluble salt content (0.05-0.16 dS/m). The subsoil CEC:clay ratio is also overestimated, and is more likely to be about 0.48, which would indicate a mixed, kaolinite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Mapala has a rooting depth of 1.2 to 1.5 m that is limited only by hard, unweathered bedrock, as subsoil salinity and sodicity are low and not limiting (see above graphs). The PAWC varies from 100 mm to 115 mm for these rooting depths. The salt graph shows also that there is significant deep drainage below the soil profile as there is only a low salt concentration in the lower subsoil, indicating that salts are mainly leached by deep drainage (i.e. absence of a significant salt bulge).

Surface Soil Fertility

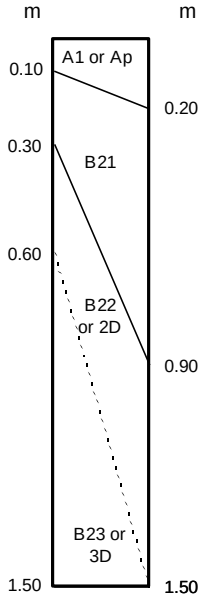
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	68	0.15	2.1	1.8	7	10	2.0
Range	23-179	.12-.18	1.5-2.5		3-12		
No of samples	5	5	5	1	5	1	1
Rating	Very high	Moderate	Moderate	High	Moderate	Moderate	Moderate

Typically for softwood scrub soils, Mapala has a high fertility as it has a very high mean phosphorous content (68 mg/kg). However it has only a moderate mean total nitrogen (0.15%) and organic carbon (2.1%) content. These lower nitrogen and organic carbon levels are most likely due to the more rapid breakdown of organic matter and leaching of nitrates on lighter textured surface soils compared to clay soils (see Lancefield fertility data). All other nutrients measured are high or moderate.

Melton (Mt)

Concept: Melton is a very deep (>1.5 m), black, non-cracking clay soil with a 0.1 to 0.2 m thick, silty light or silty light medium clay topsoil that overlies a blocky structured, silty light medium or medium clay subsoil that is formed on Quaternary alluvial sediments. Buried sandy soil horizons sometimes occur between 0.3 and 1.3 m and Melton has a neutral or alkaline soil reaction trend.
Geology: Unconsolidated, Quaternary, alluvial sediments (Qa).
Aust Class: Black Dermosol
PPF: Uf6.32
Landform: Plains and backplains of the level alluvial plains and valley flats of the Callide Creek and its tributaries, and the floodplains of the Don and Dee Rivers and Banana Creek. Slopes are 0.1 to 0.5% and the relief is <2 m.
Vegetation: Tall (12-20 m), open forest of either forest red gum, coolibah, a forest red gum – coolibah association, or rarely poplar box. Silver-leaved ironbark and Moreton Bay ash can also be present as associated species. There is an open understorey of mainly sally wattle, sometimes with isolated trees of red bauhinia, white-flowered bauhinia, whitewood and prickly mimosa. The original native grass pastures consisted of forest and Queensland blue grass, black spear grass and kangaroo grass. However due to the high surface soil fertility, introduced grasses such as buffel, green panic and rhodes grass have largely replaced the native grasses. Most areas of Melton have been cleared, mainly for rainfed and irrigated cropping.
Runoff: Very slow
Permeability: Moderately permeable
Drainage: Moderately well drained
Surface cond: Firm, can become hard setting when cultivated

Profile Description



A1 or Ap: Black, very dark brown, very dark grey or very dark grey-brown (10YR 2/1, 2/2, 3/1, 3/2); silty light or silty light medium clay texture; strong, 1 to 5 mm, subangular or angular blocky structure, or only a weak structure when cultivated; firm or very firm dry consistence; pH 6.0 to 7.5. Clear or gradual to -
B21: Black, very dark brown, very dark grey or very dark grey-brown (10YR 2/1, 2/2, 3/1, 3/2); silty light medium or silty medium clay texture; strong, 5 to 20 mm, subangular or angular blocky parting to 2 to 10 mm, blocky primary peds; firm to strong dry consistence; pH 6.5 to 8.0; either abrupt to buried sandy lenses (D horizons) or gradual to B22 horizon-
B22: (when present) Black, very dark brown or very dark grey, or sometimes dark brown (10YR 2/1, 2/2, 3/1, 3/3), occasionally 2-20%, brown or dark mottles, <5-15 mm; light medium or medium clay texture; strong 5 to 20 mm, subangular or angular blocky, or strong 10 to 50 mm prismatic parting to 2 to 10 mm, subangular or angular blocky, or occasionally lenticular primary peds; very firm or strong dry consistence; occasionally <2-10%, soft or nodular calcareous segregations, <2-6 mm; pH 7.5 and 8.5. Gradual to either a B23 or 2D -
B23: (when present) As above, except subsoil colours can also be yellow-brown or a stronger brown colour (7.5YR 3/4, 4/4; 10YR 4/3, 4/4), and calcareous segregations are almost always present. Abrupt or clear to –
2D or 3D: (when present) Dark brown to dark yellow-brown (10YR 3/3, 3/4, 4/3, 4/4); vary in texture from a sand, sandy clay loam, clay loam sandy or occasionally a fine sandy clay; sometimes 2-50%, dark or brown mottles, <5-15 mm; single grain for the sands, massive or weak to moderate, 2 to 10 mm, subangular blocky for the heavier textures; sometimes <2-20%, soft or nodular calcareous segregations, <2-20 mm; pH 7.5 to 8.5.

Soil Chemistry

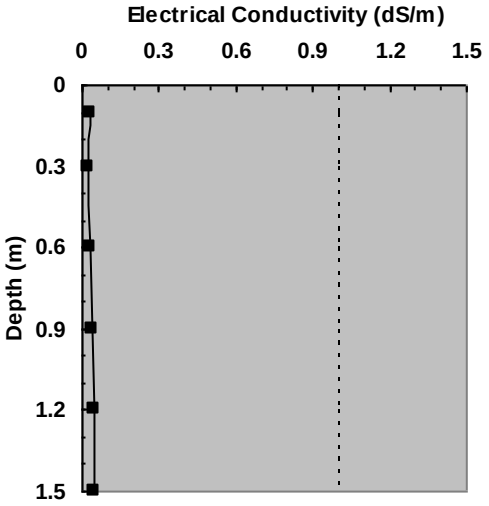
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.9	.03	.001	4	29	32	37	24[2]	17	6.0	.20	1.1	2.8	0.8	.62	.65
B_{21}	0.3	7.2	.02	.001	3	21	29	42	28[2]	19	7.7	.37	.40	2.5	1	.63	.66
B_{22}	0.6	7.7	.03	.001	3	27	28	44	33[2]	23	8.9	.50	.47	2.6	2	.62	.75
B_{23}	0.9	8.1	.04	.001	4	39	20	40	34	22	8.1	.50	.58	2.7	2	.56	.85
2D	1.2	8.3	.05	.002	22	45	13	25	23	16	5.4	.40	.36	3.0	2		.92
2D	1.5	8.2	.05	.002	27	39	8	26	23	14	5.3	.30	.36	2.6	1	.61	.88

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

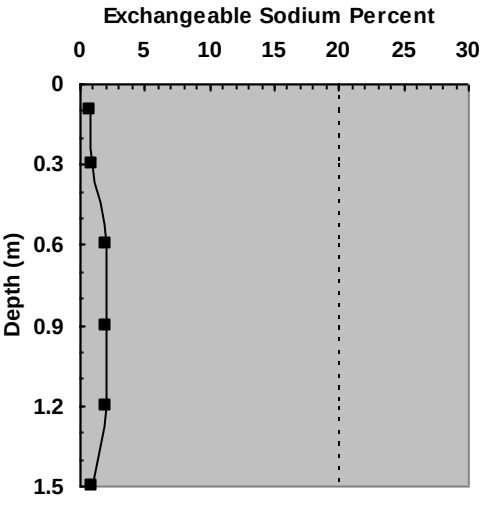
Melton typically has a neutral surface soil and alkaline subsoil. The particle size data shows the discontinuity to the buried sandy sediments at 1.2 m, with a 15% decrease in clay and large increase in coarse sand. The topsoil and subsoil have a high clay content (37-44%), and typically for alluvial soils of the study area, high to very high silt contents (28-32%). The almost equal proportions of fine sand, silt and clay make the surface soil susceptible to compaction when cultivated.

The topsoil and subsoil has a high CEC (24-34 cmol[+] kg^{-1}), that is strongly dominated by calcium (Ca/Mg ratios 2.5-3.0), which is at high contents (17-23 cmol[+] kg^{-1}). Melton is also non-sodic (ESP 1-2) and is therefore structurally stable (not indicated by the dispersion ratios due to the high fine sand content) and well drained which is indicated by the very low profile salt concentration (0.02-0.03 dS/m). The CEC:clay ratios of 0.65 to 0.85 indicate a mixed, smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Melton has a rooting depth of 1.5 m, as subsoil salts and sodicity are very low and not limiting (see above graphs), which results in a PAWC of 130 mm. The PAWC can be limited to some degree by the presence of thick, sandy buried soil layers. The salt graph shows also that there is significant deep drainage below the soil profile, as soluble salts have not accumulated in the subsoil (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	93	0.19	2.8	1.5	7	17	8.5
Range	54-155	.12-.23	2.2-3.6	1.3-1.7	5-10	13-23	5.5-15
No of samples	8	8	8	2	6	7	7
Rating	Very high	High	High	High	Moderate	High	High

Typically for an alluvial soil, Melton has high surface soil fertility as it has a very high mean phosphorous content (93 mg/kg), and a high mean total nitrogen concentration (0.19%). The total nitrogen levels are comparable to those of brigalow scrub, clay soils. The mean organic carbon level is also high (2.8%), once again showing a strong correlation with total nitrogen. The other nutrients measured are mainly high, indicating an overall high fertility.

Mungi (Mg)

Concept: Mungi is a moderately deep to very deep (0.7->1.5 m), black cracking clay soil with well developed linear gilgai that have fine self-mulching mounds, but only pedal or coarse self-mulching depressions. The lower subsoil is strongly sodic (ESP >15), with moderate levels of soluble salts (0.5-0.8 dS/m). Mungi has an alkaline soil reaction trend and is formed on Permian mudstones.

Geology: Little weathered, folded, Permian mudstones of the Gryanda formation (Puy) and various members of the Back Creek group of the Bowen Basin.

Aust Class: **Mound:** Black or occasionally Brown Vertosol **Depression:** Black or occasionally Brown Vertosol

PPF: **Mound:** Ug5.15, Ug5.14, Ug5.13, Ug5.32 **Depression:** Ug5.16, Ug5.15, Ug5.12, Ug5.34

Landform: Gently undulating plains, and mid to lower slopes of the gently undulating or undulating rises with slopes of 1 to 4% and a relief of 5 to 25 m. It often forms a catenary sequence, with either the Wandoo or Banana soils on the crests, and the Banana soil on the upper and mid-slopes.

Vegetation: Tall (12-20 m), poplar box woodland, occasionally with silver-leaved ironbark or narrow-leaved ironbark as associated species. The understorey is very sparse, consisting of isolated, low (3-6 m) trees or shrubs of dead finish, prickly mimosa or lime bush. The native grass pastures are made up mainly of forest and Queensland blue grass and kangaroo grass.

Microrelief: Linear gilgai – vertical interval: 0.05-0.2 m, horizontal interval: 3-7 m

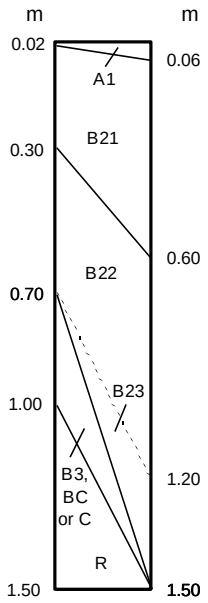
Runoff: Slow to moderately rapid

Permeability: Slowly permeable

Drainage: Imperfectly drained

Surface cond: **Mound:** fine self-mulching; periodic cracking **Depression:** pedal or coarse self-mulching; periodic cracking

Profile Description **(mounds and depressions)**



A1: Very dark grey, very dark grey-brown or occasionally dark brown (10YR 3/1, 3/2, 3/3; 2.5Y 3/2); light medium or medium clay texture; mounds-strong, 1 to 2 mm, granular structure, depressions-moderate or strong, 2 to 10 mm, subangular blocky structure, or occasionally polyhedral or granular structure;. Loose, or firm or very firm dry consistence; occasionally <2-10%, calcareous nodules, <2-6 mm (mounds only); pH 6.5 to 8.5. Abrupt or clear to -

B21: Black, very dark grey, very dark grey-brown and occasionally dark brown (10YR 2/1, 3/1, 3/2, 3/3; 2.5Y 3/2; 7.5YR 3/3); medium or medium heavy clay texture; strong, 5 to 20 mm, subangular blocky or 2 to 5 mm lenticular structure; very firm or strong dry consistence; sometimes <2-10%, soft or nodular calcareous segregations, <2-6 mm; sometimes <2-10%, quartz and mudstone gravels, 2-20 mm; pH 7.5 to 8.5. Clear or gradual to -

B22: As above, except more commonly dark brown, brown, yellow-brown or dark grey-brown (7.5YR 4/4; 10YR 4/4, 5/3; 2.5Y 4/2) and sometimes slightly mottled with few (2-20%), fine (<5 mm), faint, brown or dark mottles. It always has a strong, 2 to 10 mm, lenticular structure with slickensides and a pH of 8.0 to 8.5. Gradual to -

B23: (when present) The lower subsoil is always dark brown, dark yellow-brown, brown, yellow-brown or dark grey-brown (7.5YR 4/4; 10YR 4/3, 4/4, 5/3, 5/4; 2.5Y 4/2) sometimes with few or common (2-20%), fine or medium (<5-15 mm), dark or brown mottles. It has a strong, 2-10 mm, lenticular structure with few (2-20%) slickensides. The lower subsoil always has few or common (2-20%), fine or coarse (<2-6 mm), soft or nodular calcareous segregations and sometimes very few or few (<2-10%), small or medium (2-20 mm), quartz or mudstones gravels, and a pH of 8.5. Abrupt or clear to -

B3 or BC: (when present) The transitional horizons are very dark grey, dark brown, dark grey-brown, yellow-brown or light olive-brown (10YR 3/1, 4/3, 5/6; 2.5Y 4/2, 5/4), usually with few to many (2-50%), fine or medium (<5-15 mm), dark, brown or yellow mottles. They have a light medium clay texture and many or abundant (20-90%), weathered mudstone fragments. There are usually very few or few (<2-10%), fine or medium (<2-6 mm), soft or nodular calcareous segregations and these horizons have a pH of 8.5. Abrupt to -

C: (when present) The C horizons are composed entirely of weathered mudstone, occasionally with very few or few (<2-10%), fine or medium (<2-6 mm), soft or nodular calcareous segregations.

R: Hard, unweathered mudstone

Soil Chemistry
(a) mound

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	7.9	.10	.002	4	12	19	61	42	29	8.8	.85	.84	3.3	2	.38	.69
B_{21}	0.3	8.5	.15	.003	4	11	19	64	41	28	8.9	1.9	.41	3.1	5	.60	.64
B_{22}	0.6	8.6	.39	.022	5	10	19	65	41	23	11	5.1	.34	2.1	12	.63	.64
B_{22}	0.9	8.5	.74	.088	4	11	20	66	43	21	13	7.6	.48	1.6	18	.71	.65
BC	1.2	8.3	.66	.075	3	8	24	65	35	17	10	6.5	.35	1.7	19		.54

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

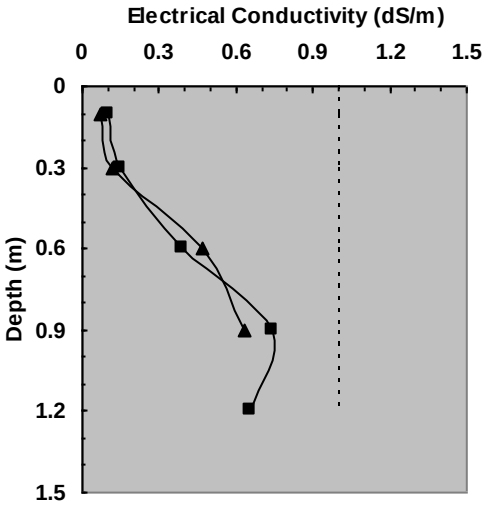
(b) depression

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	6.8	.07	.002	4	17	29	47	24[2]	15	7.5	.60	1.1	2.0	2	.52	.51
B_{21}	0.3	7.8	.12	.009	3	11	22	63	38[2]	25	10	2.7	.52	2.5	7	.53	.60
B_{22}	0.6	8.2	.47	.058	3	11	20	62	46[2]	30	11	5.0	.47	2.7	11	.63	.74
B_{22}	0.8	8.4	.63	.070													

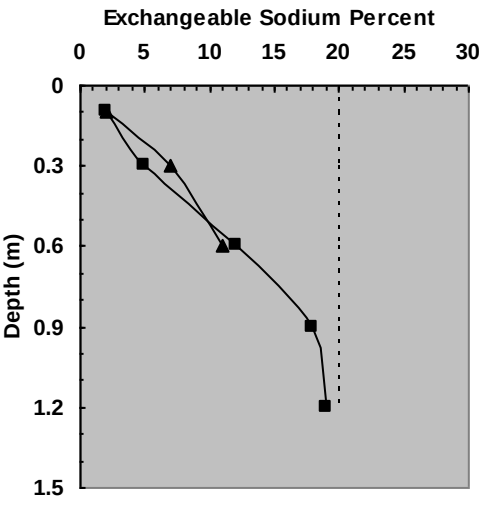
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

The mounds of the Mungi soil are typically alkaline throughout the profile, while the depressions are neutral on the surface becoming alkaline with depth. Mungi has a high, uniform clay content (47-66%), and low sand contents which reflect the mudstone parent material. The CEC is high (24-46 cmol[+] kg^{-1}) and dominated by calcium (Ca/Mg ratios 3.3-1.7), which is also at high levels (15-30 cmol[+] kg^{-1}). The subsoil is sodic to strongly sodic (ESP 7-19), but due to the high calcium content is only slightly dispersive and slowly drained as salts have accumulated to moderate levels in the lower subsoil (0.4-0.75 dS/m). The subsoil dispersion ratios are also only moderate (0.53-0.71). The CEC:clay ratios of 0.5 to 0.74 indicate a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Mungi has a rooting depth of 1.0 to 1.5 m that is limited only by hard, unweathered bedrock, as although subsoil salinity and sodicity are moderate to high they are not limiting (see above graphs). The PAWC varies from 130 mm to 160 mm for these rooting depths. Mungi has a high water holding capacity per unit depth of soil due to its very high clay content in excess of 60%. The salt graph shows also that the salt concentration reaches equilibrium at 1.2 m, however deep drainage still occurs as the salt concentration is only at a moderate level.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	11	0.10	1.2	0.44	5	20	8.5
Range	3-24	.04-.13	.29-1.8	.21-.91	4-8	15-28	6.9-11
No of samples	5	5	5	2	5	5	5
Rating	Moderate	Low	Low	Low	Low	High	High

Mungi has low surface soil fertility as it has only a moderate mean phosphorous content (11 mg/kg) and low mean total nitrogen level of 0.1%. The mean organic carbon concentration is also low (1.2%), again showing the lower organic carbon and total nitrogen concentrations of eucalypt woodlands soils compared to brigalow or softwood scrub clay soils. Apart from calcium and magnesium which are at high level, the remaining nutrients measured are all at low levels, indicating an overall low fertility.

Muruguran (Mr)

Concept: Muruguran is a very deep (>1.5 m), black, cracking clay soil with well developed normal gilgai that occurs only on seasonally flooded backplains and depressions. The topsoil is fine self-mulching with many, fine, orange mottles and it overlies an acid (pH 5.0-6.0), upper subsoil that has prominent reddish, brown or orange mottles. The lower subsoil becomes alkaline and has moderate to high levels of soluble salts (0.5-1.5 dS/m) and is moderately sodic.

Geology: Unconsolidated, Quaternary, alluvial sediments (Qa)

Aust Class: **Mound:** Aquic Vertosol **Depression:** Aquic Vertosol

PPF: **Mound:** Ug5.1, Ug5.16, Ug5.15 **Depression:** Ug5.1, Ug5.16, Ug5.15

Landform: Seasonally flooded backplains, closed depressions and broad, shallow drainage depressions that are found either on the northern area of the Callide Valley alluvial plain to the north of Lake Victoria, and on the floodplain between the Don and Dee Rivers around Lake Caroline. It also occurs in one or two small closed depressions on the valley flats of tributaries of the Callide Creek.

Vegetation: Coolibah or forest red gum, tall (12-20 m), open woodlands, occasionally with isolated trees of sally wattle in the understorey. As Muruguran is seasonally flooded, only waterlogging tolerant plants such as reed grass, blue couch, water couch and common finger rush occur in the ground layer.

Microrelief: Well developed normal gilgai – vertical interval: 0.1-0.4 m, horizontal interval: 5-10 m

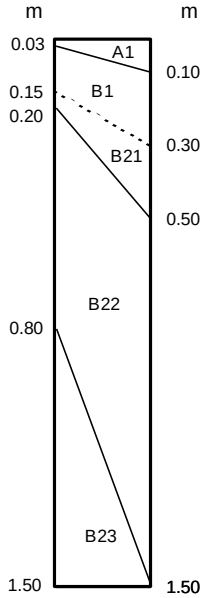
Runoff: Very slow

Permeability: Slowly permeable

Drainage: Poorly drained

Surface cond: Fine self-mulching (peds 1-2 mm) and periodic cracking on both mounds and depressions

Profile Description (mounds and depressions)



A1: Black, very dark brown, very dark grey, very dark grey-brown or occasionally dark brown (10YR 2/1, 2/2, 3/1, 3/2, 3/3), with 10-50%, orange mottles, <5 mm; silty light or silty light medium clay texture; strong, 1-2 mm, granular structure; loose dry consistence; pH 5.0 to 6.0. Abrupt or clear to -

B1: (when present) Either very dark grey, dark grey or dark grey-brown (10YR 3/1, 4/1, 4/2) with 20-50%, red, orange or brown mottles, 5-15 mm or reddish-brown or dark brown (2.5YR 4/2, 4/3; 7.5YR 3/4) with 20-50%, grey, brown or orange mottles, 5-15 mm; silty light or silty light medium clay texture; strong, 5 to 20 mm, subangular blocky structure; pH 5.5 to 6.5. Clear to -

B21: Black, very dark grey or very dark grey-brown (10YR 2/1, 3/1, 3/2), with 2-50%, orange or brown mottles,<5-15 mm; silty light medium or medium clay texture; strong, 2 to 10 mm, lenticular, or a strong, 5 to 20 mm, subangular or angular blocky structure, parting to 2 to 5 mm, lenticular or blocky primary peds; very firm or strong dry consistence; pH 6.5 to 8.0. Gradual to -

B22: Black or very dark grey (10YR 2/1, 3/1), sometimes <2-10%, orange or brown mottles, <5-15 mm; silty light medium or medium clay texture; strong, 2 to 10 mm, lenticular structure, 2-10%, slickensides; strong dry consistence; usually <2-20%, concretionary, calcareous segregations,<2-6 mm; occasionally <2-10%, gypsum crystals, <2 mm; pH 8.0 to 9.0. Gradual to -

B23: (when present) The lower subsoil either remains dark coloured, or becomes dark brown, dark grey, dark grey-brown or light yellow-brown (10YR 3/3, 4/1, 4/3; 2.5Y 4/2, 6/4), sometimes with <2-50%, dark, grey or brown mottles, <5-15 mm. The other properties are the same as for the B22 horizon.

Soil Chemistry

(a) mound

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	ECEC	Exchangeable Cations[1] Ca	Mg	Na	K	Al	Exch. acidity	Ca/Mg ratio	ESP	R1 Disp ratio	CEC: clay ratio
									cmol[+] kg^{-1}										
A_1	0.1	5.6	.41	.012	7	23	30	39	21	10	9.8	.45	.30	.40	.50	1.0	2	.51	.54
B_{21}	0.3	6.3	.31	.007	1	22	25	52	33	17	15	1.0	.30			1.1	3	.59	.63
B_{22}	0.6	7.0	.68	.016	2	15	24	58	48	27	19	2.1	.33			1.4	4	.58	.83
B_{22}	0.9	7.4	.60[2]	.060	2	14	24	60	48	22	22	3.3	.35			1.0	7	.59	.80
B_{23}	1.2	7.8	1.3[2]	.128	2	15	27	57	49	22	23	4.0	.28			1.0	8		.80
B_{23}	1.5	8.0	1.0[2]	.097															

[1] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 [2] Cl^- used to estimate the EC

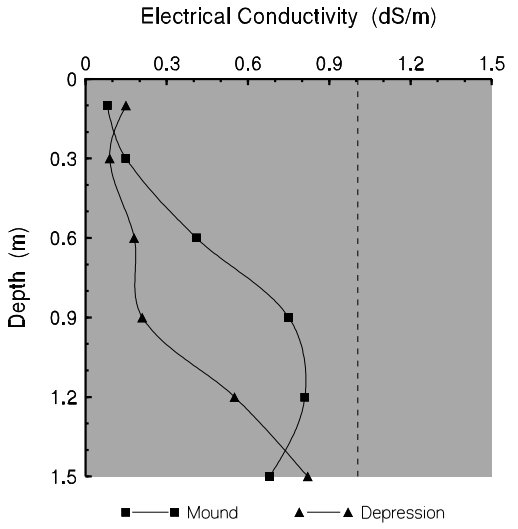
(b) depression

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl⁻ %	Particle Size CS %	FS %	S %	C %	ECEC cmol[+] kg⁻¹	Ca cmol[+] kg⁻¹	Mg cmol[+] kg⁻¹	Na cmol[+] kg⁻¹	K cmol[+] kg⁻¹	Al cmol[+] kg⁻¹	Exch. acidity cmol[+] kg⁻¹	Ca/ Mg ratio	ESP	R1 Disp ratio	CEC: clay ratio
A_1	0.1	5.5	.30	.005	13	23	22	41	19	8.8	8.0	.24	.60	.60	1.1	1.1	1	.42	.46
B_{21}	0.3	5.1	.24	.002	3	19	31	47	23	9.7	8.5	.30	.47	2.7	3.6	1.1	1	.61	.49
B_{21}	0.6	6.7	.28	.004	2	17	28	51	34	18	15	.89	.39			1.2	3	.69	.67
B_{21}	0.9	7.4	.10[(2)]	.010	1	12	28	56	42	21	19	2.0	.41			1.1	5	.73	.72
B_{22}	1.2	7.7	.20[(2)]	.018	1	11	29	58	45	20	21	3.8	.43			1.0	8		.78
B_{22}	1.5	8.1	.23[(2)]	.023															

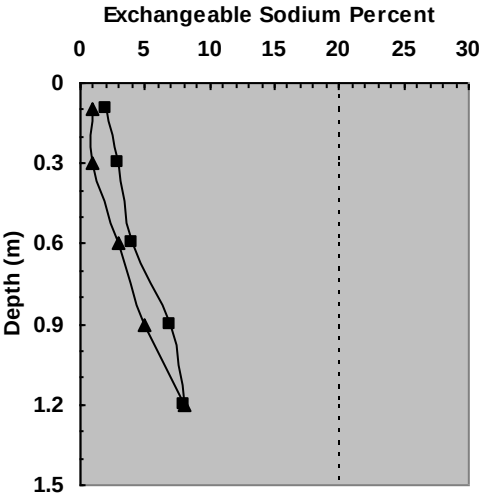
[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 [(2)] Cl^- used to estimate the EC

The Muruguran soil is characterised by its strongly to moderately acidic surface soil and upper subsoil, while the subsoil becomes alkaline with depth. It has a high to very high clay content (39-60%), and typically for alluvial soils of the study area, high levels of silt (22-31%). The CEC is mainly high throughout the profile (19-49 cmol[+] kg^{-1}), with calcium either codominant or only slighlt dominant over magnesium (Ca/Mg ratios 1.0-1.4). Calcium and magnesium are at moderate levels in the surface soil and increase to high levels in the subsoil (8.0-23 cmol[+] kg^{-1}). The lower subsoil is sodic (ESP 7-8), while profile drainage is slow due to the high clay content. High levels of chlorides (0.097-0.128%) have accumulated in the lower subsoil of the mounds, while the depressions have low levels of chlorides throughout the profile due to the seasonally ponded water, that can remain in the depressions for three to six months. The moderate salt content of the surface soil is due to the high soil fertility and is made up mainly of nitrates and sulphates, with very low chlorides. The CEC:clay ratios of 0.46 to 0.83 indicate a mixed to smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Muruguran has a very deep rooting depth of 1.5 m as subsoil salinity and sodicity are low to moderate and not limiting (see above graphs). A rooting depth of 1.5 m results in a PAWC of 150 mm. The seasonal ponding of water in the depressions has leached salts further down the profile with the depression salt curve indicating deep drainage below the soil profile as the salt concentration has not yet reached equilibrium. Whereas on the mounds, the salt graph is similar to that of an intermittent salt profile (DNR 1997), as the salt graph shows a pronounced peak between 0.9 to 1.2 m due to capillary rise of salts from a shallow, seasonal watertable during the periods of seasonal flooding.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	122	0.32	3.8	0.94	11	9.6
Range	74-228	.20-.44	2.7-4.9	.52-1.4	8.5-15	7.7-12
No of samples	4	4	4	4	4	4
Rating	Very high	Very High	High	Moderate	Moderate	High

Muruguran has a very high surface soil fertility due to its very high mean phosphorous (122 mg/kg) and total nitrogen (0.32%) contents. It also has a high mean organic carbon concentration (3.8%) as Muruguran is seasonally inundated over the summer and stays wet for long periods, which inhibits the oxidation and breakdown of organic matter. The high organic matter levels account for the very high total nitrogen and sulphur levels in the surface soil. The other nutrients measured are either moderate or high, indicating an overall high fertility.

Neimen (Nm)

Concept: Neimen is a shallow to moderately deep (0.4-1.0 m), hard setting, black or dark brown, strongly sodic duplex soil with a 0.1 to 0.35m thick, clay loamy topsoil that has a sporadically or conspicuously bleached A2 horizon. The topsoil overlies a coarse, columnar structured, medium clay subsoil which overlies Permian sandstone or siltstone between depths of 0.4 to 1.0 m. The soil reaction trend is neutral to alkaline, depending on the subsoil depth.

Geology: Little weathered, folded, Permian, lithic and felspathic sandstones and siltstones of the Back Creek Group and Rannes beds of the Bowen Basin (Pb, Pw, Puf, Purm)

Aust Class: Black or Brown Sodosol

PPF: Dd1.33, Db1.33, Dd1.43

Landform: Crests, hillslopes and pediments of gently undulating, undulating rises and low hills formed on folded, Permian sedimentary rocks. These landforms have slopes of 1 to 8%, and a relief of 10 to 40m.

Vegetation: The dominant vegetation association is a tall open forest or woodland of poplar box with a false sandalwood understorey. Woodlands of narrow-leaved ironbark with false sandalwood is the next most common association, while a silver-leaved ironbark – false sandalwood association occurs in limited areas. Other minor associations include a gum-topped box – rosewood association that is found only around the base of Mt. Cooper, while a poplar box – bendee association occurs in limited areas further to the south of Mt. Cooper. The other main understorey species that are present with false sandalwood are wilga, limebush, dead finish and currant bush. The low quality native pastures consist mainly of purple wiregrass and other wiregrasses (*Aristida spp.*), pitted blue grass, windmill grass and various annual grasses.

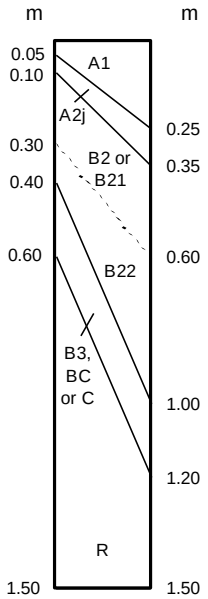
Runoff: Moderately rapid to rapid

Permeability: Very slowly permeable

Drainage: Imperfectly drained

Surface cond: Hard setting; with 2-50%, sandstone and quartz gravels and cobbles, 2-200 mm

Profile Description



A1: Very dark brown, very dark grey-brown, dark brown or dark grey-brown (10YR 2/2, 3/2, 3/3, 4/2; 7.5YR 3/2); sandy clay loam to clay loam fine sandy texture; massive or weak, 2 to 20 mm, subangular blocky or platy structure; very firm dry consistence; 2-50%, sandstone and quartz gravels, 2-60 mm; pH 6.0 to 7.5. Abrupt or clear to -

A2j, e: Dark brown, dark grey-brown, brown or light grey-brown (10YR 3/3, 4/2, 5/3, 6/2); light grey or white dry bleach colour (10YR 7/1, 7/2, 8/1); sandy clay loam to clay loam sandy texture; massive to weakly structured; 20-90%, sandstone, siltstone and quartz gravels, 2-60 mm, often in a layer overlying the subsoil; pH 6.5 to 7.5. Sharp or abrupt to -

B2 or 21: Very dark brown, very dark grey or very dark grey-brown, dark brown, yellow-brown or occasionally red-brown (7.5YR 3/2; 10YR 3/1, 3/2, 4/3, 5/4; 2.5Y 3/2; 5YR 3/3); sometimes 2-50%, yellow, brown or red mottles, <5-30 mm; light medium to medium heavy clay texture; strong, 100-300mm columnar structure; very strong dry consistence and the tops of the columns are often cemented; occasionally <2%, calcareous or manganiferous segregations, <2-6 mm; pH 7.0 to 8.5. Clear or gradual to either a B22, B3 or BC horizon -

B22: (when present) Very dark grey-brown to yellow-brown (7.5YR 4/4; 10YR 3/3, 4/4; 2.5Y 3/2, 4/2, 5/4 M); occasionally 2-50%; dark yellow or brown mottles, <5-15 mm; light medium to medium heavy clay texture; weak or moderate, 10-50mm, lenticular or blocky structure; usually 2-20%, soft or nodular calcareous segregations, <2-6 mm, and sometimes <2-10%, soft manganiferous segregations, <2 mm; pH 7.5 to 9.0 depending on the soil depth (shallower profiles do not become alkaline). Abrupt or clear to -

B3 or BC: 20-90%, weathered sandstone or siltstone fragments, mixed with grey, brown or yellowish-brown, light to medium clay subsoil; usually highly calcareous with 2-20%, soft or nodular calcareous segregations; 2-20 mm; pH 8.5 to 9.0. Sharp or abrupt to -

C: Weathered sandstone or siltstone fragments, sometimes with 2-20%, soft calcareous segregations, 2-20 mm; pH 8.5. Sharp or abrupt to -

R: Hard, unweathered sandstone or siltstone.

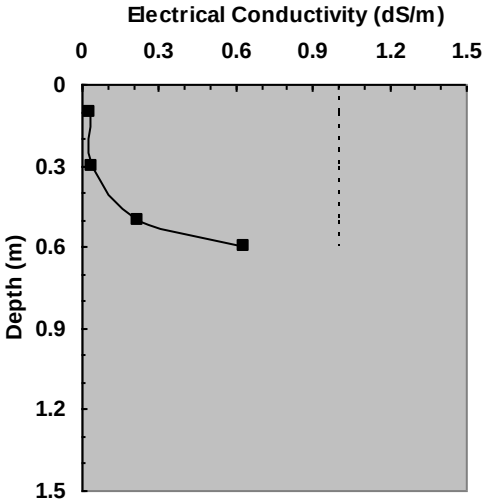
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.0	.03	.001	35	15	26	28	8.2[2]	3.0	3.9	.39	.92	0.77			
A_{2e}	0.3	7.2	.04	.002	37	15	19	30	6.9[2]	1.9	4.6	.31	.11	0.41			
B_{21}	0.5	8.7	.22	.025	14	7	12	67	24	4.4	13	7.4	.16	0.34	31	.85	.36
B_{22}	0.6	9.3	.63	.050	10	7	12	72	26	5.5	12	9.0	.18	0.46	35	.93	.36

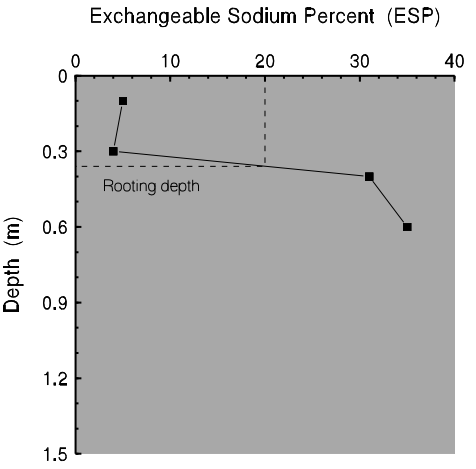
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Typically the topsoil is moderately acid to neutral with a strongly alkaline subsoil. The topsoil has a moderate clay content (28-30%), with a high level of silt (19-26%) and sand (50%), which makes it prone to surface sealing and crusting. There is a large increase in clay content in the subsoil, showing the strong texture contrast. The subsoil has a moderate CEC (24-26 cmol[+] kg^{-1}), that is dominated by magnesium (Ca/Mg ratios 0.34-0.46) and sodium (ESP 31-35), both of which are at higher concentrations than calcium, which is only at low levels of 4.4-5.5 cmol[+] kg^{-1}. The subsoil is therefore very highly dispersive (high to very high dispersion ratios 0.85-0.93), and very slowly permeable. However as the subsoils are usually less than 0.5 m thick, there is still sufficient deep drainage so that salts only accumulate to moderate concentrations (0.4-0.7 dS/m). The subsoil CEC:clay ratio of 0.36 indicates a mixed clay mineralogy, with the high total potassium levels (2.0-2.2%) indicating significant illite.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Neimen has a rooting depth of only 0.1 to 0.35 m that is limited to the topsoil, due to the extremely sodic subsoil that has an ESP in excess of 20 in the upper subsoil. Subsoil salinity is only moderate and not limiting (see above graphs). The PAWC is therefore very low, and varies from only 15 to 30 mm, depending upon the thickness of the topsoil. The salt graph shows that deep drainage below the soil profile occurs, despite the strongly sodic subsoil, as the salt concentration has not reached equilibrium.

Surface Soil Fertility

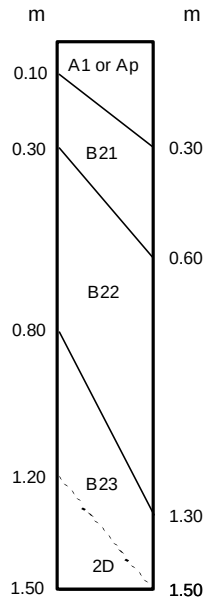
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	10	0.11	1.7	0.88	6	4.8	4.8
Range	6-23	.09-.18	1.1-2.8	.68-1.1	5-8	2.9-7.0	3.2-6.1
No of samples	10	10	10	4	6	7	7
Rating	Low	Moderate	Low	Moderate	Low	Low	Moderate

Neimen has a low fertility as it has mainly low levels of phosphorous, nitrogen and organic matter. The organic carbon content is also significantly lower than for brigalow-Dawson gum sodic, duplex soils. Most of the other nutrients measured are also low, indicating an overall low fertility.

Nikita (Nk)

Concept: Nikita is a very deep (>1.5 m), red, duplex soil with a 0.1 to 0.3 m thick, clay loamy topsoil that overlies a prismatic or blocky structured, fine sandy light medium clay subsoil. The lower subsoil becomes brown and is highly calcareous with an alkaline soil reaction trend and is formed on Cainozoic alluvial-colluvial sediments.
Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza)
Aust Class: Red Chromosol
PPF: Dr4.13
Landform: Crests and hillslopes of undulating rises formed on unconsolidated Cainozoic sediments that have slopes of 1 to 6% and a relief of 20 m. Nikita occurs in only two map units, a few kilometers south of Goovigen along the Prospect Creek – Goovigen road.
Vegetation: Softwood scrub closed forest or a coowarra box (Dawson gum) open woodland with a dense shrubby understorey. The softwood scrub has emergents of narrow and broad-leaved bottle trees above a dense, upper stratum of red bauhinia, crinkly-leaf bush, croton and wilga. The coowarra box woodland has also a dense understorey of turkey bush, holly bush and currant bush. However, most of the original vegetation has been cleared for either dryland cropping or cattle fattening on introduced grass pastures.
Runoff: Moderately rapid
Permeability: Moderately permeable
Drainage: Moderately well drained
Surface cond: Firm; with <2-10%, ironstone, silcrete or quartz gravels, 2-60 mm

Profile Description



A1 or Ap: Dark brown, or dark red-brown (7.5YR 3/3; 5YR 3/3, 3/4); clay loam fine sandy texture; weak or moderate, 2 to 10 mm, platy or polyhedral structure, or massive if cultivated; firm or very firm dry consistence; usually 2-10%, quartz or ironstone gravels, 2-20 mm; pH 6.5 to 7.0. Abrupt to -
B21: Dark red-brown or red-brown (5YR 3/3, 4/4); fine sandy light medium clay texture; strong, 10 to 20 mm, prismatic structure parting to lenticular or subangular blocky primary peds, or strong, 5 to 20 mm, subangular or angular blocky structure; very firm dry consistence; usually 2-10%, quartz or ironstone gravels, 2-20 mm; pH 7.0 to 8.0. Clear or gradual to -
B22: Dark brown or red-brown (7.5YR 4/4, 4/6; 5YR 4/4); fine sandy light medium or medium clay texture; strong, 10 to 20 mm, subangular blocky or lenticular structure; very firm dry consistence; 10-50%, soft or nodular calcareous segregations, 2-20 mm; sometimes 2-10%, quartz or ironstone gravels present, 2-20 mm; pH 8.0 to 8.5. Either clear or gradual to a B23 horizon or abrupt to a 2D horizon -
B23: Dark brown, yellow-brown, grey-brown or olive-brown (7.5YR 4/6; 10YR 5/4; 2.5Y 5/2, 5/4); sometimes with 2-10%, brown or dark mottles, <5-15 mm; fine sandy light medium clay texture; strong, 2 to 10 mm, lenticular or subangular blocky structure; 2-20%, soft or nodular calcareous segregations, 2-20 mm; sometimes 2-10%, silcrete gravels, 2-6 mm; pH 8.5 to 9.0.
2D: (when present) Dark brown or yellow-brown (7.5YR 4/4; 10YR 5/6); clay loam sandy or coarse sandy light clay texture; massive or weak, 5 to 10 mm, blocky structure; sometimes 2-10%, silcrete gravels, 2-6 mm; or soft, calcareous segregations, <2-6 mm; pH 8.5.

Soil Chemistry

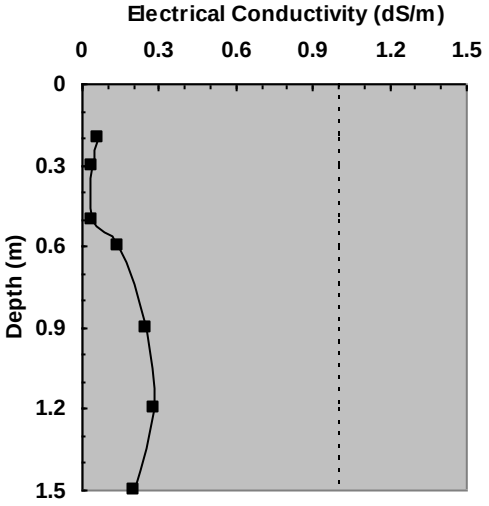
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl⁻ %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg⁻¹	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A1	0.1	6.8	.06	.003	23	41	9	25	14[2]	10	3.0	.16	1.1	3.3			
B21	0.2	7.0	.04	.002	20	39	9	31								.40	
B21	0.3	7.3	.04	.002	19	37	10	34	17[2]	12	4.6	.35	.25	2.6	2	.35	.50
B23	0.6	8.8	.14	.002	16	30	12	40	26	15	8.1	.98	.17	1.9	4	.55	.65
B23	0.9	9.0	.25	.015	15	31	16	40	22	11	9.5	1.4	.15	1.2	6	.59	.55
B23	1.2	9.0	.28	.018	19	36	12	34	23	9.9	11	1.6	.12	0.9	7	.57	.67
B24	1.5	9.2	.20	.008	28	38	7	26	22	8.3	11	1.9	.08	0.8	9	.56	.85

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

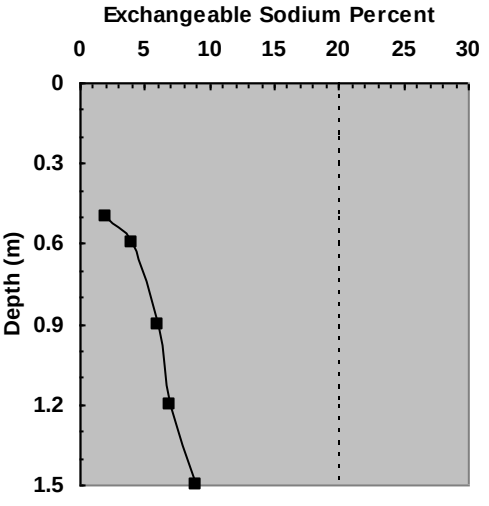
Typically Nikita has a neutral surface soil pH, while the subsoil is strongly alkaline. The surface soil has a moderate clay content (25%), and a very high fine sand content (41%) which makes it prone to crusting when cultivated The clay content of the subsoil soil is under-estimated atonly 33 to 40%, and does not show the texture contrast. The CEC is also only moderate throughout the profile (14-26 cmol[+] kg^{-1}), indicating a moderately weathered profile. The exchange capacity is mainly calcium dominant, except below 1.0 m where magnesium dominates (Ca/Mg ratios 3.3-0.8). Calcium is at moderate levels (8.3-15 cmol[+] kg^{-1}).

The subsoil only becomes sodic at 0.9 m (ESP 6-9), and overall the subsoil lis structurally stable (low to moderate dispersion ratios 0.35-0.59) and moderately well drained as indicated by the low levels of soluble salts throughout the profile (0.04-0.28 dS/m). The CEC:clay ratios are over-estimated due to the low clay contents, especially at 1.5 m.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Nikita has a rooting depth of 1.5 m as subsoil salinity and sodicity are low and therefore not limiting (see above graphs). A rooting depth of 1.5 m results in a PAWC of 125 mm. The PAWC is also under-estimated by the under-estimated clay content, and is most likely as high as 140 mm. The salt graph shows also that significant deep drainage below the soil profile occurs as soluble salt levels are low throughout the profile and only reaches equilibrium at low concentrations (i.e. only a small "salt bulge" is present due to the leaching of salts by deep drainage).

Surface Soil Fertility

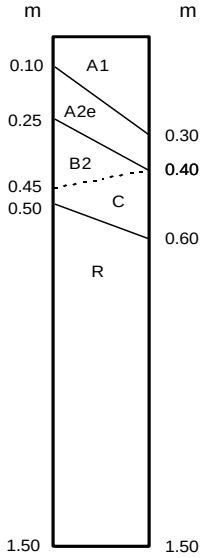
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Nutrient level	25	0.14	1.9	0.74	10	3.0
No of samples	1	1	1	1	1	1
Rating	High	Moderate	Moderate	Moderate	Moderate	Moderate

Due to its limited occurrence, the surface soil fertility was only measured at one site. However the results are typical for coowarra box (Dawson gum) scrub soils. These data show that Nikita has a moderate soil fertility due to its high phosphorous (25 mg/kg) and moderate total nitrogen (0.14%) contents. The level of organic carbon is only moderate (1.9%), which is most likely due to the more rapid breakdown of organic matter in lighter textured surface soils. As a result the total nitrogen content is also only moderate. Nikita has also moderate concentrations of potassium, calcium and magnesium.

Olinda (Od)

Concept: Olinda is a hard setting, shallow (0.4-0.5 m), brown, sodic duplex soil, or uniform clay loamy soil with a 0.2 to 0.4 m thick sandy clay loam topsoil that has a conspicuously bleached A2 horizon. The topsoil overlies either weathered syenite or a blocky structured, medium clay subsoil that over lies weathered syenite between depths of 0.4 to 0.45 m. Olinda has a neutral soil reaction trend.
Geology: Little weathered, Cretaceous, folded syenite showing almost vertical jointing (Ki)
Aust Class: Bleached-Leptic Tenosol or Brown Sodosol
PPF: Um2.12, Db1.42
Landform: Crests and hillslopes only of a low hill, to the south-east of Mt Cooper, which has steep slopes that are mainly in the order of 5 to 15%, and a relief of 40 to 60 m.
Vegetation: Either a narrow-leaved ironbark woodland, or a gum-topped box – narrow-leaved ironbark woodland, with a dense rosewood understorey. Wallaby apple, holly bush and currant bush also occur as low trees or shrubs in the mid-stratum while the native grasses consist mainly of purple and dark wiregrasses, with a minor component of pitted blue grass.
Runoff: Rapid
Permeability: Moderately to slowly permeable
Drainage: Well drained
Surface cond: Hard setting, with 10 to 50%, syenite gravels and cobbles, 2-200 mm

Profile Description



A1: Dark brown or very dark brown (7.5YR 3/2; 10YR 3/2), fine sandy clay loam or loam fine sandy texture; massive or weak, 2 to 5 mm, platy structure; weak or firm dry consistence; 20-90%, syenite gravels and cobbles, 2-200 mm; pH 5.5 to 6.5. Abrupt or clear to -

A2e: Dark brown, brown or grey-brown (10YR 3/3, 4/3, 5/2, 5/3); light grey or white dry bleach colour (10YR 7/1, 7/2, 8/1); fine sandy clay loam or clay loam fine sandy texture; massive structure; weak or firm dry consistence; 20-90%, syenite gravels and cobbles, 2-200 mm; pH 6.0 to 7.0. Sharp or abrupt to either a B2 or C horizon -

B2: (when present) Dark brown (7.5YR 4/4); medium clay texture; strong, 5 to 20 mm, subangular blocky structure; very strong dry consistence; 10-50%, syenite gravels, 2-60 mm; pH 7.0 to 8.0. Abrupt to -

C: Weathered syenite with only minimal clay development between the vertical joints. Sharp to -

R: Hard, unweathered bedrock

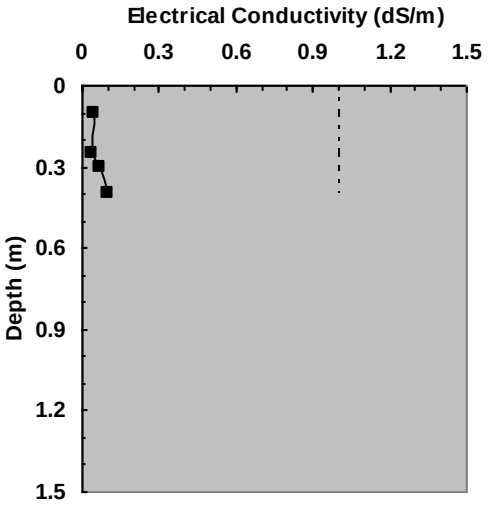
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	ECEC cmol[+] kg^{-1}	Ca cmol[+] kg^{-1}	Mg cmol[+] kg^{-1}	Na cmol[+] kg^{-1}	K cmol[+] kg^{-1}	Al cmol[+] kg^{-1}	Exch. acidity cmol[+] kg^{-1}	Ca/Mg ratio	ESP	R1 Disp ratio	CEC:clay ratio
A_1	0.1	5.7	.05	.001	24	20	19	33	10	5.6	3.7	.18	.68	.20	.20	1.5			
A_{2e}	0.25	6.2	.04	.001															
B_2	0.3	6.7	.07	.003	8	14	24	55	14	.69	12	1.4	.17			.06	10	.85	.25
B_2	0.4	7.1	.10	.006	5	10	18	65	20	.74	16	2.0	.20			.05	10	.76	.31

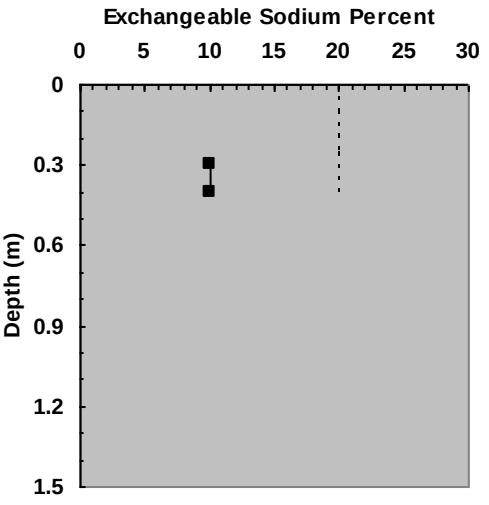
(1) Cations extracted with aqueous 1M NH_4Cl at pH 7.0

The surface soil is typically acid (pH 5.7) and the subsoil neutral (pH 6.7-7.1). The surface soil has a moderate clay content (33%) with high levels of silt (19%) and fine sand (20%), which makes it prone to hard setting, crusting and surface sealing. There is a large increase in clay content in the subsoil (55-65%), when present, showing the strong texture contrast. The subsoil has a moderate CEC (14-20 cmol[+] kg^{-1}), that is very highly magnesium dominant (Ca/Mg ratios 0.05-0.06), due to the very a low calcium content (0.69-0.74 cmol[+] kg^{-1}). The subsoil is also sodic with an ESP of 10, and is therefore highly dispersive (not indicated by the R1 dispersion ratios of only 0.76-0.85), mainly due to the very low calcium content. However there is still significant deep drainage as subsoil salts are very low (0.07-0.1 dS/m). The CEC:clay ratios of 0.25 to 0.31 indicate a mixed kaolinite – illite clay mineralogy which is indicated by the high total potassium content (1.4-1.6%).

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Olinda has a rooting depth range of 0.4 to 0.5 m that is limited by hard, unweathered bedrock, as subsoil salinity and sodicity are low and moderate respectively(see above graphs). The PAWC varies from 45 to 55 mm for these rooting depths. The high profile stone content also significantly reduces the water holding capacity. The salt graph shows that there is significant deep drainage below the soil profile as the subsoil has a low salt content (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

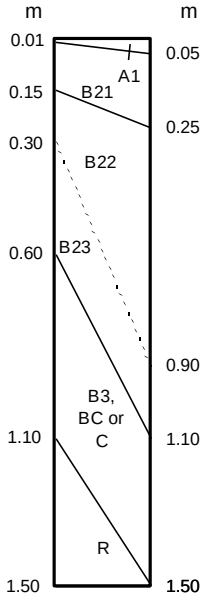
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Nutrient level	5	0.21	3.3	0.59	5.6	3.7
No of samples	1	1	1	1	1	1
Rating	Low	Very high	High	Moderate	Moderate	Moderate

The Olinda soil was only sampled at one site due to its limited occurrence. Olinda has a moderate surface soil fertility with low phosphorous (5 mg/kg), but very high total nitrogen (0.21%) due to the dense, rosewood understorey. The topsoil organic carbon content is high (3.3%), while the other three nutrients measured are all at moderate contents.

Overdeen (Ov)

Concept: Overdeen is a moderately deep to deep (0.6-1.1 m), red, non-cracking or cracking clay soil with a very fine, self-mulching, light clay topsoil that overlies a structured, medium clay subsoil. Overdeen has an alkaline soil reaction trend and is formed on basalt.
Geology: Moderately weathered, Tertiary basalt (Tb)
Aust Class: Red Dermosol or Red Vertosol
PPF: Uf6.31, Ug5.37
Landform: Crests and hillslopes of undulating rises and occasional pediments of low, relict plateaus formed from weathered basalt. The rises have slopes of 1 to 4% and a relief of 20 to 30 m, while the pediments are generally steeper with slopes of 4 to 6%. Overdeen is found mainly on the older, more weathered basalt outcrops to the west of Goovigen.
Vegetation: Overdeen originally had a softwood scrub closed forest. However all areas of Overdeen have been cleared and sown to introduced grass pastures, with only remnant trees and shrubs remaining. The most common tree species remaining are narrow and broad-leaved bottle trees, brigalow, red bauhinia, white-flowered bauhinia and crow's ash, along with shrubs such as bitter bark, holly bush and lime bush.
Runoff: Slow to moderately rapid
Permeability: Moderately permeable
Drainage: Moderately well drained
Surface cond: Very fine self-mulching (peds <1 mm), and occasionally periodic cracking, with 2 to 50%, basalt gravels and cobbles, 2-200 mm

Profile Description



A1: Dark brown or dark red-brown (7.5YR 3/2, 3/3; 5YR 3/3, 3/4; 2.5YR 2/4); light or light medium clay texture; strong, < 1 mm, granular structure; loose dry consistence; usually <2-20%, basalt gravels and cobbles, 2-200 mm; pH 7.0 to 8.0. Abrupt to -
B21: Dark red-brown (5YR 3/3, 3/4, 4/4; 2.5YR 3/4, 3/6); light or light medium clay texture; strong, 5 to 20 mm, angular or subangular blocky structure, parting to 2 to 5 mm, lenticular, polyhedral or subangular blocky primary peds; firm or very firm dry consistence; usually 2-50%, small basalt gravels to cobbles, 2-200 mm; pH 7.0 to 8.5. Clear or gradual to -
B22: As above, except very dark red-brown or dark red (5YR 3/3, 3/4; 2.5YR 3/6); and strong, 10 to 20 mm, lenticular or prismatic structure, parting to 2 to 5 mm, lenticular primary peds. Gradual to a B23, or abrupt to a B3 or BC -
B23: (when present) Dark red-brown or yellow-red (5YR 3/4, 4/6); light medium or medium clay texture; strong, 2 to 5 mm, lenticular or subangular blocky structure; 2-50%, soft or nodular calcareous segregations, 2-20 mm; occasionally 2-10%, quartz gravels, 6-20 mm; pH 8.5. Abrupt or clear to -
B3 or BC: Dark red-brown, yellow-red or dark red (5YR 3/4, 4/6; 2.5YR 3/4, 3/6); sandy light clay texture; massive to moderate, 2 to 5 mm, subangular blocky structure; 10-50%, soft calcareous segregations, 2-20 mm; 20-90%, weathered basalt fragments. pH 8.5. Abrupt to -
C: Weathered basalt.

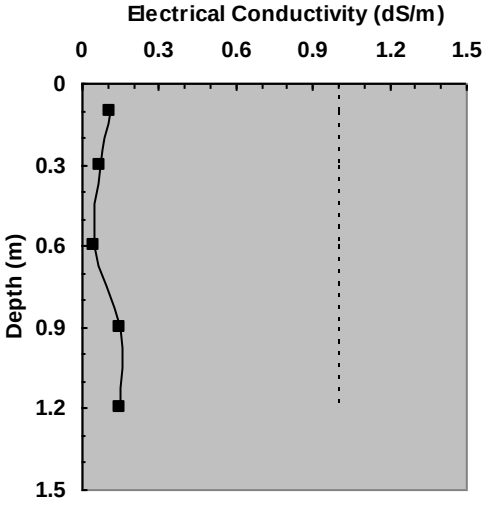
Surface Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl⁻ %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg⁻¹	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A1/B21	0.1	7.7	.11	.001	11	14	14	58	24[2]	19	2.9	.16	2.0	6.6	0.7	.26	.41
B22	0.3	8.0	.07	.001	9	11	8	70	23[2]	20	2.4	.19	.30	8.3	0.8	.33	.32
B22	0.6	7.7	.05	.002	7	10	7	73	22[2]	18	3.7	.24	.13	4.9	1	.36	.30
B22	0.9	8.2	.15	.001	8	11	7	69	29	20	9.9	.27	.14	2.0	0.9	.32	.42
BC	1.2	8.7	.15	.001	31	17	14	37	26	17	7.0	.24	.13	2.4	0.9		

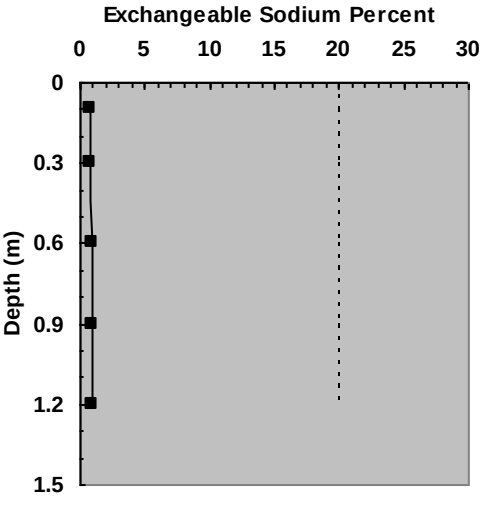
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Overdeen is typically alkaline throughout the profile (pH 7.7-8.7). It has a uniform, very high clay content (58-73%), with only low sand and silt contents which is typical for soils derived from basalt. The CEC is only 22 to 29 cmol[+] kg^{-1}, which indicates that Overdeen is moderately weathered (low CEC for such a high clay content – compare to soils on fresh basalt such as Clancy and Scoria). The exchange capacity however is highly calcium dominant (Ca/Mg ratios 2.0-8.3), and calcium is also at high levels throughout the profile (17-20 cmol[+] kg^{-1}). Exchangeable sodium levels are very low and the profile is therefore non-sodic (ESP ≤1) and structurally stable (very low R1 dispersion ratios 0.26-0.36) and well drained as indicated by the low soluble salt content (0.05-0.15 dS/m). The CEC:clay ratios of 0.3 to 0.42 indicate a mixed clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Overdeen has a rooting depth range of 1.1 to 1.5 m, that is limited only by hard, unweathered bedrock,, as subsoil salinity and sodicity are low and not limiting (see above graphs). The PAWC varies from 120 to 165 mm for these rooting depths. The salt graph shows also that there is significant deep drainage below the soil profile, as soluble salts have not accumulated in the subsoil (ie. a "salt bulge" is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

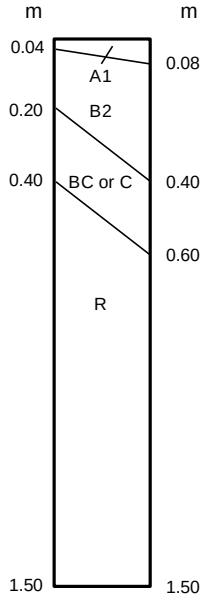
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	102	0.26	3.0	2.2	12	18	2.8
Range	51-171	.18-.39	2.3-4.2		9-19		
No of samples	8	8	8	1	7	1	1
Rating	Very high	Very high	High	Very high	High	High	Moderate

Characteristically for basaltic soils with softwood scrub vegetation, Overdeen has a very high surface soil fertility due to its very high mean phosphorous and total nitrogen contents (102 mg/kg and 0.26% respectively). Overdeen along with the other basaltic clay soils with softwood scrub (Annandale, Kooingal and Scoria), has one of the highest levels and phosphorous and total nitrogen recorded for all soils of the Banana soil survey. Overdeen also has a high mean organic carbon concentration (3.0%), which shows the strong correlation between organic matter and total nitrogen. Higher levels of organic matter also accumulate in clay soils with softwood scrub vegetation compared to eucalypt woodland clay soils (eg. Banana and Belldeen). Nearly all of the other nutrients measured are at high or very high levels.

Overdeen shallow variant (OvSv)

Concept: Overdeen shallow variant is a stony, shallow (0.2-0.4 m), red or dark brown, non-cracking clay soil with a very fine, self-mulching, light medium clay topsoil that overlies a strong, fine polyhedral structured, light medium clay subsoil. Overdeen has a neutral soil reaction trend and is formed on basalt.
Geology: Moderately weathered, Tertiary basalt (Tb).
Aust Class: Red or Brown Dermosol
PPF: Uf6.31
Landform: Flat-lying plateau surfaces and escarpments of low, remnant Tertiary, basalt plateaus. The plateau surfaces are level to gently undulating with slopes of 0 to 2%, while the escarpments are steep with slopes of 25 to 40%. Relief varies from only 10 to 15 m to 40 m.
Vegetation: Overdeen shallow variant originally had a softwood scrub, closed forest. However all areas of Overdeen shallow variant have been cleared and sown to introduced grass pastures, with only remnant trees and shrubs remaining. The most common tree species remaining are narrow and broad-leaved bottle trees, red bauhinia, scrub ironbark, coowarra box and crow's ash, along with shrubs such as bitter bark, holly bush and lime bush. The narrow crest of one remnant plateau unusually supports an open woodland of gum-topped bloodwood, while the escarpments were a softwood scrub community.
Runoff: Slow on the plateaus and rapid on the escarpments
Permeability: Moderately permeable
Drainage: Well drained
Surface cond: Very fine self-mulching (peds <1 mm), with 10-90% basalt cobbles, stones and boulders, 60 mm-2 m, and <2-10% basalt outcrop

Profile Description



A1: Dark red-brown or very dark brown (5YR 3/2; 10YR 2/2); light or light medium clay texture; strong, very fine (<1 mm), granular structure; loose dry consistence; 20-90%, basalt gravels and cobbles, 6-200 mm; pH 6.5 to 8.0. Abrupt or clear to -
B2: Dark red-brown or occasionally dark brown (5YR 3/3, 3/4; 7.5YR 3/3); light medium or medium clay texture; strong, 2 to 10 mm, polyhedral structure, sometimes parting to <2 to 5 mm, polyhedral primary peds; weak or firm dry consistence; 20-50%, basalt gravels and cobbles; 6-200 mm; pH 7.5 to 8.0. Abrupt or clear to a BC or C -
BC: Dark brown (7.5YR 3/3); light clay texture; moderate, <2 mm, polyhedral structure; 50-90%, fragments of weathered basalt; pH 8.0. Abrupt or clear to -
C: Weathered basalt fragments.
R: Hard, unweathered bedrock

Surface Soil Chemistry

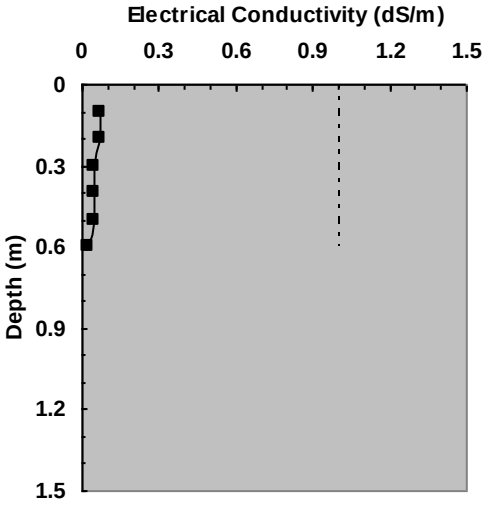
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1 /B_2	0.1	7.1	.07	.001	7	7	23	56	47	35	11	.04	.98	3.1	0.1	.36	.84
B_2	0.2	7.6	.07	.001													
B_2	0.3	7.7	.05	.001	3	6	12	74	47	32	14	.19	.35	2.3	.04	.37	.63
B_2	0.4	7.5	.05	.001													
BC	0.5	7.5	.05	.001													
BC	0.6	7.0	.02	.001	24	20	16	38	44	30	13	.51	.37	2.2	1.0	.67	1.2

[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0

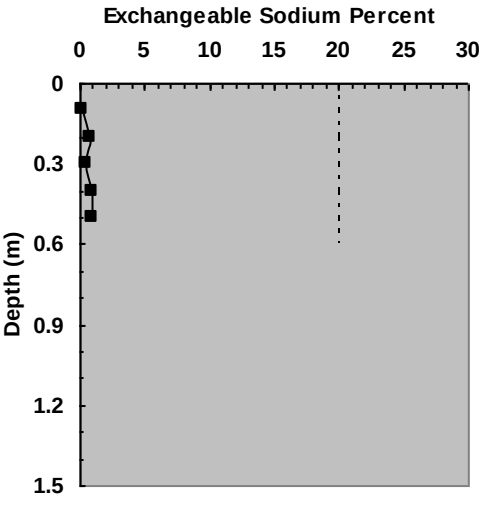
Typically the profile is neutral to slightly alkaline (pH 7.0-7.7). It has a uniform, very high clay content (56-75%0 and low levels of sand which is typical of basalt soils. The CEC is high (46 cmol[+] kg^{-1}) which is significantly higher that Overdeen which indicates that it is not as weathered. The exchange capacity is strongly dominated by calcium (Ca/Mg ratios 2.1-3.1), which is also at high levels (32-35 cmol[+] kg^{-1}).

Overdeen shallow variant is non-sodic throughout (ESP<1) with very low levels of exchangeable sodium and is therefore structurally stable (low dispersion ratios 0.36-0.37) and well drained, which is indicated by the very low levels of soluble salts throughout the profile. The CEC:clay ratios of 0.63 to 0.84 indicate a mixed, smectite dominant clay mineralogy. Free iron contents of the surface soil and subsoil varied from 1.8 to 4.8%.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Overdeen shallow variant has a shallow rooting depth range of 0.4 to 0.6 m that is limited only by hard, unweathered basalt bedrock, as subsoil salinity and sodicity are very low and not limiting (see above graphs). The PAWC varies from 35 mm 60 mm for these rooting depths. The high profile stone content significantly reduces the PAWC. The salt graph also indicates that there is significant deep drainage, as soluble salts have not accumulated in the subsoil (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

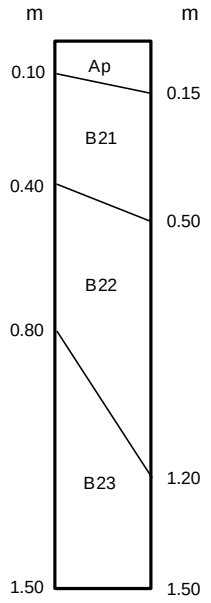
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	168	0.27	2.9	2.1	12	34	11
Range	97-290	.25-.29	2.5-3.3		11-14		
No of samples	2	2	2	1	2	1	1
Rating	Very high	Very high	High	Very high	High	High	High

Although only sampled at two locations, the data from these two sites are consistent. Overdeen shallow variant has a very high surface soil fertility due to its very high mean phosphorous and total nitrogen contents (168 mg/kg and 0.27%). Overdeen shallow variant, along with the other basalt softwood scrub soils, has one of the highest fertilities of all the soils of the Banana survey. The organic carbon content is also high, which is typical for softwood scrub soils. All other nutrients measured are also high.

Pakington (Pk)

Concept: Pakington is a very deep (>1.5 m), brown, weakly cracking clay soil with a thin (0.02-0.05), light medium clay topsoil that overlies a structured, medium clay subsoil that is strongly sodic (ESP 17-21) with high levels of soluble salts (0.9-1.3 dS/m). Pakington has an alkaline soil reaction trend.
Geology: Unconsolidated, Quaternary, alluvial sediments (Qa)
Aust Class: Brown Vertosol
PPF: Uf6.31
Landform: Pakington was found only on the upper reaches of a level, valley flat of an unnamed creek that flows in a northerly direction to the Don River adjacent to the town site of Kokotungo on the north-western edge of the Banana study area.
Vegetation: Pakington possibly originally had a brigalow – coowarra box vegetation. However the only area of Pakington mapped in the Banana study area has been cleared and either cultivated or sown to buffel grass pastures for cattle grazing.
Runoff: Slow
Permeability: Slowly permeable
Drainage: Imperfectly drained
Surface cond: Firm, occasionally weakly cracking with a thin surface flake

Profile Description



AP: Very dark grey-brown or dark brown (10YR 3/2, 3/3); light medium clay texture; weak or moderate, 10 to 50 mm, subangular blocky structure; strong dry consistence; pH 6.5 to 7.0. Abrupt to -
B21: Dark brown (10YR 3/3); medium clay texture; strong, 5 to 20 mm, subangular blocky structure; strong dry consistence; occasionally <2%, concretionary, manganese segregations, 2-6 mm; <2%, quartz gravels, 2-6 mm; pH 7.5 to 8.5. Diffuse to -
B22: Dark yellow-brown or dark brown (10YR 3/4, 4/3); medium clay texture; moderate or strong, 5 to 10 mm, subangular blocky or lenticular structure; very firm dry consistence; <2-10%, soft or nodular, calcareous segregations, <2-6 mm, and sometimes <2%, concretionary manganese segregations, <2 mm; occasionally <2%, silcrete gravels, 6-20 mm; pH 8.5 and 9.0. Diffuse to -
B23: Dark yellow-brown or dark brown (10YR 3/4, 4/3); medium clay texture; strong, 10 to 20 mm, lenticular structure with slickensides, or strong, 5 to 10 mm, subangular blocky structure becoming prismatic below 1.0 m; <2%, soft or nodular, calcareous segregations, <2-6 mm, and <2-10%, soft or concretionary, manganese segregations, <2-6 mm; sometimes <2%, quartz gravels, 2-6 mm; pH 8.5 to 9.5.

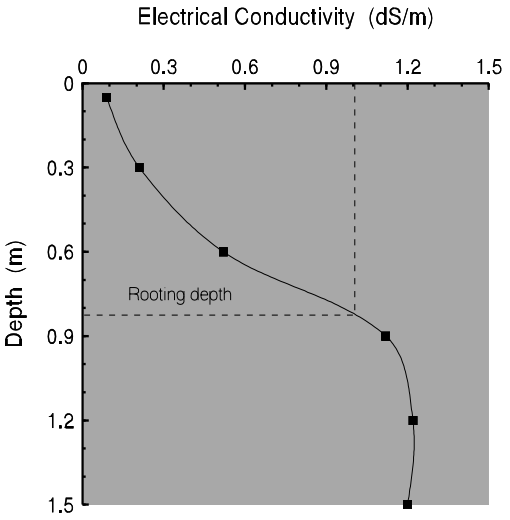
Surface Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
Ap	0.1	7.1	.17	.009	6	16	39	39	15[2]	10	3.2	.48	1.2	3.1	3	.63	.38
B_{21}	0.3	8.4	.10	.004	4	12	32	54	23	13	4.8	1.6	.23	2.7	7	.63	.43
B_{22}	0.6	8.6	.11	.005	4	11	29	58	23	12	7.4	2.5	.19	1.6	11	.84	.40
B_{22}	0.9	8.6	.14	.006	7	12	22	59	25	9.6	9.1	4.3	.19	1.1	17	.89	.42
B_{23}	1.2	9.3	.41	.006	7	14	23	56	24	7.1	8.5	5.0	.22	.80	21		.43
B_{23}	1.5	9.5	.42	.007													

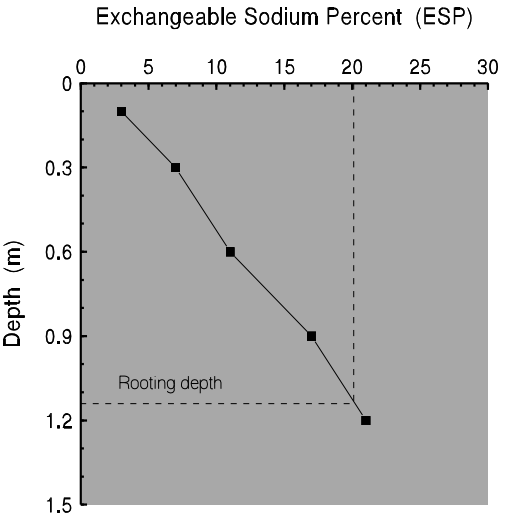
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

The surface soil is typically neutral (pH 7.1) with a strongly alkaline subsoil (pH 8.6-9.5). The surface soil is also characterised by its very high silt content (39%) which makes it prone to hard setting and crusting. The clay content is high to very high (39-59%) throughout the profile, and subsoil silt levels are high also (22-32%), which is typical of alluvial soils. The CEC is high (15-25 cmol[+] kg^{-1}), and except for the lower subsoil below 1.0 m, is dominated by calcium (Ca/Mg ratios 3.1-0.8) which is at moderate levels (7-13 cmol[+] kg^{-1}). The lower subsoil is also strongly sodic (ESP 17-21) and therefore dispersive. Subsoil drainage is therefore impeded which is also indicated by the high mean profile salt content at 0.9 m (see salt graph). The dispersion ratios of the lower subsoil (0.84-0.89) are also high indicating a dispersive subsoil and the CEC:clay ratios of 0.38 to 0.43 indicate a mixed clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Pakington has a rooting depth of 0.80 m that is limited by the high subsoil soluble salt content of 1.0 dS/m just below 0.8 m. Although Pakington also has a strongly sodic subsoil with an ESP of 20 at 1.15 m, it is not as limiting to the rooting depth as the salt content (see above graphs). Pakington therefore has a mean rooting depth of 0.8 m, which results in a PAWC of 110 mm. The salt graph shows also that the salt concentration reaches equilibrium at 0.9 m, due to impeded subsoil drainage, which indicates the long-term average depth of wetting and water uptake.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Nutrient content	88	0.20	2.3	0.95	14	9.9	3.1
No of samples	1	1	1	1	1	1	1
Rating	Very high	High	Moderate	Moderate	High	Moderate	Moderate

Due to its limited occurrence, the surface soil fertility was measured only at one site. However the results are representative of brigalow scrub alluvial clay soils. Pakington has high soil fertility as it has very high phosphorous (88 mg/kg) and high total nitrogen contents (0.2%). All alluvial soils in the Banana survey area have very high phosphorous levels while the total nitrogen is higher than for other alluvial clay soils with eucalypt woodlands due to the brigalow vegetation. Pakington also has a high sulphate-sulphur concentration (14 mg/kg), while all other nutrients measured are at moderate levels.

Police Camp (Pc)

Concept: Police Camp is a shallow to moderately deep (0.4-1.0 m), stony, hard setting, brown, red or dark, sodic duplex soil with a 0.1 to 0.3 m thick clay loamy topsoil, that usually has a sporadically bleached A2 horizon, that overlies a coarse, prismatic structured subsoil. Police Camp has a neutral or alkaline soil reaction trend and is formed on Permian sedimentary rocks.

Geology: Little weathered, folded, Permian sandstones, siltstones and shales of the Back Creek Group (Pb, Puf, Pur) and Rannes Beds (Pw) of the Bowen Basin.

Aust Class: Brown, Red or Black Sodosol

PPF: Db1.33, Db1.13, Dr2.32, Dd1.33, Dy2.32

Landform: Crests and hillslopes of gently undulating to undulating rises formed on folded, Permian sedimentary rocks in the western half of the study area. The rises have slopes of 1 to 6%, and a relief of 20 to 30 m, and are strongly dissected in some areas. Police Camp also occasionally forms soil complexes with the Fairview and Kianga soils on the almost vertically tilted sediments in the Fairview Road area.

Vegetation: Mid-high (6-12 m), brigalow – coowarra box (Dawson gum) open forest, with coowarra box usually present as an emergent. Narrow and broad-leaved bottle trees and red-flowered bauhinia sometimes also occur in the upper stratum, while the understorey species vary from low trees of wilga, lime bush, false sandalwood to shrubs of holly bush and wait-a-while. Currant bush and brigalow grasses (*Paspalidium spp.*) are the most common ground layer species. However, most of the areas of Police Camp have been cleared and sown to buffel grass pastures, with usually only remnant coowarra box trees remaining.

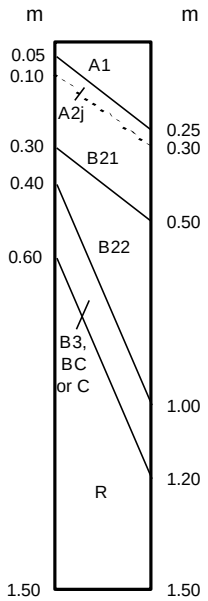
Runoff: Slow to moderately rapid

Permeability: Slowly permeable

Drainage: Imperfectly drained

Surface cond: Hard setting; with 2-50%, quartz, sandstone, siltstone or shale gravels and cobbles, 2-200 mm

Profile Description



A1: Dark brown, very dark brown or very dark grey-brown (10YR 2/2, 3/2, 3/3; 7.5YR 3/2, 3/3); sandy clay loam to clay loam fine sandy texture; massive to moderate, 2 to 10 mm, subangular blocky structure; firm or very firm dry consistence; 2-50%, quartz or sandstone gravels to cobbles, 2-200 mm; pH 6.0 to 7.5. Abrupt or clear to -

A2j: (when present) Dark brown, dark grey-brown or grey-brown (10YR 4/2, 4/3, 5/2; 7.5YR 3/4, 4/4); light grey or white dry bleach colour (10YR 7/1, 7/2, 8/1); sandy clay loam to clay loam coarse sandy texture; massive or weak, 2 to 10 mm, subangular blocky structure; firm or very firm dry consistence; 10-50%, quartz and sandstone gravels, 2-60 mm, that often occur in a layer directly overlying the subsoil; pH 6.0 to 7.5. Sharp or abrupt to -

B21: Very dark grey-brown, dark brown, brown, dark red-brown or red-brown (10YR 3/2, 3/3, 4/3, 5/3; 7.5YR 3/4, 4/4; 5YR 3/4, 4/4), sometimes <2-50%, dark, red or brown mottles, <5-15 mm; light medium or medium clay texture; strong, 10 to 100 mm, prismatic or occasionally columnar structure, usually parting to 5 to 20 mm, subangular blocky or lenticular primary peds; very firm or strong dry consistence; 2-20%, quartz and sandstone gravels, 2-60 mm; occasionally <2-10%, soft or nodular, calcareous or manganese segregations, <2-6 mm; pH 7.0 to 8.5. Clear or gradual to -

B22: Very dark grey-brown, dark brown or red-brown (10YR 3/2, 3/3, 4/3; 7.5YR 4/4; 5YR 4/4), sometimes <2-20%, dark, brown or grey mottles, <5-15 mm; light medium or medium clay texture; strong, 5 to 20 mm, subangular blocky or lenticular structure, sometimes <2% slickensides; very firm or strong dry consistence; usually <2-10%, soft or nodular, calcareous segregations, <2-20 mm, occasionally <2-10%, soft manganese segregations, <2-6 mm; 2-20%, quartz or sandstone gravels, 2-20 mm; pH 7.5 to 8.5. Abrupt to -

B3 or BC: Dark brown, light olive-brown or yellow-brown (7.5YR 4/4; 10YR 4/3, 5/4, 6/6; 2.5Y 5/4), sometimes <2-20%, brown, red or dark mottles, <5-15 mm; light or light medium clay texture; massive to moderate, 2 to 10 mm, subangular blocky structure; 20-90%, fragments of weathered sedimentary rocks; usually <2-20%, soft or nodular, calcareous segregations, <2-20 mm; pH of 8.0 to 8.5. Abrupt to -

C: Weathered sedimentary rock fragments, sometimes with <2-20%, soft or nodular calcareous segregations, 2-20 mm. Sharp to -

R: Hard, unweathered bedrock

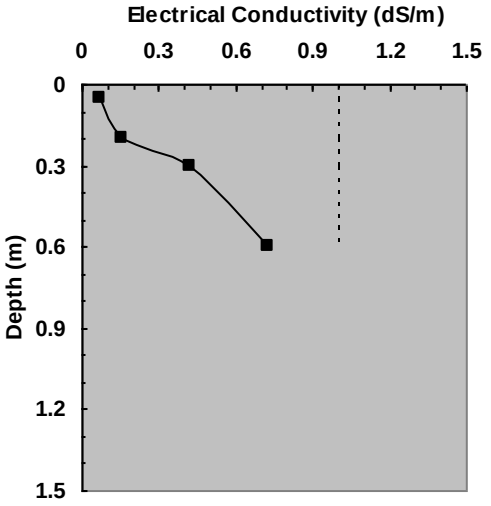
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A1	0.05	6.9	.07	.001	15	43	21	28	17[2]	11	4.9	.15	.91	2.2			
B21	0.2	7.7	.16	.015													
B22	0.3	8.6	.42	.037	7	23	13	57	37	16	15	4.6	.30	1.1	12	.77	.65
B22	0.6	8.8	.73	.078	9	22	15	56	34	13	16	5.7	.28	0.8	17	.82	.61

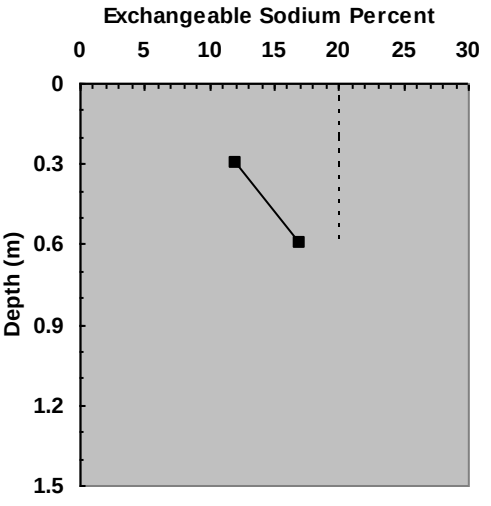
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Police Camp typically has a neutral surface soil and strongly alkaline subsoil. The topsoil has a moderate clay content (28%), with high and very high levels of silt (21%) and fine sand (43%) which makes it prone to hard setting, surface sealing and crusting. There is a large increase in the clay content of the subsoil (57%) which shows the strong texture contrast. The surface soil has a moderate CEC of 17 cmol[+] kg^{-1}, while the subsoil CEC increases to 34 to 37 cmol[+] kg^{-1}. Magnesium is either the dominant or codominant cation (Ca/Mg ratios 1.1-0.8) of the subsoil which is also strongly sodic throughout with an ESP of 12 to 17. The subsoil is therefore highly dispersive, which is indicated by the high dispersion ratios (0.77-0.82), and therefore has impeded drainage. However as the subsoil is usually <0.7 m thick, there is sufficient deep drainage so that salts only accumulate to moderate levels (0.4-0.7 dS/m). The subsoil CEC:clay ratios of 0.61 to 0.65 indicate a mixed clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Police Camp has a rooting depth range of 0.6 to 1.2 m, that is limited only by hard unweathered bedrock, as subsoil salinity and sodicity are moderate and not limiting (see above graphs). The PAWC varies from 60 mm to 95 mm for these rooting depths. The high stone content of the Police Camp soils, particularly in the topsoil, reduces the water holding capacity to some degree. The salt graph shows also that the salt concentration reaches equilibrium at 1.2 m, due to impeded subsoil drainage and minimal deep drainage, which indicates the long-term average depth of wetting.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	28	0.22	3.0	1.2	6	12	5.0
Range	9-167	.13-.37	1.8-5.1	.92-1.6	5-7	9.0-1.8	4.2-6.0
No of samples	8	8	8	2	4	5	5
Rating	High	Very high	High	High	Low	Moderate	Moderate

Police Camp has a high soil fertility due to its high mean phosphorous content (28 mg/kg) and very high mean level of total nitrogen (0.22%). Overall Police Camp has significantly higher total nitrogen levels than other brigalow – coowarra box (Dawson gum) sodic duplex soils (i.e. Eugene 0.14%; Ferguson 0.1%; Granville 0.11%; Nikita 0.14% and Thalberg 0.12%). Police Camp also has a high mean organic carbon content (3.0%), which again demonstrates the strong correlation between organic carbon and total nitrogen. All other nutrients measured are either moderate or high, except for sulphur which has a low mean content of 6 mg/kg.

Powerhouse (Ph)

Concept: Powerhouse is very deep (>1.5 m), dark brown or black, non-cracking clay soil with a pedal, light medium clay topsoil, that overlies a coarse, prismatic structured medium clay subsoil that is strongly sodic (ESP >15) with high levels of soluble salts (0.8-1.1 dS/m). Powerhouse has a neutral to alkaline soil reaction trend and is formed on unconsolidated, alluvial-colluvial sediments.

Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza).

Aust Class: Brown Dermosol

PPF: Uf6.31, Uf6.32

Landform: Steeper more dissected, undulating rises usually in close proximity to the Tertiary sandstone or basalt plateaus. The rises have a slope range of 1 to 8% and a relief of 15 to 30m. Powerhouse is found mainly in the south-east corner of the study area around the basalt plateaus and to the north of Biloela between the Callide and Argoon railway sidings.

Vegetation: The originally vegetation was a mid-high (6-20 m) closed or open forest of brigalow, with an understorey of currant bush, holly bush, lime bush and wait-a-while. However, the brigalow scrub has been predominantly cleared and sown to introduced grass pastures of buffel grass and green panic. Very few, if any, stands of remnant brigalow scrub now remain.

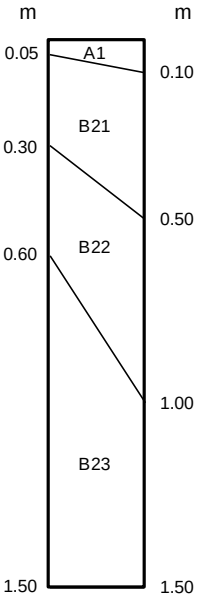
Runoff: Slow to moderately rapid

Permeability: Slowly permeable

Drainage: Imperfectly drained

Surface cond: Firm with a thin surface flake; can be very stony at times with 2-50%, silcrete, ironstone or basalt gravels and cobbles, 2-200 mm

Profile Description



A1: Black, very dark grey-brown or dark brown (10YR 2/1, 2/2, 3/2, 3/3; 7.5YR 3/2); fine sandy light to medium clay texture; strong, 2 to 10 mm, subangular blocky structure, sometimes parts to <2 mm subangular blocky primary peds; weak or firm dry consistence; 2 to 90%, silcrete, quartz or ironstone gravels and cobbles, 2-200 mm; pH 6.0 to 7.5. Abrupt to -

B21: Very dark grey-brown, dark brown or dark yellow-brown (7.5YR 3/3; 10YR 3/2, 3/3, 4/3, 4/6); occasionally 2-20%, dark or brown mottles, <5-15 mm; fine sandy light medium clay or medium clay texture; strong, 50-200mm, prismatic structure, usually parting to 10 to 50 mm, angular or subangular blocky primary peds; very strong dry consistence; sometimes 2-50%, ironstone, quartz or silcrete gravels, 2-60 mm; rarely <2-20%, soft, calcareous segregations, 2-20 mm; pH 7.0 and 8.5. Gradual or diffuse to -

B22: The lower subsoil becomes yellower in colour and is dark brown, brown, dark yellow-brown or yellow-brown (7.5YR 4/4; 10YR 4/4, 5/3, 5/6); sometimes 2-10%, dark, brown or grey mottles, <5-15 mm; light medium or medium clay texture; strong, 20 to 100 mm, prismatic structure, parting to 20 to 100 mm subangular or angular blocky primary peds; strong or very strong dry consistence; <2-20%, soft or nodular, calcareous segregations, 2-20 mm; occasionally <2-10%, silcrete or ironstone gravels, 2-20 mm; pH of 8.5 to 9.0. Diffuse to -

B23: Dark yellow-brown, yellow-brown or occasionally dark brown (10YR 4/4, 5/4, 5/6; 7.5YR 4/6); 2-50%, brown or grey mottles, <5-30 mm; fine sandy light medium to medium clay texture; strong, 20-100 mm, prismatic structure, often parting to moderate or strong, 10 to 50 mm, lenticular primary peds; strong or very strong dry consistence; occasionally 2-10%, ironstone gravels, 2-20 mm; <2-20%, soft or nodular, calcareous or manganese segregations, <2-20 mm, and occasionally 2-20%, gypsum crystals, <2-20 mm; pH 7.5 to 9.0.

Soil Chemistry

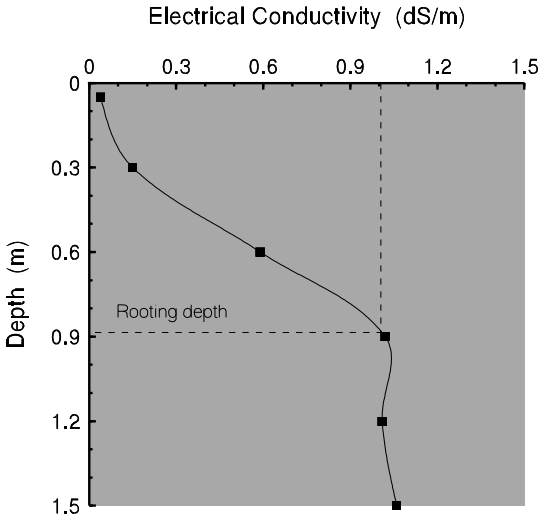
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A1/B21	0.1	6.9	.04	.002	21	26	17	34	14[2]	9.8	2.8	.14	.87	3.5	1	.30	.41
B21	0.3	7.6	.08	.002	21	24	14	41	22[2]	11	8.3	2.0	.28	1.3	9	.74	.54
B22	0.6	9.1	.67	.060	21	26	13	42	23	6.5	11	4.2	.22	0.6	18	.77	.55
B22	0.9	8.9	1.2	.121	22	25	13	42	22	5.3	12	5.8	.30	0.4	26	.83	.52
B23	1.2	8.9	1.2	.120	21	24	13	44	21	5.0	12	5.8	.28	0.4	28	.90	.48
B23	1.5	8.9	1.2	.117	23	25	12	40	19	3.2	12	6.0	.24	0.3	32	1.0	.48

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

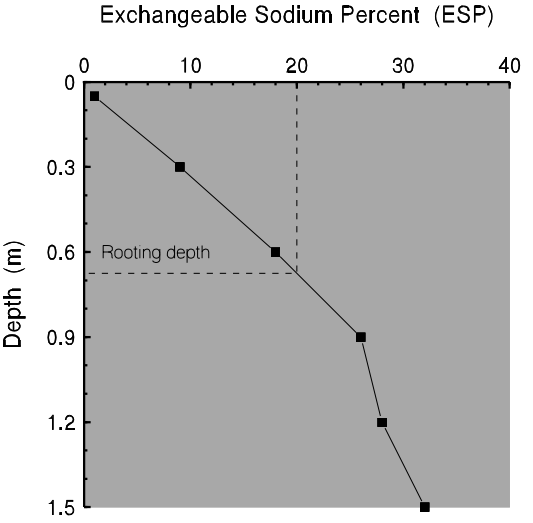
Powerhouse typically has a neutral surface soil and strongly alkaline lower subsoil. The clay content is underestimated in the surface soil (only 34%) and at high levels in the subsoil (40-44%). The surface soil also has high levels of silt (17%) and fine sand (26%) making it prone to surface sealing and crusting. The CEC is only moderate throughout the profile (14-23 cmol[+] kg^{-1}) indicating a moderately weathered soil.

Apart from a strongly calcium dominant surface soil, the subsoil is mainly magnesium dominant (Ca/Mg ratios 1.3-0.3) with only low calcium levels (6.5-3.2 cmol[+] kg^{-1}). The subsoil is strongly sodic (ESP 18-32) and therefore highly dispersive with impeded subsoil drainage, as indicated by the very high subsoil salt content (1.2 dS/m). The CEC:clay ratios of 0.4 to 0.55 indicate a mixed clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Powerhouse has a rooting depth of 0.7 m that is limited by the very high subsoil sodicity (ESP ≥ 20). The soluble salt content is also high, but not as limiting (see above graphs). A rooting depth of 0.7 m results in a PAWC of 85 mm. The salt graph shows also that the salt concentration reaches equilibrium at 0.9 m, due to impeded subsoil drainage, which indicates the long term depth of wetting and water uptake.

Surface Soil Fertility

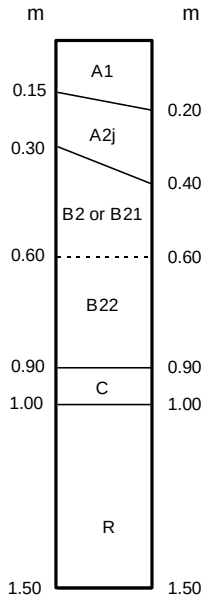
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	65	0.15	2.0	1.6	6	10	2.9
Range	41-94	.11-.21	1.4-2.5	1.4-1.8	5-7	9.6-11	2.8-3.1
No of samples	5	5	5	2	4	2	2
Rating	Very high	Moderate	Moderate	High	Low	Moderate	Moderate

Powerhouse has high surface soil fertility as the mean phosphorous content is very high (65 mg/kg), with a moderate mean total nitrogen content (0.15%). The organic carbon concentration is also moderate, with a mean of 2.0%, reflecting the total nitrogen levels. Although the mean organic carbon and total nitrogen concentrations are only moderate, they are still significantly higher than for eucalypt clay soils. All other nutrients measured are either moderate or high except for sulphur which has a low mean of only 6 mg/kg.

Precipice (Pp)

Concept: Precipice is a moderately deep (0.9-1.0 m), red or grey, mottled, acid duplex soil, with a stony, clay loamy topsoil, 0.3 to 0.4 m thick, that has a sporadically bleached A2 horizon. The topsoil overlies a very strongly acid, mottled, medium clay subsoil, and is formed on quartzose sandstone.
Geology: Deeply weathered, Jurassic, fine-grained, quartzose sandstone (Jlp)
Aust Class: Red or Grey Kurosol
PPF: Dr 3.31, Dy5.31
Landform: Undulating, strongly dissected low hills and rises with slopes of 1 to 15% and relief of 30 to 40 m. Precipice is confined to one small area which adjoins the northern boundary of the Boundary Hill coal mine lease, on the eastern edge of the study area.
Vegetation: Tall (12-20m), open forest of a narrow-leaved ironbark and lemon-scented gum – rosewood association. Rosewood is the main understorey species and forms a mid high (6-12 m), closed or dense understorey where the rosewood canopies are overlapping. Other shrubs such as turkey bush, soap bush, and emu apple also occur in the mid-stratum. The ground layer consists of low quality native grass pastures of wire grasses (*Aristida spp*.), curly windmill grass and barbwire grass. Rosewood becomes a severe regrowth problem following clearing.
Runoff: Moderately rapid
Permeability: Moderately permeable
Drainage: Moderately well drained
Surface cond: Hard setting or firm, with 2-20%, sandstone gravels and cobbles, 6-200 mm.

Profile Description



A1: Black (10YR 2/1); fine sandy clay loam texture; massive structure; 2-90%, sandstone gravels and cobbles, 6-200 mm; weak dry consistence; pH 6.0 to 7.0. Clear to -
A2j: Dark grey-brown (10YR 4/2), with pale grey to white (10YR 7/1, 8/1) dry bleach colour; clay loam, fine sandy texture; massive structure; 2-90%, sandstone gravels to cobbles, 6-200 mm; weak dry consistence; pH 5.5 and 6.5. Sharp or abrupt to -
B2 or 21: Either red-brown or grey-brown (5YR 5/4; 10YR 5/2); 10-50%, grey or red mottles, 5-15 mm; medium clay; strong, 5-10 mm, subangular blocky structure, parting to strong, 2 to 5 mm, subangular blocky primary peds; firm dry consistence; <2-20%, sandstone gravels to cobbles, 6-200 mm; very strongly acid throughout with a pH of 4.5 to 5.5. Gradual to a B22, or abrupt to a C horizon -
B22: (when present) Similar to the B21 horizon, except that the colour becomes grey (5YR 6/1) with 2-10%,brown mottles, <5 mm. Abrupt to -
C: The C horizon is grey (10YR 5/2), with 20-50%, red or brown, prominent mottles, 5-30 mm. Sharp to -
R: Hard, unweathered bedrock

Soil Chemistry

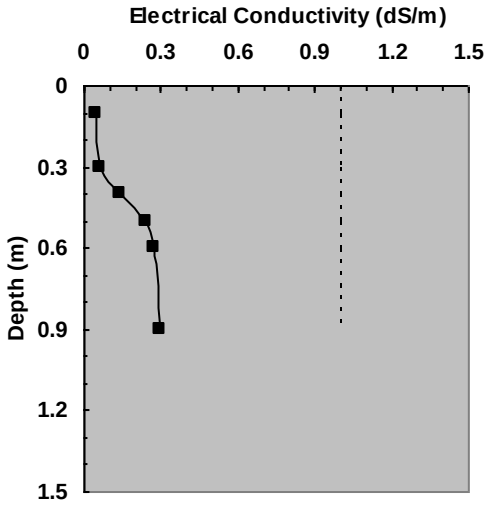
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	ECEC	Exchangeable Cations[1] Ca	Mg	Na	K	Al	Exch. acidity	Ca/Mg ratio	ESP	R1 Disp ratio	CEC: clay ratio
									cmol[+] kg^{-1}										
A_1	0.1	6.6	.05	.001	36	28	9	24	14	8.2	4.6	.05	1.1	-	-	1.8			
A_{2j}	0.3	6.2	.06	.003	36	24	10	28	7	2.0	3.6	.13	.99	-	-	.56			
B_{21}	0.4	5.1	.14	.014					7	.58	3.7	.23	1.2	.80	.90	.16	3		
B_{21}	0.5	4.7	.24	.025	16	9	4	71	7	.60	3.8	.27	1.1	1.1	1.4	.16	4		.10
B_{21}	0.6	4.4	.27	.030	16	10	8	65	7	.35	3.6	.35	1.0	1.6	1.7	.10	5	.54	.11
B_{22}	0.9	4.2	.30	.032	7	14	16	61	7	.24	3.2	.60	.88	2.1	2.1	.08	9	.48	.12

[1] Cations extracted with aqueous 1M NH_4Cl at pH 7.0, and exchangeable sodium adjusted for soluble salts

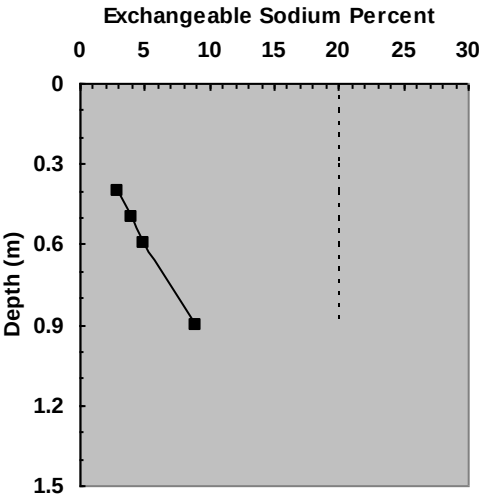
Precipice has a very strongly acid subsoil (pH 4.2-5.1), which characterises this soil profile class. The topsoil has a clay content of 24 to 28% with high levels of fine and coarse sand. There is a large increase in the clay content of the subsoil (61-71%) which shows the strong texture contrast. The subsoil CEC however is only low (7 cmol[+] kg^{-1}) indicating a highly weathered subsoil. The calcium concentration is virtually non-existant (0.24-0.6 cmol[+] kg^{-1}) and the exchange capacity is dominated by magnesium (Ca/Mg ratios 0.16-0.08) and exchangeable aluminium, due to the very low pH.

The subsoil is only sodic in the lower subsoil (ESP 9) and is structurally stable throughout, despite the very low calcium levels, due to the exchangeable aluminium. As a result the subsoil is well drained as indicated by the low soluble salt content (0.14-0.3 dS/m) as there is significant deep drainage below the soil profile. The subsoil CEC:clay ratios of 0.1 to 0.12 indicate a kaolinite clay mineralogy.

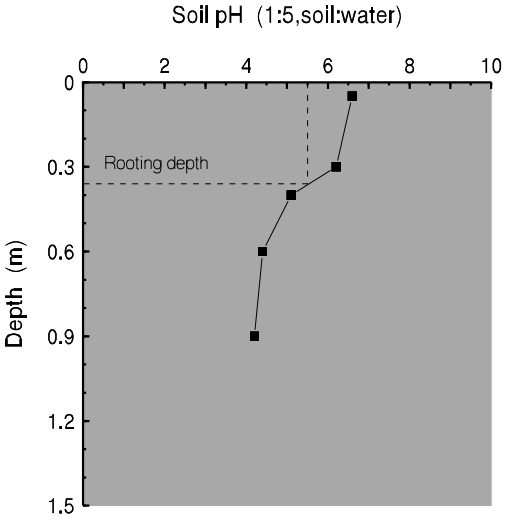
Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph



Profile pH graph

Precipice has a rooting depth of 0.3 to 0.4 m, that is limited to the topsoil due to the very strongly acidic subsoil, which has a pH less than 5.5 (see above graph). A rooting depth of 0.3 to 0.4 m results in a PAWC of only 35 to 50mm. The water holding capacity is also significantly reduced by the high stone content of the topsoil. The salt graph also shows that there is significant deep drainage below the soil profile as the salt content is only low and has not reached equilibrium (ie. a salt bulge is absent).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	14	0.14	3.3	0.64	9	8.1	4.5
Range	7-30	.12-.16	2.8-3.8	.5-.81	7-11	-	-
No of samples	2	2	2	2	2	1	1
Rating	Moderate	Moderate	High	Moderate	Moderate	Moderate	Moderate

Although limited by the small number of samples, the fertility data indicates a moderate soil fertility. It is difficult to reliably rate the available phosphorous as the two samples varied from low to very high (7-30 mg/kg). The mean total nitrogen level is moderate (0.14%) which is most likely due to the presence of the thick stands of rosewood in the understorey. The mean organic carbon content is also high (3.3%) as both samples were taken from uncleared areas. Calcium and magnesium are at moderate levels in the surface soil (8.1 and 4.5 cmol[+] kg^{-1} respectively), however as shown earlier calcium levels are very low throughout the subsoil. The mean potassium and sulphur contents are both also at moderate levels of 0.64 meq% and 9 mg/kg respectively.

Rannes (Rn)

Concept: Rannes is a deep to very deep (1.1->1.5 m), brown or red, cracking clay soil with a thin (0.05-0.1 m), very fine, self-mulching topsoil that overlies a medium clay subsoil that is strongly sodic (ESP >15) with high levels of soluble salts (0.8-1.3 dS/m). Rannes has an alkaline soil reaction trend and is formed on basic to intermediate volcanic rocks.

Geology: Little weathered, Permian, intermediate volcanic rocks (spilite and andesite) of the Rookwood volcanics (Pr) and Camboon andesites (Pln). As Rannes occurs footslopes and pediments, colluvial deposition has also played a role in soil formation.

Aust Class: Brown or Red Vertosol

PPF: Ug5.32, Ug5.34, Ug5.38

Landform: Footslopes and pediments of the steep, dissected hills formed on intermediate volcanic rocks to the west of Goovigen. These lower slopes have gradients of 2 to 4% and the Rannes soil grades into Earlsfield which almost always occurs further downslope on the unconsolidated, Cainozoic, clay sediments.

Vegetation: Rannes originally had a softwood scrub closed forest vegetation. However all areas of Rannes on the Banana study area have been cleared for either rainfed cropping, or sown to introduced grass pastures for cattle fattening. Only remnant, isolated trees of broad and narrow-leaved bottle trees, brigalow and red bauhinia or white-flowered bauhinia now remain.

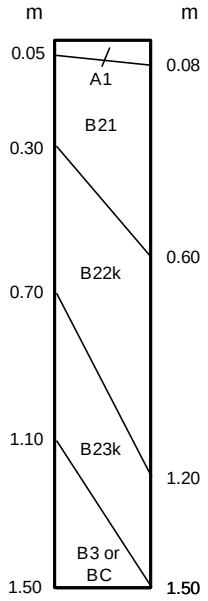
Runoff: Slow

Permeability: Slowly permeable

Drainage: Moderately well drained

Surface cond: Very fine self-mulching (peds <1 mm) and periodic cracking; with 2-50%, spilite and andesite gravels and cobbles, 6-200 mm.

Profile Description



A1: Dark brown or dark red-brown (5YR 3/3; 7.5YR 3/3; 10YR 3/3); light medium or medium clay texture; strong, <1 mm, granular structure; loose dry consistence; usually 2-20%, spilite or andesite gravels, 2-20 mm; sometimes slightly to highly calcareous; pH 7.0 to 8.5. Abrupt or clear to -

B21: Dark brown, dark red-brown or red brown (2.5YR 4/4; 5YR 3/4; 7.5YR 3/3; 10YR 3/3); light medium or medium clay texture; either strong, 2 to 5 mm, lenticular or a 2 to 10 mm, polyhedral structure; firm or very firm dry consistence; 2-20%, spilite or andesite gravels, 2-20 mm; sometimes <2%, soft or nodular calcareous segregations, 2-20 mm; pH 8.0 to 9.0. Gradual to -

B22k: Red-brown, yellow-red or occasionally dark brown (5YR 4/4, 4/6, 5/6; 7.5YR 4/4); light medium or medium clay texture; strong, 2-10 mm, lenticular structure; very firm dry consistence; <2-10%, spilite or andesite gravels, 2-20 mm; 2-20%, soft or nodular calcareous segregations, <2-20 mm; pH 8.5 to 9.5. Gradual or diffuse to -

B23k: As above, except some profiles have 2-50%, dark or brown mottles, <5-15 mm; and 2-20%, soft manganese segregations, <2-6 mm; rarely <2%, gypsum crystals, 2-6 mm. Abrupt or clear to -

B3 or BC: Brown, yellow-brown, light yellow-brown or occasionally red-brown (10YR 5/3, 5/6, 6/8; 2.5Y 6/4; 5YR 4/4); usually 2-50%, pale or dark mottles, <5-15 mm; medium clay texture; weak or moderate, 2 to 10 mm, lenticular or subangular blocky structure; 20-90%, weathered spilite or andesite fragments; sometimes 2-20%, soft calcareous segregations, 2-6 mm; pH 8.0 to 9.0.

Soil Chemistry

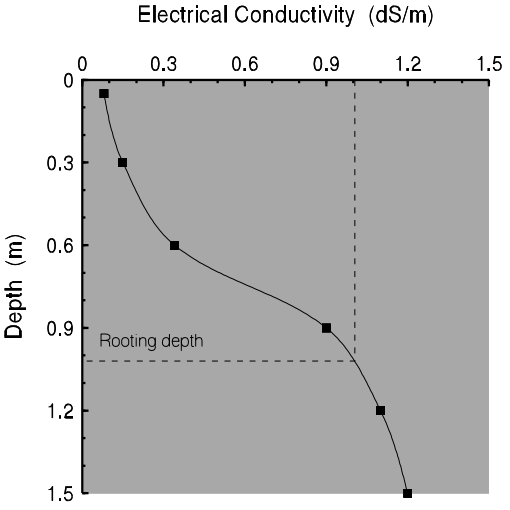
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	8.5	.16	.002	8	16	15	57	51	37	12	.55	.51	3.1	1	.35	.89
B_{21}	0.3	9.0	.21	.001	8	13	26	55	47	20	21	.23	.20	.95	5	.46	.85
B_{22}	0.6	9.3	.40	.007	7	13	24	57	45	10	29	5.7	.11	.34	13	.62	.79
B_{23}	0.9	9.0	.90	.049	10	12	21	57	42	6.5	27	8.1	.09	.24	19	.60	.74
B_{23}	1.2	8.9	1.2	.080	14	16	26	47	34	7.0	19	7.6	.08	.37	22	.71	.72
BC	1.5	8.8	1.3	.090	26	14	28	39	26	5.3	15	3.8	.11	.35	15	.86	.67

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

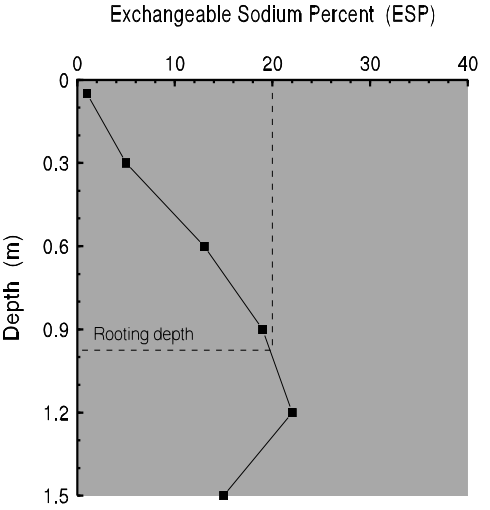
Rannes is typically strongly alkaline and has a very high clay content (47-57%) throughout the profile. The silt content is also high in the subsoil (21-26%). The CEC is high (34-51 cmol[+] kg^{-1}), and magnesium is the dominant cation of the subsoil (Ca/Mg ratios 0.95-0.35) with quite low calcium contents in the lower subsoil (7.0-5.3 cmol[+] kg^{-1}). The very high calcium content of the topsoil (37 cmol[+] kg^{-1}) however explains the very fine surface structure.

The subsoil is sodic to strongly sodic (ESP 13-22) and is therefore dispersive (not reflected by the dispersion ratios) with impeded drainage as indicated by the high subsoil salt content below 0.6 m (0.9-1.3 dS./m). The CEC:clay contents of 0.7 to 0.9 indicates a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Rannes has a rooting depth of 1.0 m, that is limited by both subsoil salinity and sodicity (see above graphs). A rooting depth of 1.0 m results in a PAWC of 125 mm. The salt graph shows also that the salt concentration reaches equilibrium at 1.0 m, due to impeded subsoil drainage, which indicates the long-term, average depth of wetting.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	31	0.15	1.9	0.54	11	36	12
Range	14-60	.10-.22	1.0-2.3	-	6-16	-	-
No of samples	4	4	4	1	3	1	1
Rating	High	Moderate	Moderate	Moderate	High	Very high	High

Rannes has high surface soil fertility with a high mean phosphorous content (31 mg/kg), but only a moderate mean level of total nitrogen (0.15%). However this is the lowest fertility for a softwood scrub clay soil, which usually have phosphorous and nitrogen contents in excess of 60 mg/kg and 0.2% respectively. The lower fertility may be due to the fact that all samples were taken from areas that had previously been cropped. The mean organic carbon concentration of 1.9% also indicates a cropping history. The interpretation of the remaining data is limited by the low number of samples, however these data do indicate an overall high fertility with only potassium at a moderate content.

Retro (Rt)

Concept: Retro is a very deep (>1.5 m), hard setting, black or occasionally brown, sodic duplex soil with a 0.1 to 0.4 m thick, fine sandy or silty clay loam topsoil that has a sporadically bleached A2 horizon. The topsoil overlies a prismatic structured, fine sandy light medium clay subsoil, which sometimes overlies buried sandy soil materials below 0.7 m. Retro has an alkaline soil reaction trend and is formed on unconsolidated, alluvial sediments.

Geology: Unconsolidated, Quaternary, alluvial sediments (Qa).

Aust Class: Black or occasionally Brown Sodosol

PPF: Dd1.33, Db1.33, Dd1.13

Landform: Retro occurs on the level plains and backplains of the Callide Valley floodplain, and valley flats of the many tributaries of the Dawson River and Callide Creek in the Banana study area. These landforms have very low slopes of 0.1 to 0.3%, and a low relief of only 1 to 3 m. Retro is a widespread alluvial soil and is found mainly on the northern areas of the Callide Valley alluvium to the north of Goovigen and along the alluvial plain of the Bell Creek to the east of Goovigen.

Vegetation: Tall (12-20 m), open forest or woodland of poplar box, occasionally with associates of coolibah, forest red gum and Moreton Bay ash, with an understorey dominated by sally wattle. There are also minor amounts of false sandalwood, lime bush and whitewood in the mid-stratum. The native grass pastures are of moderate to high quality with the main species being black spear grass, forest blue grass and occasional wire grasses (*Aristida spp.*).

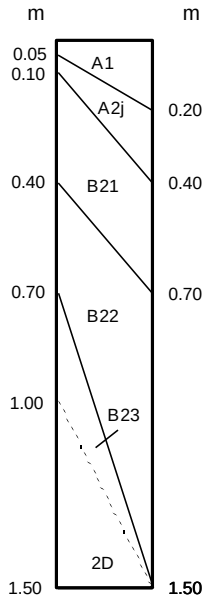
Runoff: Very slow

Permeability: Slowly permeable

Drainage: Imperfectly drained

Surface cond: Hard setting

Profile Description



A1: Black, very dark brown, very dark grey, very dark grey-brown or dark brown (10YR 2/1, 2/2, 3/1, 3/2, 3/3); fine sandy clay loam, clay loam fine sandy or silty clay loam texture; massive or weak, 2-10 mm, subangular blocky structure; very firm or strong dry consistence; pH 6.0 to 7.5. Abrupt or clear to -

A2j: Very dark grey, very dark grey-brown, dark grey, dark grey-brown or dark brown (10YR 3/1, 3/2, 4/1, 4/2, 4/3), light grey or white dry bleach colour (10YR 7/1, 7/2, 8/1); fine sandy clay loam, clay loam fine sandy or silty clay loam texture; massive structure; firm to strong dry consistence; pH 6.0 to 7.5. Sharp or abrupt to -

B21: Brown, very dark brown, very dark grey, very dark grey-brown or occasionally dark brown (10YR 2/1, 2/2, 3/1, 3/2, 3/3; 7.5YR 4/4); fine sandy light medium clay or medium clay texture; strong, 20 to 100 mm, prismatic structure, parting to 5 to 20 mm, angular or subangular blocky primary peds; very firm or strong dry consistence; occasionally <2%, soft or nodular, calcareous segregations, <2-6 mm; pH 7.0 to 8.5. Gradual or diffuse to -

B22 and 23: Similar to the B21 except that the structure sometimes becomes strong, 5 to 20 mm, lenticular, and usually 2-20%, soft or nodular, calcareous segregations, <2-20 mm. pH 8.0 to 9.0.

2D: (when present) The sandy buried layers are characterized by their dark brown colours (7.5YR 3/4, 4/4, 4/6; 10YR 3/3, 4/3, 4/4) and sandy textures of coarse sand to sandy light medium clay; single grain, massive or weak or moderate, 5 to 20 mm, prismatic or subangular blocky structure depending on texture; occasionally either <2-10%, calcareous segregations, 2-6 mm, or <2-10%, rounded river gravels, 2-20 mm; pH 7.0 to 8.5.

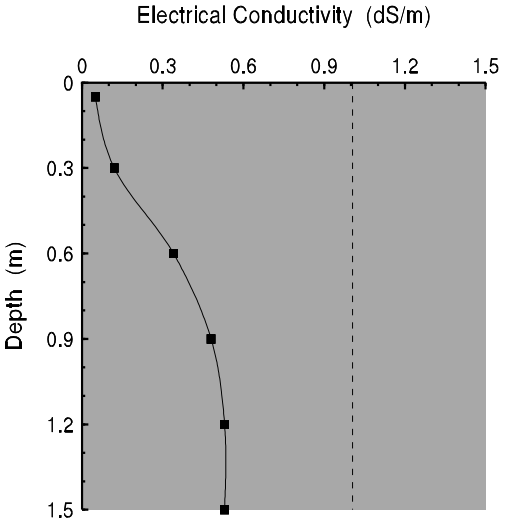
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl⁻ %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg⁻¹	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A1	0.1	6.8	.08	.005	2	45	28	29	20[2]	13	4.8	.33	1.2	2.7			
A2j	0.25	7.4	.04	.001	1	59	21	24	18	11	4.0	.65	.38	2.8			
B21	0.4	6.8	.16	.015	2	43	16	41	22	12	6.0	2.0	.36	2.0	9	.66	.54
B22	0.6	8.3	.15	.014	1	45	19	42	29	15	9.0	3.5	.30	1.7	12	.71	.69
B22	0.9	8.7	.70	.088	2	41	17	43	30	16	10	4.0	.20	1.6	13	.51	.70
B23	1.2	8.8	.67	.102	3	38	17	41	38[2]	16	16	5.5	.30	1.0	15		.93
B23	1.5	8.9	.62	.074													

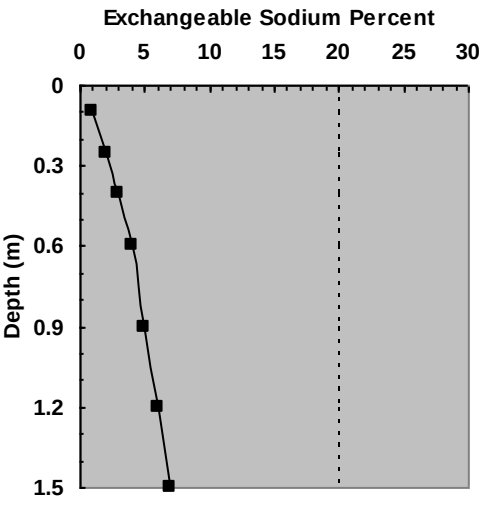
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5, except at 0.4 m [2] ECEC used to estimate the CEC

Retro typically has a neutral topsoil and a strongly alkaline subsoil. The surface soil has very high fine sand (45%) and silt (28%) contents which make it prone to hard setting, surface sealing and crusting. The clay content increases to 41% in the subsoil showing the strong texture contrast. Retro has a high subsoil CEC (22-38 cmol[+] kg^{-1}), that is dominated by calcium (Ca/Mg ratios 2.0-1.0) which is mainly at moderate levels (12-16 cmol[+] kg^{-1}). The subsoil is sodic (ESP 9-15), and most likely only slightly dispersive due to the dominance of calcium. The moderate salt content of the lower subsoil (0.62-0.7 dS/m) indicates that it has restricted drainage, while the dispersion ratios are moderate also (0.51-0.66). The subsoil CEC:clay ratios of 0.54 to 0.93 indicate a mixed clay mineralogy, with significant smectite content at 1.2 m.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Retro has a rooting depth of 1.5 m, as subsoil salinity and sodicity are only moderate and not limiting to plant rooting depth. A rooting depth of 1.5 m results in a PAWC of 125 mm. The clay content of 40% in the subsoil restricts the PAWC of this soil to some degree as a PAWC of 125 mm for a 1.5 m rooting depth is not that high (see Tognolini soil). The salt graph shows also that the salt concentration reaches equilibrium at 0.9 m, but at much lower concentrations than soils with more dispersive subsoils, and which indicates the long-term average depth of wetting. The limited salt bulge evident in this graph indicates that there is still sufficient deep drainage to maintain subsoil salt concentrations at moderate levels.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	42	0.13	2.1	1.13	12	11	4.2
Range	12-126	.09-.25	1.5-3.3	.86-1.3	11-14	8.8-139	3.7-4.7
No of samples	10	10	10	2	4	2	2
Rating	Very high	Moderate	Moderate	High	High	Moderate	Moderate

Retro has high surface soil fertility, mainly due to its very high mean phosphorous content (42 mg/kg), which is typical for Callide Valley alluvial soils, while the mean total nitrogen concentration is only moderate (0.13%). The mean moderate organic carbon level (2.1%) shows that eucalypt woodland soils have lower levels of organic matter and total nitrogen than brigalow or softwood scrub soils. However, the mean potassium and sulphur levels are both high (1.1 meq% and 12 mg/kg respectively), while calcium and magnesium are at moderate concentrations (11 and 4.2 cmol[+] kg^{-1}).

Rundull (Rd)

Concept: Rundull is a shallow (0.2-0.4 m), stony, brown or red, uniform clay loamy soil with a massive or weak structure. It has an acid soil reaction trend and is formed on folded, Permian meta-sediements.

Geology: Little weathered, folded, Permian, slate or cleaved siltstones (meta-sediments) of the Rannes Beds (Pw), of the Bowen Basin.

Aust Class: Brown or Red Kandosol

PPF: Um5.51

Landform: Crests and hillslopes of the strongly dissected, rolling, low hills to the south-west of Biloela, that have slopes of 5 to 15%, and a relief of 30 to 60 m.

Vegetation: Originally a mid-high (6-12 m) open forest of a rosewood – softwood scrub association. The main species in the upper stratum are rosewood, scrub ironbark, narrow and broad-leaved bottle trees and crow's ash, with a low (3-6 m), closed understorey of wilga, cassia and sticky hop bush. The lower stratum or ground layer has mainly isolated low shrubs of currant bush and very sparse wire grasses (*Aristida spp.*). However all areas of Rundull have now been cleared and sown to introduced grass pastures.

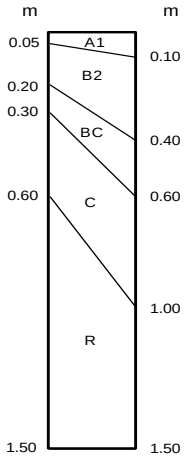
Runoff: Moderately rapid

Permeability: Moderately permeable

Drainage: Well drained

Surface cond: Firm or occasionally hard setting; with 20-90%, slate or siltstone gravels and cobbles, 6-200 mm.

Profile Description



A1: Dark brown (7.5YR 3/2, 3/3, 3/4); sandy clay loam or clay loam sandy texture; massive or weak, 2 to 5 mm, platy structure; firm dry consistence; 10-50%, slate or siltstone gravels, 2-20 mm; pH 5.5 to 6.5. Clear or gradual to -

B2: Dark brown, dark red-brown or yellow-red (7.5YR 3/4; 5YR 3/4, 4/6); clay loam sandy texture; massive or weak, 2 to 10 mm, subangular blocky structure; weak dry consistence; 10-50%, slate or siltstone gravels, 2-60 mm; pH 5.0 to 6.0. Abrupt or clear to -

BC: Dark brown, yellow-brown or dark red (7.5YR 3/4; 5YR 4/6; 2.5YR 3/6); clay loam or clay loam sandy texture; 50-90%, weathered slate or siltstone, 6-60 mm; pH 5.5 to 6.0. Abrupt to -

C: The C horizons are composed entirely of weathered slate or cleaved siltstone.

R: Hard, unweathered bedrock

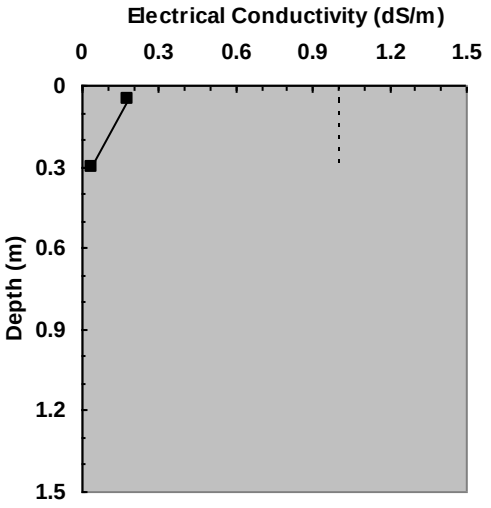
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Al	Exch. acidity	Ca/Mg ratio	ESP
A_1	0.05	5.9	.18	.001	43	13	18	25	15	10	2.7	.07	2.1	.10	.10	3.7	<1
B_2	0.30	5.4	.04	.001	37	11	22	31	8	3.6	2.2	.19	.29	1.5	1.7	1.6	2

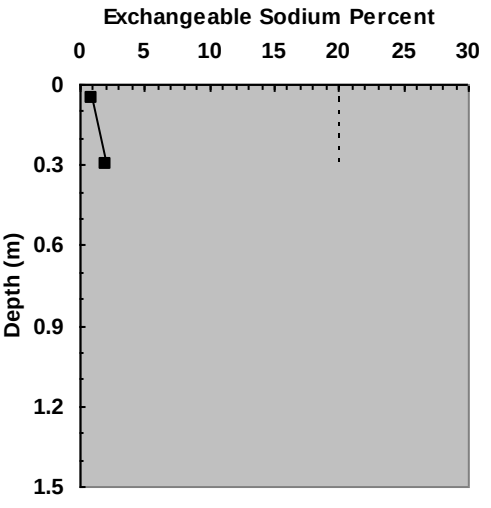
[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 ECEC= Ca + Mg + Na +K+ Exchangeable acidity

The Rundull soil is well drained and leached with a very low soluble salt content (0.04-0.18 dS/m) and an acid pH (5.9-5.4). The higher conductivity of the surface soil is due to its high fertility (nitrates and sulphates) rather than sodium chloride. It has a moderate clay content (25-31%) and high coarse sand content (37-43%). The CEC is only moderate due to the lower clay content (8-15 cmol[+] kg^{-1}) and is dominated by calcium (Ca/Mg ratios 3.7-1.6). As the profile is well drained it has a very low exchangeable sodium content and is therefore non-sodic (ESP 0.5-2). There is also a moderate exchangeable aluminium content in the subsoil (1.5 cmol[+] kg^{-1}) in response to the acid pH. The dispersion ratio and CEC:clay ratio are not relevant at these clay contents.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

The Rundull soil has a rooting depth range of 0.6 to 1.0 m, that is limited only by hard, unweathered bedrock, as subsoil salinity and sodicity are negligible (see above graphs). The PAWC varies from only 25 to 40 mm for these rooting depths. However, half of the profile is made up of weathered parent material which stores very little water and the water holding capacity of the soil is significantly reduced by its high profile stone content. The very low salt level throughout the profile indicates that nearly all water that infiltrates this soil is lost to deep drainage as it is freely draining with a low water holding capacity. The salt profile is therefore typical for a recharge soil.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	160	0.29	3.4	1.1	21	9.0	2.4
Range	111-230	.20-.41	2.2-5.2				
No of samples	2	2	2	1	1	1	1
Rating	Very high	Very high	High	High	Very high	Moderate	Moderate

Although limited by the low number of samples, the above data indicates that Rundull has a very high surface soil fertility due to its very high mean phosphorous and total nitrogen contents (160 mg/kg and 0.29% respectively). Rundull also has a high mean level of organic carbon (3.4%), which is typical of softwood scrub soils. Of the other nutrients measured, only calcium and magnesium are at moderate levels

Santo (Sn)

Concept: Santo is a shallow to moderately deep (0.3-.9 m), structured, red or brown, gradational or non-cracking clay soil with a thin or moderately thick (0.1-0.3 m) clay loam or light clay topsoil that overlies a blocky structured, light medium or medium clay subsoil. Santo has a neutral to alkaline soil reaction trend and is formed on intermediate to basic volcanic rocks.

Geology: Little weathered, Permian, andesite and andesitic lavas of the Camboon andesite (Pln), Owl Gully volcanics (Plq), undifferentiated Devonian lavas (Du), and spilite of the of the Rookwood volcanics (Pr).

Aust Class: Red or Brown Dermosol

PPF: Uf6.31, Gn3.22, Gn3.12

Landform: Crests and convex hillslopes of the gently undulating to undulating rises and low hills formed on intermediate volcanic rocks that have slopes of 1 to 12%, and a relief of 10 to 50 m.

Vegetation: Mid-high (6-12 m), woodlands or open woodlands of silver-leaved ironbark and gum-topped bloodwood. In the Rannes area, ghost gum is also present as a minor species. Woodlands of narrow-leaved ironbark also occur in areas where the soil fertility is lower. The understorey is sparse and consists only of very widely spaced shrubs of quinine berry or pretty wattle. Corkwood wattle can become a woody weed problem if Santo is over-cleared. The moderate quality native grass pastures are comprised mainly of forest blue grass, Queensland blue grass, black spear grass and kangaroo grass. Native legumes such as rhynchosia and *Indigofera pratensis* can also be present, but only as a minor component of the native pastures.

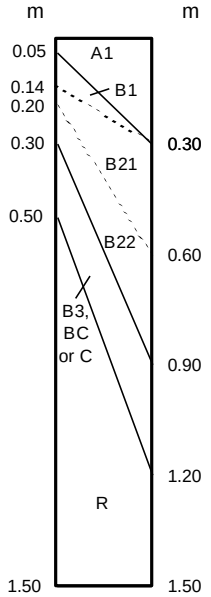
Runoff: Moderately rapid

Permeability: Moderately permeable

Drainage: Moderately well drained

Surface cond: Firm, occasionally self-mulching; with 2 to 20%, andesite gravels or cobbles, 2-200 mm.

Profile Description



A1: Black, very dark grey-brown, dark brown or dark red-brown (10YR 2/1, 3/2; 7.5YR 3/2, 3/3; 5YR 3/2, 3/3); clay loam to light medium clay texture; moderate to strong, 2 to 5 mm, subangular blocky structure parting to strong, <2 mm, subangular blocky or granular primary peds; loose to very firm dry consistence; 2-20%, andesite or quartz gravels, 2-60 mm; pH 6.0 to 7.0. Clear or gradual to -

B1: (when present) Dark brown or dark red-brown (10YR 3/3; 7.5YR 3/2, 3/3; 5YR 3/4); clay loam fine sandy or light clay texture; strong, 2 to 5 mm, subangular blocky or polyhedral structure; firm or very firm dry consistence; 2-20%, andesite and quartz gravels, 2-60 mm; pH 6.5 to 7.5. Clear or gradual to -

B2 or B21: Dark red-brown, red-brown or dark brown (10YR 3/3; 7.5YR 3/2, 3/3; 5YR 3/3, 3/4, 4/4; 2.5YR 3/4); occasionally 2-20%, dark, brown or red mottles, <5-15 mm; light to medium clay texture; strong, 10 to 50 mm, angular or subangular blocky structure parting to 2 to 10 mm, blocky primary peds; <2-20%, andesite and quartz gravels and cobbles, 6-200 mm; pH 6.5 to 8.0. Gradual to -

B22: (when present) Red-brown to dark red (5YR 3/3, 3/4, 4/4; 2.5YR 3/6); sometimes 2-20%, dark or brown mottles, <5-15 mm; light to medium clay texture; either strong, 10 to 50 mm, subangular blocky or occasionally strong 2 to 20 mm, lenticular peds; occasionally 2-20%, soft and nodular calcium carbonate segregations, 2-20 mm; pH 7.0 to 8.5. Clear to -

B3 or BC: Dark brown or red-brown (10YR 3/3; 7.5YR 3/3, 3/4; 5YR 3/4, 4/4); light to light-medium clay; 50 to 90%, weathered andesite; 2–20%, soft calcareous segregations, <2-20 mm; pH 7.0 and 8.5. Clear to -

C: The C horizons are composed entirely of weathered andesite, occasionally <2-20%, soft calcareous segregations, 2-20 mm; pH 7.0 to 8.5. Abrupt or sharp to -

R: Hard, unweathered bedrock

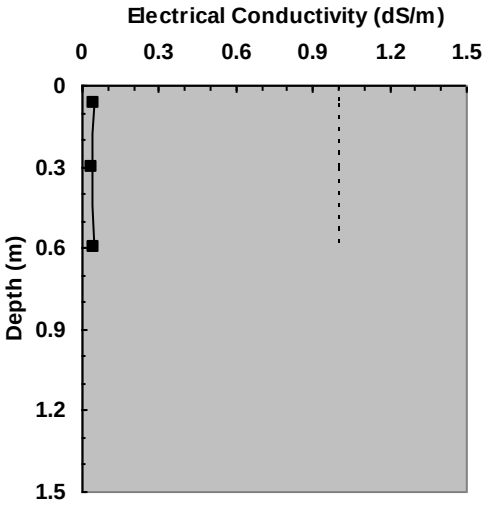
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	007	7.5	.05	.001	13	27	21	41	32[2]	20	11	.24	.63	1.8	0.8	.52	.78
B_{21}	0.2				11	30	20	43									
B_{21}	0.3	7.7	.04	.001	10	25	17	50	30[2]	17	12	.37	.19	1.4	1	.43	.60
B_{22}	0.5				13	27	17	45									
B_3	0.6	8.1	.05	.001	12	30	17	47	26	14	11	.38	.10	1.3	1	.50	.55

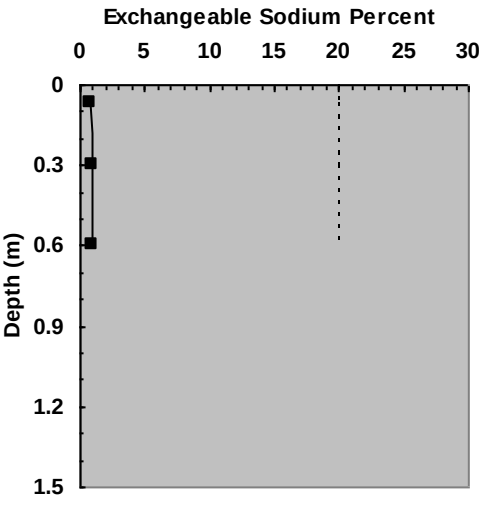
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Santo is typically neutral in the surface soil (pH 7.5) with an alkaline subsoil (pH 7.7-8.1). It has a high clay content throughout the profile (41-50%) with significant silt and fine sand contents. The CEC is high also (26-32 cmol[+] kg^{-1}) and strongly calcium dominant (Ca/Mg ratios 1.8-1.3), which is also at high levels (14-20 cmol[+] kg^{-1}). Santo is non-sodic (ESP 1) throughout and therefore structurally stable and well drained with significant deep drainage, as indicated by the low dispersion ratios (0.43-0.52) and very low salt content (0.04-0.05 dS/m). The CEC:clay ratios of 0.55 to 0.78 indicate a mixed clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Santo has a rooting depth range of 0.5 to 1.2 m that is limited only by shallow bedrock, as subsoil salinity and sodicity are very low and not limiting (see above graphs). The PAWC varies from 55 mm for the shallowest profile, to a maximum of 100 mm for these rooting depths. The water holding capacity is also limited to some degree by the moderate profile stone content. The salt graph shows also that Santo has significant deep drainage below the soil profile, as salts have not accumulated to any extent in the subsoil (i.e. a salt bulge is absent due to leaching of salts by deep drainage). Santo therefore represents significant areas of groundwater recharge throughout the landscape.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	22	0.13	2.0	0.79	6	20	11
Range	8-60	.06-.20	.9-3.6	.34-1.2	3-16		
No of samples	17	17	17	3	16	1	1
Rating	High	Moderate	Moderate	Moderate	Low	High	High

Santo has a moderate surface soil fertility due mainly to its high mean phosphorous content (22 mg/kg). However it has only a moderate mean level of total nitrogen (0.13%), which is typical for these silver-leaved ironbark eucalypt woodland soils. The mean organic carbon is also moderate (2.0%), while Santo has a moderate mean level of potassium (0.79 meq %). Although the mean sulphur concentration is low (6 mg/kg), one third of the sites sampled had high to very high sulphur levels of 8 to 16 mg/kg. Apart from calcium and magnesium that were only measured once, the other nutrients were highly variable, ranging from low to high. This indicates that the fertility of Santo can vary considerably from location to location.

Santo, fertile phase (SnFp)

Concept: Santo fertile phase is shallow to moderately deep (0.3 to 0.9 m), structured, red or brown, non-cracking clay with a moderately thick (0.1 to 0.2 m), light clay or light medium clay topsoil that overlies a blocky structured, light clay to medium clay subsoil. Santo fertile phase has a neutral or alkaline soil reaction trend and is formed on intermediate to basic volcanic rocks.

Geology: Little weathered, Permian andesite and andesitic lavas of the Camboon andesite (Pln), Owl Gully volcanics (Plq), undifferentiated Devonian lavas (Du), and spilite of the of the Rookwood volcanics (Pr).

Aust Class: Red or Brown Dermosol, or occasionally Vertosol or Chromosol

PPF: Uf6.31, Gn3, Dr2.1, Ug5.3

Landform: Santo fertile phase tends to occur on gentler sloping landforms than Santo or Santo stony phase and is found mainly on the crests and hillslopes of undulating rises that have slopes of 1 to 10% and a relief of 10 to 30 m. It often occurs along the margins of the intermediate volcanic rocks where they join scrub soils formed on either Permian sedimentary rocks, basalt or the unconsolidated, Cainozoic alluvial-colluvial, sediments.

Vegetation: Santo fertile phase is distinct from the other two Santo soil profile classes in that it originally supported a closed softwood scrub forest. However all areas have been cleared and sown to introduced grass pastures for fattening cattle, with only isolated trees, or small pockets of scrub remaining. The main remnant trees consist of narrow and broad-leaved bottle trees, brigalow, red bauhinia, white-flowered bauhinia, coowarra box and occasional silver-leaved ironbark.

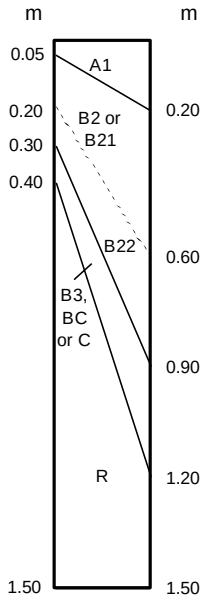
Runoff: Slow to moderately rapid

Permeability: Moderately permeable

Drainage: Moderately well drained

Surface cond: Firm, or occasionally fine, self-mulching or hard setting; with 2-50%, andesite or spilite gravels and cobbles, 2-200 mm; and <2% rock outcrop.

Profile Description



A1: Dark red-brown, dark brown or very dark brown (5YR 3/3, 3/3; 7.5YR 3/2, 3/3, 3/4; 10YR 2/2); light clay, light medium clay or occasionally clay loam texture; weak to strong, 2 to 10 mm, subangular blocky for most profiles to strong, 1-2 mm, granular or subangular blocky for the cracking clay profiles; loose to firm dry consistence; 2-50%, andesite or spilite gravels and cobbles, 2-200 mm; pH 6.5 to 7.5. Clear or gradual to -

B2 or B21: Dark red-brown or dark brown (2.5YR 3/4; 5YR 3/3, 3/4; 7.5YR 3/4; 10YR 3/3); occasionally 2-10%, dark mottles, <5-15 mm; light, light medium or medium clay texture; strong, 2 to 10 mm, subangular blocky or polyhedral structure, or a strong, 2 to 5 mm, lenticular structure for the cracking clay profiles; firm to very firm dry consistence; 2-50%, andesite or spilite gravels and cobbles, 2-200 mm; occasionally <2-10%, soft or nodular, calcareous segregations, <2-6 mm; pH 6.5 to 8.5. Clear or gradual to -

B22: (when present) Dark red-brown, red-brown or dark brown (2.5YR 3/4; 5YR 3/3, 4/4; 7.5YR 3/4, 4/4, 4/6); sometimes 2-10%, dark mottles, <5-15 mm; light medium or medium clay texture; strong, 5 to 20 mm, subangular blocky structure or a strong, 2 to 20 mm lenticular structure for the few cracking clay profiles; <2-20%, andesite or spilite gravels, 2-20 mm; occasionally 2-50%, soft or nodular, calcareous segregations, <2-20 mm; pH 7.0 and 8.5. Abrupt or clear to -

B3 or BC: Dark red-brown, red-brown, dark brown, brown or light olive-brown (5YR 3/4, 4/4, 4/6; 7.5YR 4/4; 10YR 5/3; 2.5Y 5/4); occasionally 2-10%, brown mottles, <5-15 mm; clay loam sandy, light or light medium clay texture; massive to strong, 2 to 10 mm, subangular blocky structure; 20-90%, weathered fragments of andesite or spilite; usually 2-50%, soft or nodular, calcareous segregations, 2-20 mm; pH 7.5 to 8.5. Abrupt or clear to -

C: The C horizons are composed entirely of weathered andesite or spilite fragments, sometimes with 10-90%, soft or nodular, calcareous segregations, 2-20 mm.

R: Hard, unweathered bedrock

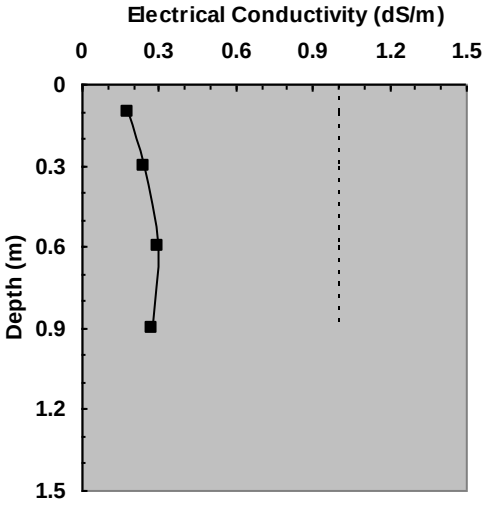
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.5	.18	.001	11	23	19	46	29[2]	20	8.6	.09	.67	2.3	0.3	.44	.63
B_{21}	0.3	7.8	.24	.001	10	20	12	55	39[2]	25	13	.29	.19	1.9	0.7	.50	.71
B_{22}/B_3	0.6	8.3	.30	.003	30	16	12	42	28[2]	17	11	.18	.09	1.5	0.6	.56	.67
B_3	0.9	8.5	.27	.001	32	17	17	35	25	13	9.6	.14	.09	1.4	0.6	.46	.71

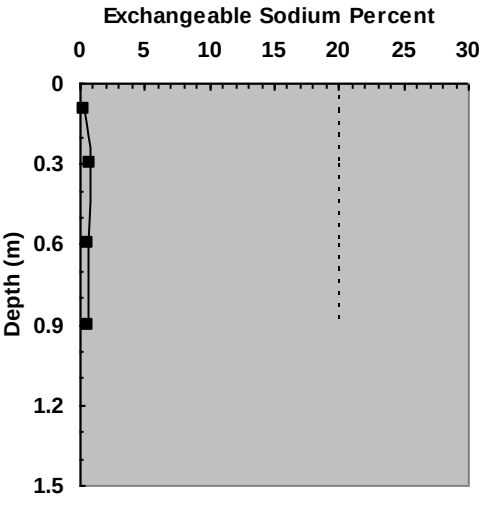
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Santo fertile phase is typically neutral in the surface soil (pH 7.5) with an alkaline subsoil (pH 7.8-8.5). The clay content is high (formed on andesite compared to spilite) throughout the profile, with a significant silt and fine sand content. The CEC is also high throughout the profile (25-39 cmol[+] kg^{-1}) and is strongly dominated by calcium (Ca/Mg ratios 2.3-1.4), which is also at high levels (13-25 cmol[+] kg^{-1}). Santo fertile phase is also non-sodic (ESP <1) and is therefore structurally stable and well drained with significant deep drainage as indicated by the low dispersion ratios (0.44-0.56) and low profile salt content (0.001-0.003% Cl^-). Most of soluble salts are due to nitrates and sulphates because of the high soil fertility rather than sodium chloride. The CEC:clay ratios of 0.63 to 0.71 indicate a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Santo fertile phase has a rooting depth range of 0.4 to 1.2 m that is limited only by shallow bedrock as subsoil salinity and sodicity are very low and not limiting (see above graphs). The moderate to high stone content throughout the profile also reduces the water holding capacity to some extent. As a result Santo fertile phase has a PAWC that varies from 45 mm to 95 mm for these rooting depths. The salt graph shows also that Santo fertile phase has significant deep drainage below the soil profile, as salts have not accumulated to any extent in the subsoil (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage). Santo fertile phase therefore represents significant areas of groundwater recharge throughout the landscape.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	46	0.22	2.6	1.1	7	16	6.4
Range	10-138	.12-.30	1.8-3.9	.54-1.6	4-13	14-19	4.9-8.3
No of samples	9	7	9	5	7	2	2
Rating	Very high	Very high	High	High	Moderate	High	High

Santo fertile phase soil has a very high surface soil fertility due to its very high mean phosphorous and total nitrogen contents (46 mg/kg and 0.22% respectively). These levels are significantly higher than for those of Santo and Santo stony phase soils. The mean organic carbon concentration is also high (2.6%), which is considered to be due to the higher biomass of a softwood scrub forest, compared to a eucalypt woodland. All other nutrients measured are also high except for sulphate-sulphur which has a moderate mean content of 7 mg/kg.

Santo, stony phase (SnSp)

Concept: Santo stony phase is a shallow to moderately deep (0.2-0.8 m), stony, red or brown, uniform or gradational soil with a 0.05 to 0.25 m thick, clay loam fine sandy to light medium clay topsoil that overlies a blocky structured light clay to medium clay subsoil. Santo stony phase has a neutral to alkaline soil reaction trend and is formed on intermediate to basic, volcanic rocks.

Geology: Little weathered, Permian, andesite and andesitic lavas of the Camboon andesite (Pln), Owl Gully volcanics (Plq), undifferentiated Devonian lavas (Du), and spilite of the of the Rookwood volcanics (Pr).

Aust Class: Red or Brown Dermosol or Chromosol

PPF: Uf6.31, Gn3.22, Dr2.12, Db1.12

Landform: Crests and hillslopes of strongly dissected, undulating to rolling rises, low hills and hills formed on intermediate volcanic rocks. These landforms have modal slopes of 5 to 25%, with occasional steeper slopes of 30 to 50%, and a relief of up to 120 m on the steeper hills. These landforms are very stony with many cobbles and boulders and rock outcrop of andesite or spilite.

Vegetation: Mid-high (6-12 m) silver-leaved ironbark – gum-topped bloodwood woodland is the dominant association. However on the steeper hills, either a narrow-leaved ironbark – gum-topped bloodwood or pure narrow-leaved ironbark woodland are common associations, while ghost gum often occurs as a minor species within the silver-leaved ironbark – gum-topped bloodwood association in the Rannes area. Kurrajong trees occur sporadically in any of these associations. The mid-stratum is very sparse and consists of isolated low trees and shrubs of pretty and corkwood wattle, myrtle tree, quinine berry and bats wing coral tree. Corkwood wattle can become a minor regrowth problem following clearing. The native grass pastures consist mainly of forest blue, black spear and kangaroo grass, along with a minor component of native legumes such as rhynchosia and Birdsville indigo.

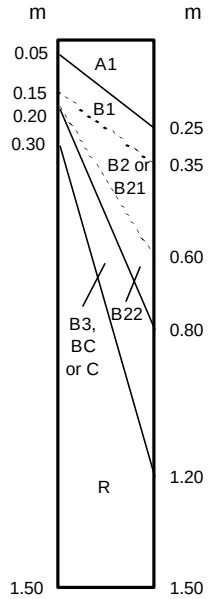
Runoff: Moderately rapid to rapid

Permeability: Moderately permeable

Drainage: Well drained

Surface cond: Firm or hard setting; with 20-90%, andesite or spilite gravels to boulders, 6mm-2m; and 2-10%, rock outcrop.

Profile Description



A1: Dark red-brown, very dark brown, very dark grey-brown or dark brown (5YR 3/2; 7.5YR 3/2; 10YR 2/2, 3/2, 3/3); clay loam fine sandy, light clay or light medium clay texture; massive or weak to strong, 2 to 5 mm, subangular blocky structure, or polyhedral structure (on splilite only); weak to very firm dry consistence; 20-90%, andesite or spilite gravels to stones, 2-600 mm; pH 6.0 to 7.5. Clear or gradual to either a B1 or B2 horizon -

B1: (when present) Dark red-brown, very dark brown or dark brown (5YR 3/2; 7.5YR 3/2, 3/3; 10YR 3/2, 3/3); clay loam fine sandy, light clay or light medium clay texture; moderate or strong, 2 to 10 mm, subangular blocky or occasionally polyhedral structure (on spilite only); firm or very firm dry consistence; 20-90%, andesite or spilite, gravels and cobbles, 2-200 mm; pH 6.5 to 7.5. Clear or gradual to -

B2 or B21: Dark red-brown, red-brown or dark brown (2.5YR 3/4; 5YR 3/3, 3/3, 4/4; 7.5YR 3/3; 10YR 3/3); sometimes 2-20%, dark, brown or red mottles, <5-15 mm; light clay, light medium clay or medium clay texture; strong, 2 to 10 mm, subangular blocky or polyhedral structure, or occasionally a strong, prismatic secondary structure that parts to blocky primary peds; firm to strong dry consistence; 10-90%, andesite or spilite gravels and cobbles, 2-200 mm; pH 6.5 to 7.5. Clear or gradual to either a B3, BC or B22 horizon -

B22: (when present) Dark red-brown or red-brown (2.5YR 3/4; 5YR 3/4, 4/4); occasionally <2-20%, dark mottles, <5-15 mm; light medium clay or medium clay texture; strong, 2-10 mm, subangular blocky or lenticular structure; very firm or strong dry consistence; 2-50%, andesite or spilite gravels, 2-60 mm; pH 7.0 to 8.5. Clear to -

B3 or BC: Dark red-brown, red-brown, dark brown, brown or light olive-brown (5YR 3/4, 4/4; 7.5YR 3/4, 4/4; 10YR 3/4, 5/3; 2.5Y 5/4); usually 2-50%, yellow or brown mottles, <5-15 mm; light clay, light medium clay or medium clay texture; massive or weak to strong, 2 to 20 mm, subangular blocky structure; 20-90%, fragments of weathered andesite or spilite; rarely 2-50%, soft or nodular, calcareous segregations, 2-20 mm; pH 7.5 to 8.5. Abrupt to -

C: The C horizons are composed entirely of weathered andesite or spilite fragments, occasionally <2-50%, soft calcareous segregations, <2-20 mm; pH 7.5 to 8.5. Abrupt or sharp to -

R: Hard, unweathered bedrock

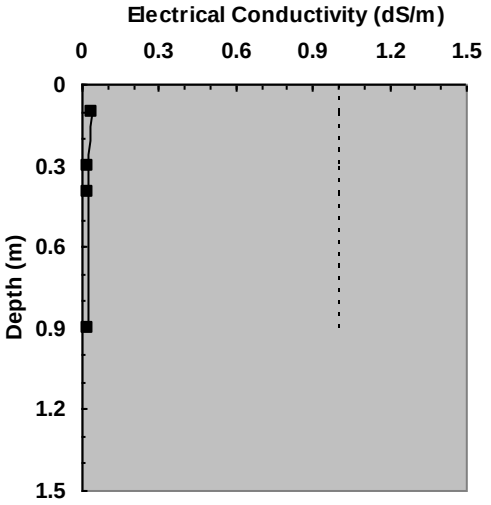
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.9	.04	.001	14	21	21	46	29	20	8.1	.10	.42	2.5	0.3	.38	.63
B_{21}	0.3	7.2	.02	.001	10	16	16	60	30	19	11	.19	.15	1.7	0.6	.51	.50
B_{22}	0.4	7.4	.02	.001	7	12	15	64	34	22	13	.26	.14	1.7	0.9	.50	.53
B_3	0.6	7.6	.02	.001	18	16	22	41	46	28	18	.40	.12	1.6	0.9	.57	1.1

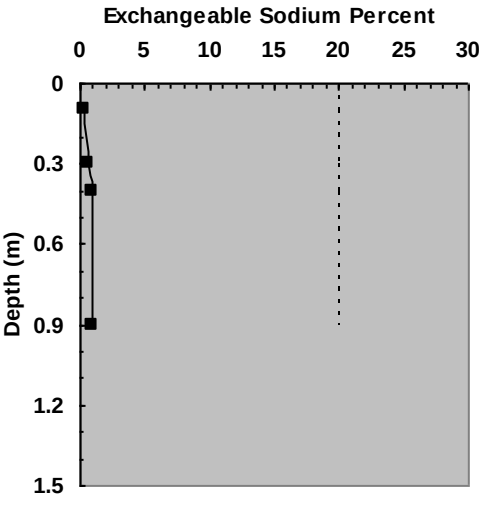
[1] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 ECEC= Ca + Mg + Na +K

Santo stony phase is typically neutral in the surface soil (pH 6.9) with an alkaline subsoil (pH 7.2-7.6). It has a high to very high clay content (46-64%) as it is formed on spilite. The CEC is high also throughout the profile (29-46 cmol[+] kg^{-1}) and is strongly dominated by calcium (Ca/Mg ratios 2.5-1.6), which is also at high levels (19-28 cmol[+] kg^{-1}). Santo stony phase is also non-sodic (ESP <1) and is therefore structurally stable and well drained with significant deep drainage, as indicated by the low dispersion ratios (0.38-0.57) and very low salt content throughout the profile (0.02-0.04 dS/m). The CEC:clay ratios of 0.5 to 0.63 indicate a mixed clay mineralogy, while the increase to 1.1 at 0.6 m shows a change to smectite clay minerals closer to the weathered spilite.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Santo stony phase has a rooting depth range of 0.3 to 1.2 m that is limited only by shallow bedrock, as subsoil salinity and sodicity are very low and not limiting (see above graphs). The water holding capacity is also significantly reduced by the high stone content of the soil profile. As a result the PAWC varies from 30 mm to 80 mm for these rooting depths. The salt graph shows also that Santo stony phase has significant deep drainage below the soil profile, as salts have not accumulated to any extent in the subsoil (i.e. a salt bulge is absent due to leaching of salts by deep drainage). Santo stony phase therefore represents significant areas of groundwater recharge throughout the landscape.

Surface Soil Fertility

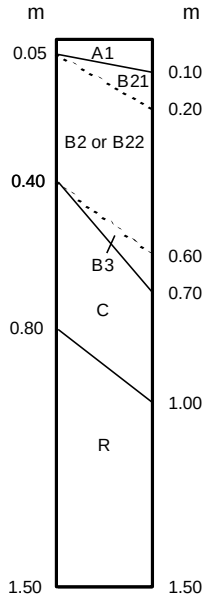
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	33	0.14	2.3	1.2	5	18	7.2
Range	5-63	.10-.21	1.3-3.2	.84-.2.2	2-10		
No of samples	11	11	11	6	10	1	1
Rating	High	Moderate	Moderate	High	Low	High	High

Santo stony phase has a moderate surface soil fertility with a high mean phosphorous content (33 mg/kg), but only a moderate mean level of total nitrogen (0.14%) and organic carbon (2.3%). These levels are very similar to those of the Santo soil. All other nutrients measured are high, except for sulphate-sulphur which has a low mean content of 5 mg/kg.

Scoria (Sc)

Concept: Scoria is a shallow or moderately deep (0.4-0.7 m), black, strongly cracking clay soil with a thin (0.05-0.1 m), fine, self-mulching topsoil and an alkaline soil reaction trend that is formed on basalt. Weakly developed normal gilgai are only present on the deeper profiles.
Geology: Little weathered, Tertiary, olivine basalt (Tb)
Aust Class: Black Vertosol
PPF: Ug5.12
Landform: Flat-lying, plateau surfaces of the basalt plateaus to the south of the Dawson highway in the south-eastern area of the Banana study area. The level plateau surfaces are narrow, only 200 to 500 m wide, and up to three kilometres long with slopes of 1% and a relief of 2 to 4 m.
Vegetation: Scoria had originally a closed forest of softwood scrub, which has been cleared and sown to green panic and buffel grass pastures for fattening cattle. Only remnant trees of brigalow, narrow and broad-leaved bottle trees and scrub ironbark now remain.
Microrelief: Weakly developed normal gilgai, only on the deeper profiles: VI: 0.1 m, HI: 3 m
Runoff: Very slow
Permeability: Slowly permeable
Drainage: Moderately well drained
Surface cond: Fine, self-mulching (peds 1-2 mm) and strongly cracking; with 10-50%, basalt cobbles, stones and boulders, 200 m to 2 m; and <2%, basalt outcrop

Profile Description



A1: Black or very dark grey (10YR 2/1, 3/1); medium or medium heavy clay texture; strong, 1-2 mm, granular or subangular blocky structure; loose dry consistence; occasionally 2-20%, soft, carbonate segregations, <2 mm on the gilgai mounds; pH 6.5 to 8.5. Abrupt or clear to -
B21: (when present) Very dark grey (7.5YR 3/0); medium heavy clay texture; strong, 10 to 20 mm, subangular blocky structure parting to strong, 2 to 5 mm, lenticular primary peds; 2-10%, basalt gravels and cobbles, 20-200 mm; 2-10%, soft, calcareous segregations, 2-6 mm; pH 8.5. Gradual to -
B2 or B22: Black, very dark grey or occasionally dark brown (10YR 2/1; 7.5YR 3/0, 3/3); medium or medium heavy clay texture; strong, 2 to 10 mm, lenticular structure, sometimes parting to <2 mm, lenticular primary peds; firm consistence (mod. moist); usually <2-20%, basalt gravels and cobbles, 6-200 mm; occasionally <2%, nodular, calcareous segregations, <2 mm; pH 7.0 to 8.5. Clear to -
B3: (when present) Black or dark grey-brown (10YR 2/1; 2.5Y 4/2); sometimes 2-10%, faint, brown mottles, 5-15 mm; light medium or medium clay texture; 20-50%, fragments of weathered basalt; sometimes 2-20%, soft or nodular, calcareous segregations, 2-20 mm; pH 7.0 to 8.5. Sharp or abrupt to -
C: The C horizons are composed entirely of weathered basalt.
R: Hard, unweathered bedrock

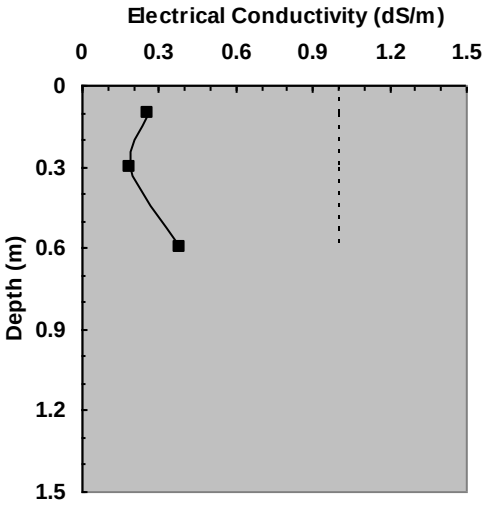
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	8.1	.26	.003	7	13	18	59	62[2]	46	12	.54	3.1	3.8	0.9	.36	1.1
B_2	0.3	8.4	.19	.004	2	13	17	71	63[2]	45	15	1.3	1.6	3.0	2	.42	.89
B_2	0.6	8.3	.38	.022	2	13	14	74	64[2]	43	18	2.5	.39	2.4	4	.45	.87

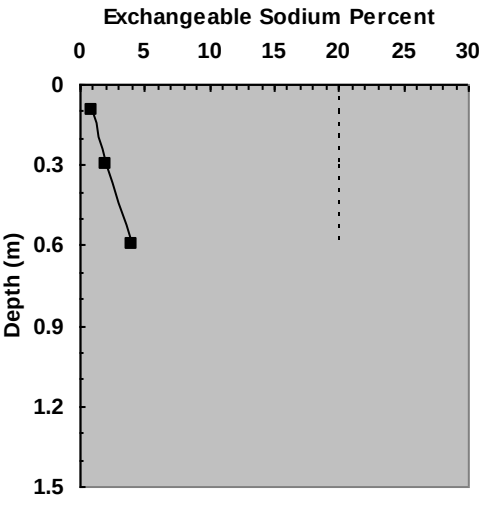
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Scoria is typically alkaline throughout with a pH of 8.1 to 8.4. The basalt clay soils have the highest clay content of all soils with extremely high levels of 70 to 80%, while the coarse sand content is also typically very low (2-7%). The CEC is also extremely high throughout the profile (62-64 cmol[+] kg^{-1}), and is strongly dominated by calcium (Ca/Mg ratios 3.8-2.4) which is also at very high levels (43-46 cmol[+] kg^{-1}). Scoria is non-sodic with very low to low sodicity (ESP <1-4) and is therefore structurally stable (low dispersion ratios 0.36-0.45) with sufficient deep drainage to maintain subsoil soluble salts at low levels (0.19-0.38 dS/m). The majority of the salts in the upper 0.3 m are due to plant available nutrients, such as nitrates and sulphates, as the chloride content is very low (0.002-0.003%). The high CEC:clay ratios of 0.97 to 1.1 indicates a smectite clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Scoria has a rooting depth range of 0.8 to 1.0 m, that is limited only by hard, unweathered bedrock, as the subsoil salinity and sodicity are low and not limiting (see above graphs). These rooting depths result in a PAWC that varies from 90 to 130 mm. The very high clay content of the Scoria soil gives it a high water holding capacity per unit depth of soil. The salt graph shows also that there is significant deep drainage below the soil profile, as soluble salts have not accumulated in the subsoil (i.e. a salt bulge is absent).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	95	0.27	3.2	1.1	12	41	14
Range	58-178	.21-.45	2.5-5.1	.86-1.3	11-14	30-43	11-18
No of samples	5	5	5	2	4	2	2
Rating	Very high	Very high	High	High	High	Very high	High

Scoria has very high surface soil fertility, as it has very high mean phosphorous and total nitrogen contents of 95 mg/kg and 0.27% respectively, which is typical for basaltic soils with softwood scrub. Scoria has one of the highest levels of phosphorous and total nitrogen recorded for all soils of the Banana soil survey. Scoria has also a high mean organic carbon concentration (3.2%), which again shows the strong correlation between organic matter and total nitrogen, and the high levels of organic matter that accumulate in clay soils with softwood scrub vegetation compared to eucalypt woodlands. Scoria is one of the few soils with a high mean level of sulphur (12 mg/kg), while calcium, magnesium and potassium, though only measured twice, are always consistently high for little weathered, black, basalt, clay soils.

Shield (Sd)

Concept: Shield is a shallow to moderately deep (0.3-0.85 m), stony, sandy loam to clay loam, uniform or gradational soil, with a dark or dark brown, massive subsoil that overlies either weathered or unweathered, resistant sandstone or pebble conglomerate. Shield has an acid pH throughout.

Geology: Resistant sandstones and strongly cemented pebble conglomerates of the deeply weathered, Tertiary, sedimentary rocks (Ta).

Aust Class: Brown or Black Kandosol or Orthic Tenosol

PPF: Gn2.01, Gn2.41, Uc5.11, Um5.42

Landform: Shield occurs on low, remnant plateaus formed on resistant, Tertiary sedimentary rocks that occur as small, isolated outcrops. The plateau surfaces are either flat lying or gently inclined in one direction with slopes less than 2%, and are only one to one and a half kilometres long and three to five hundred metres wide. These plateaus have steep to precipitous scarp slopes, which often form a cliff at the top of the scarp, on which the Bluff soil is found.

Vegetation: Mid-high to tall (6-20 m), open forests or woodlands of either a Queensland peppermint – lemon-scented gum, or a narrow-leaved ironbark – lemon-scented gum association, sometimes with long-fruited bloodwood as a minor species. The mid-stratum is made up of a closed layer of low trees (3-6 m) of rosewood, black wattle, soap bush and *Maytenus cunninghamii*, while the native pastures consist mainly of wire grasses (*Aristida spp.*), barb-wire grass and annual grasses such as *Enneapogon spp*.

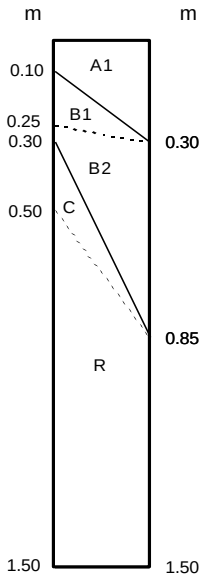
Runoff: Very slow to slow

Permeability: Moderately to highly permeable

Drainage: Well drained

Surface cond: Hard setting or firm depending on surface soil texture; with 2 to 50%, gravels and cobbles of quartz, sandstone or conglomerate, 2-200 mm, and 2 to 20%, rock outcrop

Profile Description



A1: Black, very dark brown or very dark grey-brown (7.5YR 2/0, 2/2; 10YR 2/2, 3/2); sandy loam, sandy clay loam or clay loam sandy texture; massive structure; very weak to firm dry consistence, depending upon the texture; 10-50%, sandstone, quartz or ironstones gravels, 2-60 mm; pH 5.5 to 6.0. Clear or gradual to -

B1: (when present) Dark brown (7.5YR 3/2, 3/3); fine sandy clay loam texture; massive structure; weak dry consistence; 2-20%, quartz, ironstones or sandstone gravels, 2-20 mm; pH of 5.5 to 6.0. Clear or gradual to -

B2: Very dark brown, dark brown or dark red-brown (7.5YR 2/2, 3/3, 3/4, 4/3; 5YR 3/2); sandy loam to clay loam fine sandy or rarely fine sandy light clay texture; massive structure; weak or firm dry consistence, depending upon texture; 10-90%, sandstone, quartz or conglomerate gravels, 2-60 mm; pH of 5.5. Sharp or abrupt to either weathered substrate or bedrock -

C: (when present) The C horizons are composed entirely of weathered sandstone (C horizons are absent when the parent material is pebble conglomerate). Sharp to -

R: Either hard, unweathered sandstone or occasionally cemented, pebble conglomerate.

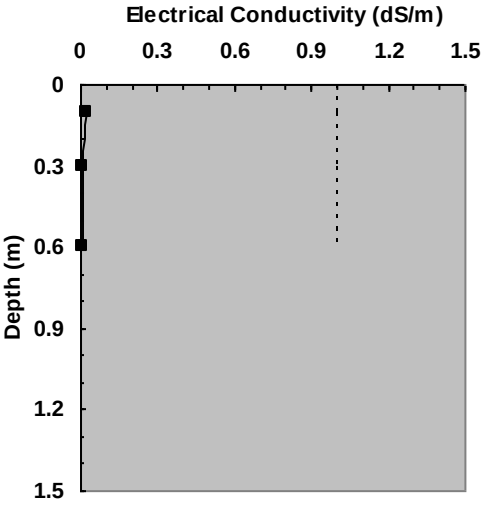
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl⁻ %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Al	Exch. acidity
A_{11}	0.1	6.2	.02	.002	39	49	9	5	4.4	3.1	1.0	.06	.26		
A_{12}	0.3	5.9	.01	.001	38	49	8	7	2.5	2.0	.26	.05	.07	.10	.10
B_2	0.6	5.2	.01	.001	33	53	8	6	1.3	.17	.18	.06	.04	.80	.80

[1] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 ECEC= Ca + Mg + Na +K+ exchangeable acidity

Shield typically has a moderately to strongly acid pH (6.2-5.2), as it is very sandy with a only a low clay content (5-7%) and therefore well drained and leached with very low levels of soluble salts (0.01-0.02 dS/m). The CEC is therefore also low (4.4-1.3 cmol[+] kg^{-1}) with only low levels of calcium and magnesium in the surface soil, and below the level of sufficiency in the subsoil. As the pH is strongly acid in the subsoil, there are also low levels of exchangeable aluminium present. The Ca/Mg ratio, ESP, dispersion ratio and CEC:clay ratio are not applicable at these low clay contents.

Plant Available Water Capacity



Mean profile salt graph

Shield has a rooting depth range of 0.3 to 0.85 m, that is limited only by hard, unweathered bedrock, as subsoil salinity and sodicity are negligible (see above graph). The PAWC varies from only 25 to 40 mm for these rooting depths. The water holding capacity is also significantly reduced by the soils' high sand and stone contents. The very low salt levels throughout the profile indicates that nearly all water that infiltrates this soil is lost to deep drainage as it is freely draining with a low water holding capacity. The salt profile is therefore typical for a recharge soil.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	5	0.07	1.4	0.20	3	3.1	1.0
Range	2-14	.04-.12	1.0-2.5		2-5		
No of samples	3	3	3	1	2	1	1
Rating	Low	Low	Low	Low	Very low	Low	Low

Although limited by the low number of samples due to its limited occurrence, these data are considered representative as they are consistently low and are what would be expected from a sandy, leached soil. Shield has low surface soil fertility, as all nutrients that were measured are low, except for sulphur, which is very low.

Spier (Sp)

Concept: Spier is a deep to very deep (1.1->1.5 m), massive, red gradational soil with a fine sandy loam to clay loam fine sandy topsoil that grades into a clay loam fine sandy to fine sandy light medium clay subsoil. Spier is formed on Tertiary sandstone and has a neutral or acid soil reaction trend.

Geology: Deeply weathered, Tertiary sandstones (Ta) on remnant plateaus.

Aust Class: Red Kandosol

PPF: Gn2.11, Gn2.12

Landform: Spier occurs mainly on the level to undulating plateaus formed on the deeply weathered Tertiary sedimentary rocks. On two occasions Spier was also found on low-lying level plains as the plateaus have been weathered down to almost the same level as the surrounding plains of unconsolidated Cainozoic sediments. Most of the plateaus are flat-lying, while several were weathering unevenly with the more resistant rocks forming the crests and upper slopes along one side of the plateau, with hillslopes of up to 7% sloping down to the escarpment on the other side. Some of the escarpments are poorly expressed as they have either been almost weathered away or buried by colluvium. Generally the plateaus stand 10 to 60 m above the surrounding plains.

Vegetation: The dominant vegetation association is a tall (12-20 m) open forest of narrow-leaved ironbark – long-fruited bloodwood. Narrow-leaved ironbark also forms minor associations with pink bloodwood, Queensland peppermint and lemon scented gum. Other minor associations that occur are silver-leaved ironbark – long-fruited bloodwood and Queensland peppermint with long-fruited bloodwood or lemon-scented gum. Kurrajong often occurs, as occasional trees, within any of these associations, as occasionally does the narrow-leaved bottle tree. On a few plateaus where the soil fertility is higher, narrow-leaved ironbark is an emergent above a softwood scrub of narrow-leaved bottle tree, crow's ash, soap bush, wallaby bush and quinine tree. Black wattle is the dominant mid-stratum species and forms a low (3-6 m), open forest with soap bush, rosewood, bitter bark, quinine tree and wallaby bush. Black wattle can become a regrowth problem following clearing. The low quality native grass pastures consist mainly of purple wiregrass and other wiregrasses (*Aristida spp.*), *Enneapogon spp.*, with a minor component of black speargrass. A few of the plateaus have been cleared, fertilised and sown to buffel grass which appears to be persisting, despite the low inherent fertility.

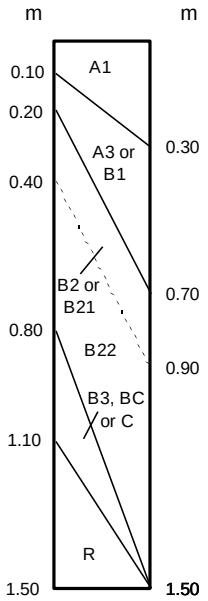
Runoff: Very slow to slow

Permeability: Moderately permeable

Drainage: Well drained

Surface cond: Hard setting; occasionally with 2 to 20%, ironstone or quartz gravels,2-60 mm.

Profile Description



A1: Dark red-brown, dark brown or occasionally dusky red (2.5YR 3/2; 5YR 3/2, 3/3, 3/4; 7.5YR 3/2, 3/3); fine sandy loam, fine sandy clay loam or clay loam fine sandy texture; massive or occasionally weak, 2 to 10 mm, platy structure; weak to very firm dry consistence; occasionally <2-20%, ironstone, quartz or sandstone gravels, 2-20 mm; pH 5.5 to 6.5. Clear or gradual to -

A3 or B1: Dark red-brown, red-brown or occasionally dark brown (2.5YR 3/4; 5YR 3/3, 3/4, 4/4; 7.5YR 4/4); fine sandy clay loam, clay loam fine sandy or fine sandy light clay texture; massive structure; weak to very firm dry consistence; occasionally <2-10%, quartz or ironstone gravels, 2-20 mm; occasionally <2-20%, ferruginous nodules, 2-6 mm; pH 5.5 to 7.0. Gradual or diffuse to -

B2 or B21: Dark red, very dark red-brown or yellow-red (2.5YR 3/4, 3/6, 4/6; 5YR 3/4, 4/6); clay loam fine sandy, fine sandy light clay or fine sandy light medium clay texture; massive and porous; firm or very firm dry consistence; sometimes <2-20%, quartz, ironstone or sandstone gravels, 2-20 mm; occasionally <2-10%, ferruginous or ferro-manganese nodules, <2-6 mm; pH 5.5 to 7.0. Diffuse to –

B22: (when present) As above except dark red-brown, dark red or red (2.5YR 3/4, 3/6, 4/6); clay loam fine sandy, fine sandy light clay or fine sandy light medium clay texture. Clear to -

B3 or BC: (when present) Dark-red brown, dark red , yellow-red or yellow-brown (2.5YR 3/4, 3/6; 5YR 4/6; 10YR 5/6, 6/6); 2-50%, grey, brown or red mottles; 5-30 mm; clay loam fine sandy to sandy light or light medium clay texture; massive; 20-90%, weathered sandstone fragments; occasionally <2-20%, ferruginous nodules, 2-20 mm or soft or nodular, manganese or ferro-manganese segregations, <2-6 mm; pH 5.0 to 6.0. Abrupt or clear to -

C: (when present) Weathered, reddish sandstone or siltstone with 20-50%, creamy, grey and brown mottles, >30 mm (reticulite horizon). Abrupt or sharp to -

R: Hard, unweathered bedrock

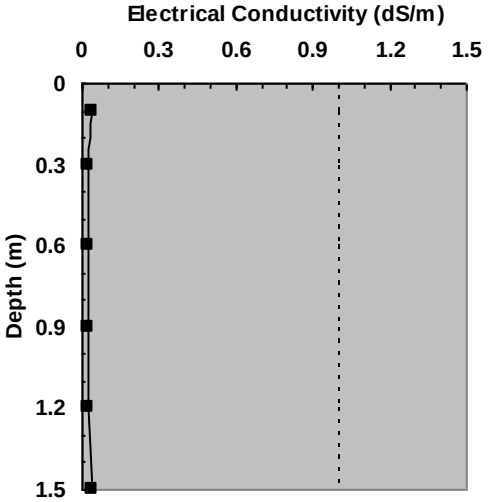
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Al	Exch. acidity	Ca/ Mg ratio	ESP	R1 Disp ratio	CEC: clay ratio
A_{11}	0.1	5.7	.04	.001	25	36	16	23	5.4	3.7	1.2	.06	.29	.10	.10	3.1	1	.49	.23
B_1	0.3	5.6	.02	.001	23	24	14	31										.48	
B_{21}	0.6	5.9	.02	.001	16	24	7	56	5.0	2.8	1.9	.11	.06	.10	.10	1.5	2	.26	.09
B_{22}	0.9	5.7	.02	.001	13	24	9	57	3.9	1.6	1.9	.14	.08	.20	.20	.84	4	.09	.07
B_{22}	1.2	5.1	.02	.002	12	24	8	55	2.8	.53	1.1	.12	.07	.90	1.0	.48	4	.10	.05
B_{22}	1.5	4.6	.04	.004	12	28	15	49	2.7	.23	.70	.10	.05	1.5	1.6	.33	4	.10	.06

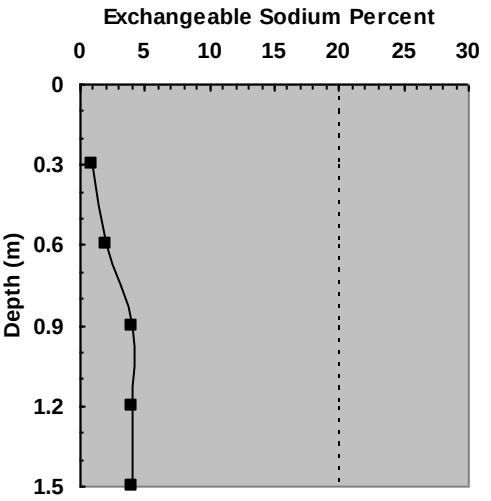
[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 ECEC= Ca + Mg + Na +K + exchangeable acidity

Spier is typically moderately to strongly acid throughout the profile as it is freely draining and leached as indicated by the very low soluble salt content. The surface soil has a moderate clay content that increases to a maximum of 57% in the subsoil. The higher fine sand and silt contents of the surface soil make it prone to hard setting, crusting and surface sealing. The CEC however is only low (5.4-2.7 cmol[+] kg^{-1}), with low to very low levels of calcium and magnesium, which indicate a deeply weathered and leached soil. The calcium and magnesium levels fall below the level of sufficiency in the lower subsoil. There is also a small amount of exchangeable aluminium and acidity in the lower subsoil due to the strongly acid pH. Exchangeable sodium and soluble salts are also very low throughout the profile as it is porous and freely draining with significant deep drainage (the ESP of the B22 is exaggerated due to the low cation contents and CEC). The subsoil CEC:clay ratios of 0.05 to 0.09 indicate a kaolinite clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Spier has a rooting depth range of 1.1 to 1.5 m, that is limited only by hard, unweathered bedrock, as subsoil salinity and sodcity are very low and not limiting (see above graphs). These rooting depths result in a PAWC that varies from 85 mm to 105 mm. The salt graph shows also that there is significant deep drainage below the soil profile, as the soluble salt content is very low (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage). This salt profile is typical of a recharge soil.

Surface Soil Fertility

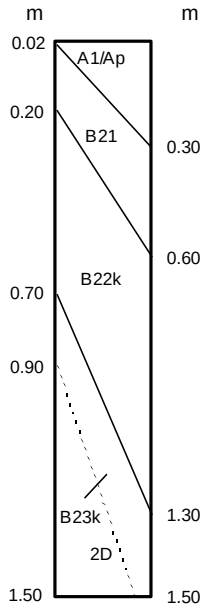
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	5	0.09	1.9	0.31	6	3.8	1.3
Range	1-14	.05-.16	1.0-3.6	.08-.95	2-11	3.7-4.0	1.2-1.3
No of samples	16	16	16	7	15	2	2
Rating	Low	Low	Moderate	Moderate	Low	Low	Low

Spier has a low surface soil fertility as it has been highly weathered and leached, resulting in low mean phosphorous (5 mg/kg) and total nitrogen (0.09%) contents. Fixation of phosphorous onto the iron oxides present in the red earth soils is not believed to be significant in central Queensland (Ahern *et al*, 1994). The phosphorous and nitrogen levels show some surprising high results for a red earth, with four phosphorous levels above 10 mg/kg and five total nitrogen levels in excess of 0.1%. The higher total nitrogen contents always occurred at sites that have above average organic carbon levels (2.5-3.5%). Overall organic carbon levels are moderate (1.9%). Potassium, sulphur, calcium and magnesium are also all at low levels. It is also unlikely that there is significant accumulation of sulfate sulphur and nitrate-nitrogen in the subsoil of Spier (Ahern *et al*, 1994).

Tarramba (Tr)

Concept: Tarramba is a very deep (>1.5 m), black, cracking clay soil with weakly to well developed normal gilgai. The surface soil is coarse self-mulching and the lower subsoil is strongly sodic (ESP>15) and saline (EC 0.8-1.5 dS/m). Tarramba has an alkaline soil reaction trend and is formed on Quaternary alluvium.
Geology: Unconsolidated, Quaternary, alluvial sediments (Qa).
Aust Class: Black Vertosol
PPF: Ug5.1, Ug5.15, Ug5.16, Ug5.17
Landform: Level backplains and plains of the Callide Valley floodplain, and valley flats of the many tributaries of the Callide Creek and Dawson River. These plains and valley flats are almost level with slopes less than 0.3%, and of low relief that is usually less than 3 m.
Vegetation: Tall to very tall (12-35 m), open forest or woodland of forest red gum or coolibah with an open understorey of predominantly sally wattle. In the Callide Valley, coolibah is only found to the north of Jambin. Moreton Bay ash and poplar box are occasionally present in the upper stratum, while white bauhinia, red-flowered bauhinia and ram's horn wattle are sometimes associated with sally wattle in the mid-stratum. The original native pastures consisted of forest blue grass, black speargrass and Queensland blue grass, however many areas of Tarramba have been cleared for cropping or sown to introduced grasses such as green panic and buffel grass.
Microrelief: Weakly to well developed normal gilgai – vertical interval: 0.05 to 0.3 m, horizontal interval: 3 to 10 m. However as most areas of Tarramba are cultivated, the gilgai are no longer apparent.
Runoff: Very slow
Permeability: Slowly drained
Drainage: Imperfectly drained
Surface cond: Coarse self-mulching (peds 2-5 mm) with a thin surface flake, or firm and pedal; periodic cracking

Profile Description (mounds and depressions[1])



A1: Black, very dark brown, grey or grey-brown (10YR 2/1, 2/2, 3/1, 3/2); light medium clay to silty medium heavy clay texture; strong, 2 to 5 mm, subangular blocky structure, sometimes parting to moderate, 1 to 2 mm, subangular blocky or granular primary peds; loose to weak dry consistence, fragments and clods when cultivated; rarely <2-10%, nodular, calcareous segregations, <2-6 mm; pH 6.0 to 8.5. Abrupt to -
B21: Black, very dark brown, grey or grey-brown (10YR 2/1, 2/2, 3/1, 3/2; 7.5YR 2/0); light medium clay to medium heavy clay texture; strong, 5 to 50 mm, subangular blocky structure parting to strong, 2 to 5 mm, lenticular primary peds, or strong, 2 to 5 mm, lenticular structure; very firm or strong dry consistence; sometimes <2-10%, nodular calcareous segregations, <2-6 mm; pH 7.0 to 9.0. Clear or gradual to -
B22k: Black, very dark brown, grey, grey-brown or occasionally dark brown (10YR 2/1, 2/2, 3/1, 3/2, 3/3; 2.5Y 3/2); occasionally <2-50%, brown, grey or dark mottles, <5-15 mm; light medium clay, medium clay or medium heavy clay texture; moderate to strong, 2 to 20 mm, lenticular structure with 2-10% slickensides; strong dry consistence; sometimes <2%, rounded gravels, 2-6 mm; <2-20%, nodular or soft, calcareous segregations, <2-20 mm; pH 8.0 to 9.0. Gradual or diffuse to a B23 or sharp or abrupt to a 2D -
B23k: As above, except dark brown or occasionally grey (10YR 3/1, 3/2, 3/3, 4/2, 4/4), and the structure is sometimes strong, 20 to 100 mm, prismatic parting to lenticular primary peds.
2D: (when present) Dark brown or dark yellow-brown (10YR 3/3, 4/3, 4/4); sometimes 10-50%, dark mottles, <5-15 mm; textures vary from coarse sand, sandy loam, coarse sandy clay loam to fine sandy light medium clay; massive for the light textures, and moderate or strong, 5 to 20 mm, subangular blocky or prismatic for the clay textures; sometimes <2%, nodular or soft, calcareous segregations, <2-6 mm; occasionally 20-90%, rounded gravels, 2-20 mm; pH 7.0 to 8.5.

[1] As most sites are cultivated, normal gilgai were only occasionally recorded, and the properties of the mounds and depressions were not different enough to separate.

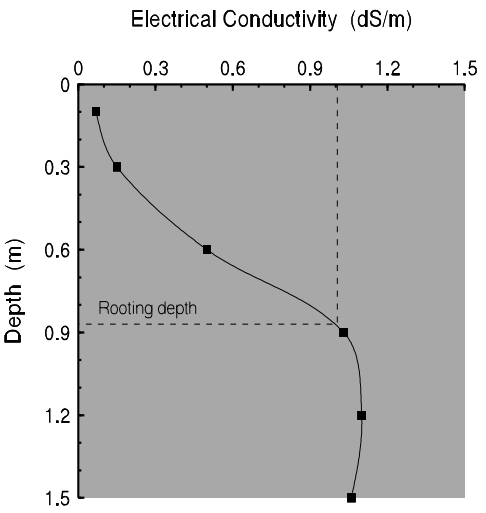
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	8.1	.19	.002	4	14	20	63	47	23	17	1.4	.62	1.4	3	.48	.75
B_{21}	0.3	8.7	.32	.020	4	14	18	65	49	19	22	3.9	.28	0.9	8	.53	.75
B_{22}	0.6	8.6	.82	.095	3	14	21	65	49	16	25	7.1	.30	0.6	15	.65	.75
B_{22}	0.9	8.6	1.0	.129	3	10	18	70	52	15	28	9.2	.28	0.5	18	.71	.74
B_{23}	1.2	8.6	1.1	.140	4	12	22	64	48	14	26	8.0	.25	0.5	17		.75
B_{23}	1.5	8.6	1.1	.149													

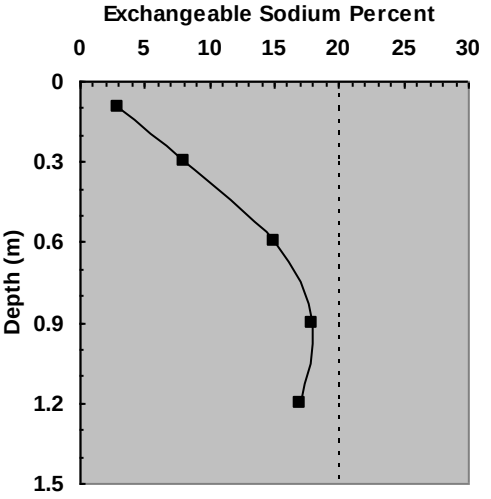
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

Tarramba is typically alkaline throughout the profile (pH 8.1-8.7), with a uniform very high clay content of 63 to 70%. The backplain alluvial clay soils are second in clay content to only the basaltic clay soils. The silt content is also high throughout the profile (18-22%), which is also very characteristic of the Callide alluvial soils. The CEC is high throughout the profile (47-52 cmol[+] kg^{-1}), and is magnesium dominant apart from the surface soil (Ca/Mg ratios 1.4-0.5). However the calcium content is still high throughout the profile (23-14 cmol[+] kg^{-1}). The lower subsoil is also strongly sodic (ESP 15-18), and despite the high calcium concentration it is dispersive with impeded drainage as indicated by the very high level of soluble salts in the lower subsoil (0.82-1.1 ds/m). The CEC: clay ratios of 0.75 indicate a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Tarramba has a mean rooting depth of 0.85 m that is limited by the high concentration of soluble salts in the subsoil that exceeds the critical limit of 1.0 dS/m at 0.85 m. The subsoil sodicity is not considered limiting to plant rooting depth, as the ESP is less than the critical limit of 20 throughout the profile (see above graphs). A rooting depth of 0.85 m results in a PAWC of 145 mm. The high clay content gives Tarramba a high water holding capacity per unit depth of soil. The salt graph also shows that the profile salt concentration reaches equilibrium at 0.9 m, due to impeded subsoil drainage, which indicates the long term, average depth of wetting.

Surface Soil Fertility

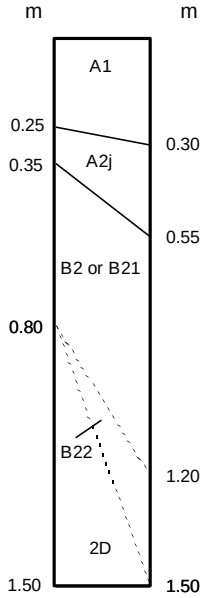
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	45	0.12	1.8	1.2	6	23	16
Range	12-115	.08-.15	1.3-2.4	.89-1.4	3-13	18-40	13-22
No of samples	8	8	8	3	6	8	8
Rating	Very high	Moderate	Moderate	High	Low	High	High

Tarramba has a high fertility as it has a very high mean phosphorous content (45 mg/kg), which is typical of the Callide alluvial soils, but only a moderate mean total nitrogen content (0.12%). The organic carbon content is also only moderate (1.8%), which is also typical of the eucalypt woodland soils, compared to the softwood scrub clay soils (see Scoria and Kooingal soils). All other nutrients measured apart from sulphate-sulphur are at high levels.

Tequila (Tq)

Concept: Tequila is a hard setting, very deep (>1.5 m), brown, duplex soil with a thick (0.35-0.55 m), fine sandy loam topsoil, which has a sporadically bleached subsurface. The topsoil overlies a brown, prismatic structured, fine sandy light clay or clay loam subsoil, which usually overlies buried sandy materials below 0.8 m. Tequila has a neutral or alkaline soil reaction trend and is formed on Quaternary alluvium.
Geology: Unconsolidated, Quaternary, alluvial sediments (Qa).
Aust Class: Brown Chromosol
PPF: Db1.32, Db1.33
Landform: Tequila was found only on one valley flat of a tributary of the Callide Creek, just to the south of Goovigen, which has slopes of 0.5% and a relief of 2 m.
Vegetation: The only area of Tequila found in the Banana study area has been cleared and sown to introduced grass pastures of buffel grass and green panic. However the remnant trees suggest a former closed forest of softwood scrub comprising narrow and broad-leaved bottle trees and red-flowered bauhinia, with shrubs of holly bush and wait-a-while.
Runoff: Very slow
Permeability: Moderately permeable
Drainage: Moderately well drained
Surface cond: Hard setting; occasionally with <2%, quartz gravels, 2-6 mm.

Profile Description



A1: Dark brown (10YR 3/3, 4/3); fine sandy loam or fine sandy clay loam texture; massive or moderate, 5 to 10 mm, platy structure; very weak or weak dry consistence; pH 6.5 to 7.5. Clear to -
A2j: Dark brown or strong brown (7.5YR 3/3, 4/6; 10YR 4/4), with a light grey or very pale brown (10YR 7/1, 7/2, 8/3), dry bleach colour; fine sandy loam or fine sandy clay loam texture; massive structure; weak or firm dry consistence; pH 7.0 to 8.5. Abrupt or clear to -
B2 or B21: Dark brown (7.5YR 3/4, 4/4; 10YR 4/3); occasionally <2%, faint, brown mottles, 5-15 mm; fine sandy light clay or clay loam fine sandy texture; moderate or strong, 20 to 50 mm, prismatic structure; very firm or strong dry consistence; occasionally 10-20%, soft, calcareous segregations, <2 mm; pH 7.5 to 8.5. Either sharp or abrupt to a 2D, or gradual to a B22 -
B22: (when present) Dark brown (7.5YR 4/4; 10YR 4/3); sometimes 20-50%, brown mottles, <5 mm; fine sandy light medium clay or clay loam fine sandy texture; strong, 5 to 10 mm, subangular blocky or massive structure; firm or very firm dry consistence; pH 7.5 to 8.0. Abrupt to -
2D: (when present) Dark or strong brown (7.5YR 4/4, 4/6); sand, clayey sand or fine sandy clay loam texture; massive structure; weak to firm dry consistence, depending upon texture; sometimes <2%, soft calcareous segregations present, <2 mm; pH 8.0 and 8.5.

Soil Chemistry

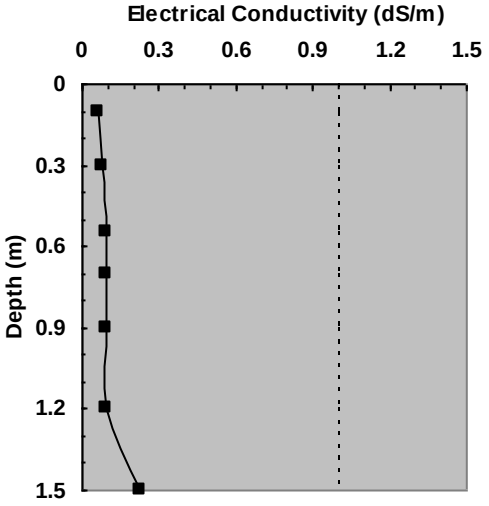
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.8	.06	.001	11	62	19	13	10	6.9	1.1	.04	.63	6.3			
A_1	0.3	8.5	.08	.001	8	65	19	13	5	4.8	.47	.01	.52	10			
A_{2j}	0.55	8.6	.09	.001	6	61	20	13	4	3.4	.47	.05	.09	7.2			
B_2	0.7	8.8	.09	.001	4	48	14	34	13	8.0	3.8	.23	.08	2.1	2	.56	.38
$2D_1$	0.9	8.8	.09	.001	4	62	24	12	10	5.8	3.7	.17	.08	1.6			
$2D_1$	1.2	8.9	.09	.003	18	61	5	17	8	3.5	2.3	.19	.11	1.5			
$2D_2$	1.5	8.8	.23	.022													

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5

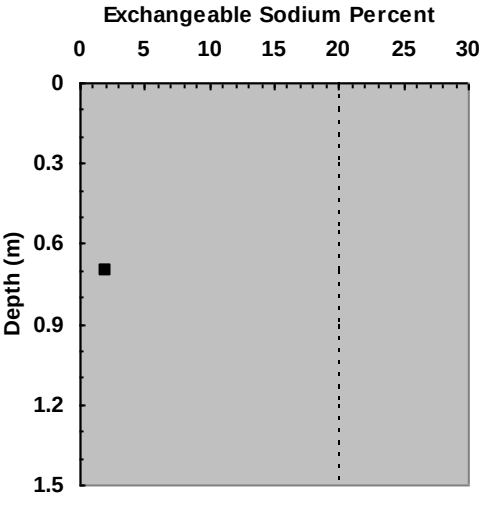
Tequila typically has an alkaline surface soil, subsoil and buried soil layers (pH 7.8-8.9). The profile is dominated by fine sand throughout (48-65%), and along with the high silt content of the surface soil makes it prone to hard setting, crusting and surface sealing. There is a large increase in clay content in the subsoil (34%), which shows the strong texture contrast. The surface soil has a high CEC (10 cmol[+] kg^{-1}) for only 13% clay content which is mainly due to organic matter as evident by the decrease in CEC in the bleached A2 horizon (4-5 cmol[+] kg^{-1}). The subsoil has a moderate CEC of 13 cmol[+] kg^{-1}, that is strongly dominated by calcium (Ca/Mg ratio 2.1), which is also at a moderate level (8.0 cmol[+] kg^{-1}). Calcium is also very dominant over magnesium throughout the topsoil, which is below the level of sufficiency.

The subsoil is non-sodic (ESP 2) and is therefore structurally stable and well drained as indicated by the low profile salt content. The subsoil CEC:clay ratio of 0.38 indicates a mixed clay mineralogy. The ESP, dispersion and CEC:clay ratios do not apply at the low clay contents of the sandy layers.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Tequila has very deep rooting depth of 1.5 m, as subsoil salinity and sodicity are very low and not limiting (see above graphs). A rooting depth of 1.5 m results in a PAWC of 90 to 100 mm (depending upon the thickness of topsoil and buried sandy layers). This PAWC is relatively low for a rooting depth of 1.5 m, due to the very high fine sand, and low clay content of most of the profile. The salt graph shows also that there is significant deep drainage as soluble salts are at only very low levels throughout the profile and do not reach equilibrium (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage). This salt profile is typical of a recharge soil.

Surface Soil Fertility

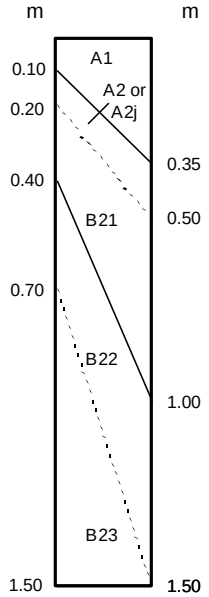
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Nutrient content	17	0.10	1.5	0.7	2	6.8	1.1
No of samples	1	1	1	1	1	1	1
Rating	High	Low	Low	Moderate	Very low	Moderate	Low

Tequila was only sampled once due to its limited occurrence, and these data show that Tequila has a moderate surface soil fertility as it has a high phosphorous content (17 mg/kg), but only low total nitrogen and organic carbon concentrations (0.1% and 1.5% respectively). The potassium and calcium levels are also moderate while magnesium and sulphur are low and very low levels respectively. The moderate soil fertility is due to the sandy topsoil being freely draining with a low cation exchange capacity thus making it difficult for the topsoil to retain nutrients.

Thalberg (Tb)

Concept: Thalberg is a hard setting, very deep (>1.5 m), brown or red, duplex soil, with a 0.2 to 0.5 m thick, fine sandy clay loam or clay loam fine sandy topsoil, that occasionally has a pale or sporadically bleached A2 horizon. The topsoil overlies a prismatic or blocky structured, fine sandy light medium or medium clay subsoil that has a neutral or alkaline soil reaction trend. Thalberg is formed on Cainozoic, alluvial-colluvial sediments.
Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza).
Aust Class: Brown or Red Chromosol
PPF: Db1.1, Dr2.1, Db1.3, Db 3.2
Landform: Gently undulating plains to undulating rises formed on the unconsolidated, Cainozoic sediments with slopes of 0 to 6% and a relief of 6 to 25 m.
Vegetation: Cowarra box (Dawson gum) – brigalow association with a dense, shrubby understorey. However all areas of Thalberg have been cleared and sown to introduced grasses such as buffel grass and green panic for fattening cattle, with only remnant trees and shrubs remaining. The most common tree species found are narrow and broad-leaved bottle trees, cowarra box, brigalow, crow's ash and red-flowered bauhinia with shrubs such as holly bush, lolly bush, bitter bark, wait-a-while and currant bush.
Runoff: Slow to moderately rapid
Permeability: Moderately permeable
Drainage: Moderately well drained
Surface cond: Hard setting or occasionally firm; sometimes with <2-50%, ironstone, quartz or sedimentary gravels and cobbles, 6-200 mm.

Profile Description



A1: Dark brown, very dark grey-brown or dark red-brown (7.5YR 3/2, 3/3, 3/4; 10YR 3/2, 4/3; 5YR 3/2); fine sandy clay loam, clay loam fine sandy or occasionally fine sandy loam texture; massive or weak to moderate, 2 to 10 mm, subangular blocky or platy structure; weak to very firm dry consistence; <2-20%, quartz and ironstone gravels, 2-60 mm; pH 6.0 to 8.0. Sharp or abrupt to a B21, or abrupt or clear to an A2 or A2j -
A2j or A2: (when present) Dark brown, strong brown, dark grey-brown to dark yellow-brown (7.5YR 4/4, 4/6; 10YR 4/2, 4/3, 4/6), sometimes with a light grey, pink-grey, pink or pink-white dry bleach colour (10YR 7/2; 7.5YR 7/2, 7/4, 8/2); fine sandy loam, fine sandy clay loam or clay loam fine sandy texture; massive or weak, 2 to 10 mm, subangular blocky structure; weak to very firm dry consistence; <2-50%, quartz or ironstones gravels, 2-60 mm; pH 6.5 to 8.5. Sharp or abrupt to -
B21: Dark brown, strong brown, red-brown, yellow-brown or dark red (7.5YR 4/4, 4/6; 5YR 4/4, 4/6; 2.5YR 3/6, 4/4; 10YR 4/3); occasionally <2-10%, grey, red or yellow mottles, <5 mm; fine sandy light medium or fine sandy medium clay texture; strong, 20 to 100 mm, prismatic structure parting to 5 to 20 mm, subangular blocky primary peds, or occasionally strong, 2 to 10 mm, polyhedral structure; firm or strong dry consistence; <2-10%, quartz or ironstone gravels, 2-20 mm; rarely <2%, soft or nodular, calcareous or manganese segregations, <2 mm; pH 5.0 to 8.5. Gradual to –
B22: Dark brown, strong brown, dark red-brown to red or dark yellow-brown to yellow-brown (7.5YR 4/4, 4/6; 2.5YR 3/4, 4/6; 10YR 4/4, 5/6); sometimes <2-50%, grey or brown mottles, <5-15 mm; fine sandy light medium clay texture; structure similar to B21, except occasionally strong, 5-20 mm, lenticular structure; firm or strong dry consistence; sometimes <2-10%, ironstone or quartz gravels, 2-60 mm; <2-50%, soft or nodular calcareous, or less often, manganese segregations, <2-20 mm; pH 5.5 and 8.5. Gradual to -
B23: (when present) Similar to above except less red (7.5YR 4/4, 4/6; 10YR 4/4, 4/6; 5YR 4/4, 4/6); with <2-20%), soft or nodular, calcareous or manganese segregations, <2-6 mm; rarely <2%, ironstone gravels, 6-20 mm.

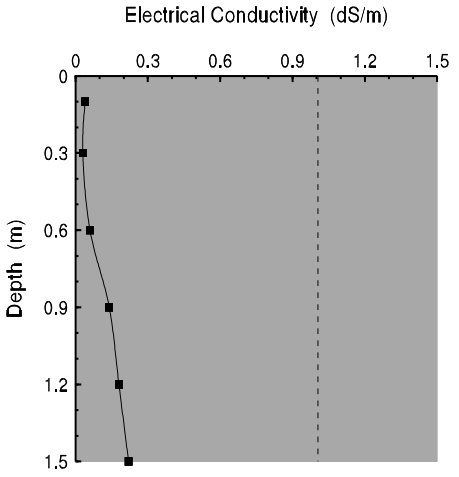
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	7.0	.06	.003	21	31	22	28	8.9	6.8	1.1	.01	1.0	6.2	0.1	.45	.32
B_{21}	0.3	7.5	.03	.002	15	23	11	50	6.8	5.3	1.3	.03	.20	4.1	0.4	.58	.14
B_{22}	0.4	7.6	.04	.002	14	22	10	52	8.9	5.9	2.5	.22	.32	2.4	3	.52	.17
B_{22}	0.6	7.5	.05	.003	11	20	12	56	9.2	5.0	3.5	.41	.27	1.4	5	.54	.16
B_{23}	0.9	6.7	.14	.014	11	20	10	57	9.5	4.4	4.3	.66	.13	1.0	7	.50	.17
B_{23}	1.2	7.5	.34	.037	11	20	11	59	10	4.3	4.8	.95	.19	0.9	10	.47	.17
B_{23}	1.5	7.8	.37	.040	13	22	11	54	9.3	3.4	4.3	1.4	.18	0.8	15	.50	.17

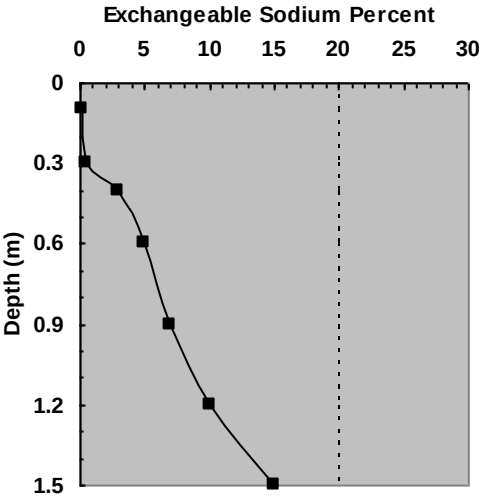
(1) Cations extracted with aqueous 1M NH_4Cl at pH 7.0

The topsoil typically has a neutral pH (pH 7.0), with an alkaline subsoil which is occasionally strongly acid (pH 5.0-8.5). The surface soil has high clay, silt and fine sand contents (22-31%) which make it prone to hard setting, crusting and surface sealing. There is a large increase in clay content in the subsoil (50-59%) showing the strong texture contrast. The subsoil CEC is moderate (6.8-10 cmol[+] kg^{-1}) which indicates a weathered soil for such a high clay content. Calcium is the dominant cation for most of the profile except for the lower subsoil where magnesium is dominant (Ca/Mg ratios 6.2-0.8). Calcium is at a moderate concentration in the surface soil and decreases to low levels in the lower subsoil (6.8-3.4 cmol[+] kg^{-1}), whereas exchangeable sodium becomes significant with depth with the subsoil becoming sodic from 0.9 m (ESP 7-15). Overall however the subsoil is structurally stable and well drained as indicated by the low profile salt content (0.03-0.37 dS/m) and low dispersion ratios (0.47-0.58). The subsoil CEC:clay ratios of 0.14 to 0.17 indicate a kaolinite dominant clay mineralogy, largely derived from the weathering of the Tertiary land surface.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Thalberg has a deep rooting depth of 1.5 m, as the subsoil salinity is low, and even though the subsoil sodicity reaches an ESP of 15 at 1.5 m, it is still below the critical limit of 20 and therefore not limiting to the rooting depth (see above graphs). A rooting depth of 1.5 m results in a PAWC of 130 mm. The salt graph shows also that there is significant deep drainage below the soil profile as the salt content is low throughout the profile and has only reached equilibrium at 0.9 m at low concentrations (i.e. only a small "salt bulge" is present due to leaching of salts by deep drainage).

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	41	0.13	1.6	1.1	6	6.7	1.1
Range	16-128	.06-.23	1.0-2.4		3-8		
No of samples	5	5	5	1	4	1	1
Rating	Very high	Moderate	Moderate	High	Low	Moderate	Low

Thalberg has only moderate surface soil fertility that is limited by its moderate mean total nitrogen concentration (0.13%) even though it has a very high mean phosphorous content (41 mg/kg),. The mean organic carbon content is also only moderate (1.6%), which is low for a softwood scrub soil, as most areas of Thalberg have been previously cropped. The potassium level, though only measured once, is high, while both sulphate-sulphur and magnesium are both low, with magnesium being below the level of sufficiency. Calcium is at a moderate content.

Tiamby (Tm)

Concept: Tiamby is a moderately deep to deep (0.5-1.3 m), black or brown, non-cracking or cracking clay soil with a fine, pedal, or self-mulching, light or light medium clay topsoil that overlies a light medium or medium clay subsoil. The deeper profiles have high levels of soluble salts (0.8-1.5 dS/m) and are sodic (ESP 10-15) in the lower subsoil below 0.5 m. Tiamby has an alkaline soil reaction trend and is formed on intermedite volcanic rocks.

Geology: Little weathered, Carboniferous, intermediate volcanic rocks (unidentified) (Ct).

Aust Class: Black or Brown Dermosol, or Black Vertosol

PPF: Uf6.31, Uf6.32, Ug5.12

Landform: Crests and hillslopes of moderately dissected, undulating rises and low hills, which have slopes of 2 to 8% and a relief of 20 to 50 m.

Vegetation: Cosed forest of softwood scrub or brigalow scrub. However all areas have been cleared and sown to introduced grass pastures with only remnant indicator species of brigalow, narrow and broad-leaved bottle trees, coowarra box (Dawson gum) and red-flowered bauhinia remaining.

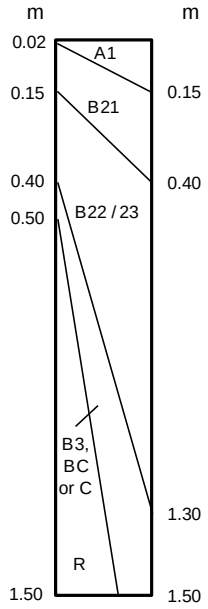
Runoff: Moderately rapid

Permeability: Slowly permeable

Drainage: Moderately well drained

Surface cond: Firm and pedal, or fine self-mulching (peds 1-2 mm); with 2-20% quartz and volcanic rock gravels and cobbles, 6-200 mm.

Profile Description



A1: Black, very dark brown or dark brown (10YR 2/1, 2/2, 3/2; 7.5YR 3/2); light or light medium clay texture; weak to strong, 2 to 10 mm, subangular blocky structure sometimes parting to 1 to 2 mm, subangular blocky or granular primary peds if self-mulching; loose to firm dry consistence; <2-20%, volcanic rock gravels, 2-20 mm; pH 6.5 and 8.0. Abrupt or clear to -

B21: Black or dark brown (10YR 2/1, 3/3; 7.5YR 3/2, 3/3); light medium or medium clay texture; strong, 10 to 50 mm, prismatic or subangular blocky parting to strong, 2 to 10 mm, subangular blocky or lenticular primary peds; very firm or strong dry consistence; <2-10%, quartz or volcanic rock gravels, 2-20 mm; pH 7.5 to 8.5. Clear or gradual to -

B22k, 23k: Black, dark or strong brown, very dark grey-brown, dark grey-brown or dark yellow-brown (10R 2/1, 3/2, 4/2, 4/4; 7.5YR 4/4, 4,6); occasionally 2-20%, dark, grey or brown mottles; <5-15 mm; light medium or medium clay texture; strong, 5 to 50 mm, prismatic or subangular blocky structure parting to 2 to 10 mm, subangular blocky or lenticular primary peds or strong, 2 to 10 mm, lenticular structure; strong dry consistence; <2-10%, quartz and volcanic rock gravels, 2-20 mm; occasionally <2-50%, soft or nodular, calcareous segregations, 2-20 mm; pH 8.5 to 9.0. Abrupt or clear to -

B3 or BCk: Grey-brown to light yellow-brown (2.5Y 5/4, 6/4; 10YR 4/1, 4/2, 5/6); sometimes 2-10%, dark or brown mottles, <5 mm; fine sandy light or light medium clay texture; weak or moderate, 2-10 mm, subangular blocky or occasionally lenticular structure; firm to strong dry consistence; 10-50%, weathered fragments of volcanic rock; 2-50%, soft or nodular, calcareous segregations, <2-20 mm; pH 8.5 to 9.0. Abrupt or clear to -

C: Weathered intermediate volcanic rock fragments, with 10-90%, soft, calcareous segregations, 2-60 mm.

R: Hard, unweathered bedrock

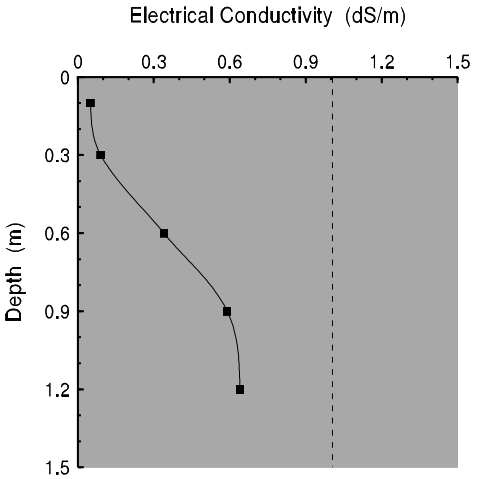
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/B_{21}	0.1	7.6	.10	.002	12	21	20	44	35[2]	26	7.2	.33	1.9	3.6	0.9	.48	.80
B_{22}	0.3	8.7	.17	.004	7	17	17	56	46	35	12	1.7	.30	2.9	4	.67	.82
B_{22}	0.6	8.8	.36	.026	9	18	16	53	42	22	15	4.5	.25	1.5	11	.82	.79
B_{23}	0.9	8.7	.74	.109	8	15	17	57	45	20	16	6.6	.26	1.3	15	.85	.79
B_{23}	1.2	8.7	.89	.124	9	15	16	57	46	20	17	6.8	.29	1.2	15		.81

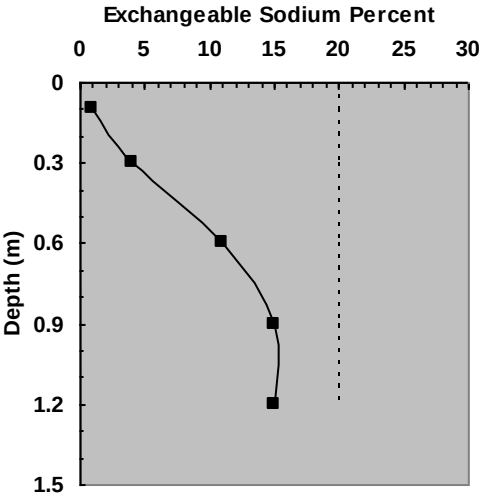
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

Tiamby typically has a neutral surface soil (pH 6.5-7.5) and alkaline to strongly alkaline subsoil (pH 8.0-9.0). It has a uniform high clay content (44-57%) with significant levels of silt (16-20%). The CEC is also high throughout the profile (35-46 cmol[+] kg^{-1}) and is dominated by calcium (Ca/Mg ratios 3.6-1.2) which is also at high levels (20-35 cmol[+] kg^{-1}). The lower subsoil becomes strongly sodic (ESP 11-15) and despite the high calcium content is dispersive (high dispersion ratios 0.82-0.85) with impeded drainage that restricts deep drainage and causes soluble salts to accumulate to moderate levels (0.74-0.89 dS/m). The CEC:clay ratios of 0.79 to 0.82 indicate a smectite dominant clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Tiamby has a rooting depth range of 0.5 to 1.5 m that is limited only by shallow bedrock, as subsoil salinity and sodicity are moderate and not limiting (see above graphs). Tiamby therefore has a wide PAWC range that varies from 75 to 150 mm. The salt graph shows also that the salt concentration reaches equilibrium at 0.9 m, due to impeded subsoil drainage, which indicates the long-term, average depth of wetting.

Surface Soil Fertility

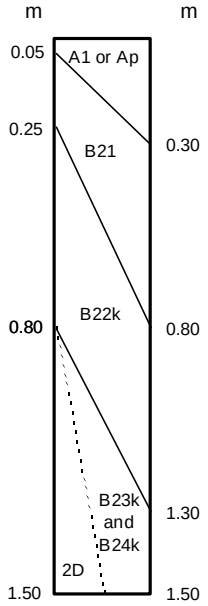
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	59	0.29	3.3	1.6	8	25	6.9
Range	28-119	.23-.33	2.6-3.9		8		
No of samples	3	3	3	1	2	1	1
Rating	Very high	Very high	High	High	Moderate	High	High

Although only sampled at three sites due to its limited occurrence, the data is consistent and indicates a very high surface soil fertility as Tiamby has very high mean phosphorous and total nitrogen contents (59 mg/kg and 0.29%), which are typical for softwood scrub clay soils. The mean organic carbon level is also high (3.3%), which again shows the higher levels of organic carbon of softwood scrub soils compared to eucalypt woodland clay soils. The other nutrients measured are also mainly at high mean levels, except for sulphate-sulphur which is at a mean moderate concentration.

Tognolini (Tn)

Concept: Tognolini is a very deep (>1.5 m), black cracking clay soil with a fine, self-mulching, silty light medium or medium clay topsoil. The subsoil is calcareous below 0.3 m and has a fine, lenticular structure and an alkaline soil reaction trend. Some profiles have moderate levels of soluble salts (0.4-0.8 dS/m) and are sodic (ESP 6-15) in the lower subsoil below 1.0 m. Tognolini is formed on Quaternary alluvium.
Geology: Unconsolidated, Quaternary, alluvial sediments (Qa).
Aust Class: Black Vertosol
PPF: Ug5.1, Ug5.15, Ug5.16, Ug5.17
Landform: Level backplains of the Callide Valley alluvial plain, and on the valley flat of only the Prospect Creek, which is a tributary of the Callide Creek in the southern area of the Banana study area. The backplains have very low slopes less than 0.5%, and very low relief, usually less than 3 m.
Vegetation: Tall or very tall (12-35 m), woodland of forest red gum with a mid-high (6-12 m), open understorey of sally wattle. The native pastures are of high quality and consisted of forest blue grass, black spear grass and kangaroo grass. However nearly all areas of Tognolini have been cleared for either irrigated or rainfed cropping.
Runoff: Very slow
Permeability: Slowly permeable
Drainage: Moderately well drained
Surface cond: Fine self-mulching (peds 1-2 mm) and strongly cracking

Profile Description



A1 or Ap: Black, very dark brown or very dark grey (10YR 2/1, 2/2, 3/1); silty light medium or medium clay texture; strong, 1-2 mm, granular or subangular blocky structure, or if cultivated, fragments and clods; loose dry consistence; pH 6.5 to 8.5. Abrupt to -
B21: Black, very dark brown, very dark grey or very dark grey-brown (10YR 2/1, 2/2, 3/1; 2.5Y 3.2); silty light medium or medium clay texture; strong, <2 to 5 mm, lenticular, or strong, 5 to 20 mm, subangular blocky structure parting to <2 to 5 mm, lenticular primary peds; firm or very firm dry consistence; pH 7.0 to 8.5. Clear or gradual to -
B22k: Black, very dark brown, very dark grey, very dark grey-brown or occasionally dark brown or dark grey-brown (10YR 2/1, 2/2, 3/1, 3/2, 3/3, 4/2); occasionally <2-10%, brown mottles, <5-15 mm; silty light medium or medium clay texture; strong, 2 to 5 mm, lenticular structure with slickensides; firm or very firm dry consistence; <2-10%, carbonate concretions or nodules, <2-6 mm; pH 8.0 to 9.0. Clear or gradual to -
B23, 24k: Black, very dark grey, very dark grey-brown, dark brown, dark grey-brown or brown (10YR 2/1, 3/1, 3/2, 3/3, 4/2, 5/3); sometimes 2-20%, dark or brown mottles, <5-15 mm; light medium clay or medium clay texture; strong, 5 to 20 mm lenticular parting to 2 to 5 mm, lenticular primary peds with slickensides, or a strong, 20 to 50 mm, prismatic structure that parts to 2 to 5 mm, lenticular primary peds; very firm or strong dry consistence; <2-20%, concretionary, nodular or soft, calcareous segregations, <2-20 mm; pH 8.0 to 8.5. Sharp or abrupt to -
2D: (when present) The buried sandy layers occur only rarely and are dark brown, dark yellow-brown or yellow-brown (10YR 3/3, 4/4, 5/4); coarse sand, sand or coarse sandy light medium clay texture; structure varies with texture from single grain for the sands to massive or strong, 10 to 20 mm, angular blocky for the sandy clays; sometimes 2-20%, rounded gravels, 2-20 mm; pH 7.0 to 8.5.

Soil Chemistry

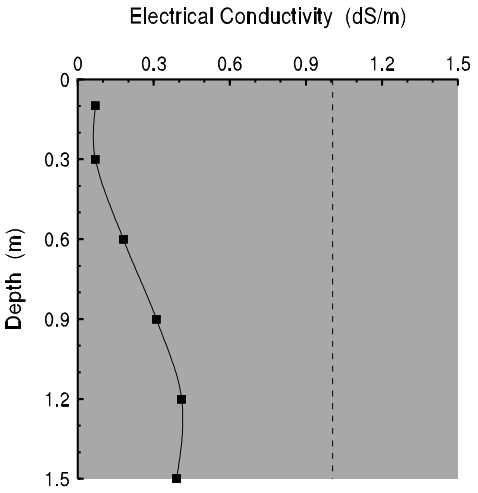
Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/ B_{21}	0.1	7.3	.09	.002	1	10	29	60	38[2]	22	14	1.2	.76	1.6	3	.53	.63
B_{21}	0.3	7.6	.13	.004	1	6	28	63	41[2]	23	15	2.4	.33	1.5	6	.62	.65
B_{22}	0.6	8.1	.21	.020	1	6	25	65	43[2]	23	16	4.1	.27	1.4	9	.77	.66
B_{22}	0.9	8.3	.48	.050	1	4	25	71	50	22	18	6.3	.24	1.2	13	.82	.70
B_{23}	1.2	8.4	.81	.100	2	5	19	73	50	21	19	8.1	.24	1.1	16		.59
B_{24}	1.5	8.3	.83	.109													

[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

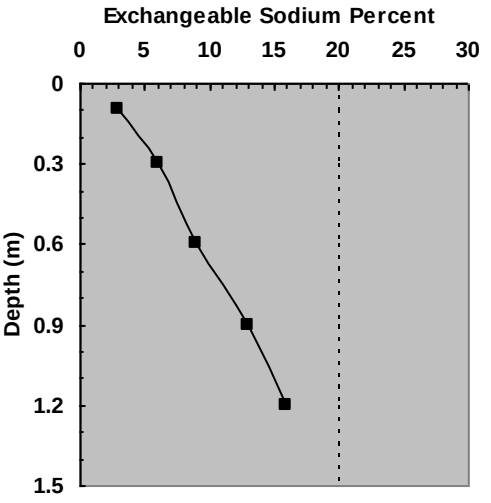
Tognolini typically has a neutral surface soil (pH 6.5-7.5) and an alkaline subsoil (pH 7.5-8.5). It has a uniform very high clay content throughout the profile (60-73%), that is second only to the basaltic clay soils. Another characteristic of the Callide alluvial soils are the high levels of silt (19-29%), and the backplain clay soils typically have very low sand contents. The CEC is high also (38-50 cmol[+] kg^{-1}) and is dominated by calcium throughout the profile (Ca/Mg ratios 1.6-1.1), which is also at consistent high levels in the surface soil and subsoil (21-23 cmol[+] kg^{-1}).

The subsoil is sodic to strongly sodic (ESP 6-16), but is considered to be structurally stable in the upper metre of the profile as salts do not accumulate to high levels until 1.2 m (0.81-0.83 dS/m). Overall however, Tognolini has a mean maximum subsoil salt content of only 0.45 dS/m indicating better subsoil conditions that the sampled profile (see salt graph below). The CEC:clay ratios of 0.59 to 0.7 indicate a mixed clay mineralogy dominated by smectite clay minerals.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Tognolini has a deep rooting depth of 1.5 m, as subsoil salinity and sodicity are both below the critical limits that limit the rooting depth (see above graphs). As Tognolini has a very high clay content and is stone free, a rooting depth of 1.5 m results in a very high PAWC of 195 mm. This is the highest PAWC for any soil of the Banana soil survey. The salt graph shows also that the salt concentration reaches equilibrium at 1.2 m, which indicates the long term average depth of wetting. The salt content however is only moderate due to significant deep drainage below the soil profle.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	76	0.12	2.0	0.81	7	19	12
Range	47-123	.08-.18	1.3-3.1		6-8	18-21	11-13
No of samples	2	2	2	1	2	2	2
Rating	Very high	Moderate	Moderate	Moderate	Moderate	High	High

As Tognolini was almost always cropped, it was only sampled twice, and the lower of the data range is from a cultivated site (the representative profile). This demonstrates the effect of cropping on soil nitrogen and carbon levels. As these data are similar to those of other alluvial cracking clay soils (see Tarramba), Tognolini is considered to have a high soil fertility due mainly to its very high mean phosphorous content (76 mg/kg). Alluvial clay soils with eucalypt woodlands consistently have only moderate total nitrogen and organic carbon levels, which is why the fertility is downgraded to only high. The potassium, calcium, and magnesium contents are also always high for these alluvial soils, while the sulphur levels are generally low.

Ulogie (Ug)

Concept: Ulogie is a very deep (>1.5 m), brown or grey, strongly sodic, duplex soil with a moderately thick to thick (0.15-0.5 m), fine sandy loam to clay loam sandy topsoil that has a sporadically bleached A2 horizon. The topsoil overlies a coarse columnar structured, fine sandy light medium or medium clay subsoil that is sometimes mottled. Ulogie has variable subsoil pH so that the soil reaction trend is equally acid, neutral or alkaline and is formed on Cainozoic, alluvial-colluvial sediments.

Geology: Unconsolidated, Cainozoic, alluvial-colluvial sediments (Cza).

Aust Class: Brown or Grey Sodosol

PPF: Db1.33, Dy2.33, Dy2.32, Db2.33, Db1.31

Landform: Gently undulating plains to undulating rises formed on the unconsolidated, Cainozoic, alluvial-colluvial sediments, but only in the Callide Valley. Ulogie did not occur in the Dawson valley in the western half of the Banana study area. Slopes vary from level to 7% with a relief of 7 to 25 m, and Ulogie is found mainly, along with Kokotungo, on the plains and rises surrounding or in close proximity to the deeply weathered, Tertiary, sandstone plateaus.

Vegetation: Very tall or tall (12-35 m), woodland of either a gum-topped box – narrow-leaved ironbark association, or a pure gum-topped box or narrow-leaved ironbark woodland. A minor association is a tall, poplar box woodland that was found only in the eastern area of the Callide valley to the north of Biloela. The understorey is sparse and consists of false sandalwood, wilga, soap bush, quinine berry and whitewood, while the low quality native pastures are made up of wire grasses (*Aristida spp.*), pitted blue grass, curly windmill grass, sometimes with minor amounts of forest blue and black spear grass.

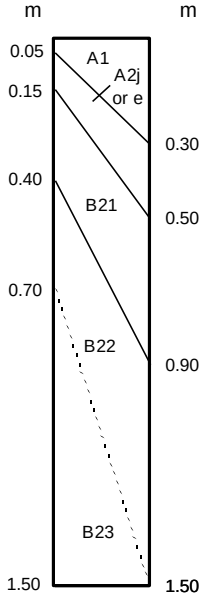
Runoff: Slow to moderately rapid

Permeability: Slowly permeable

Drainage: Imperfectly drained

Surface cond: Hard setting; sometimes with <2-20%, ironstone, quartz or silcrete gravels and cobbles, 2-200 mm.

Profile Description



A1: Dark brown, very dark grey-brown, dark grey-brown or black (10YR 3/3, 3/2, 4/2, 2/1; 7.5YR 3/2, 3/3); sandy loam, fine sandy clay loam or clay loam fine sandy texture; massive or occasionally weak, 2 to 10 mm, subangular blocky or platy; weak to very firm dry consistence; <2-20%, quartz, ironstone or silcrete gravels, 2-60 mm; occasionally <2-10%, nodules of ferruginous, manganese or ferro-manganese segregations, 2-20 mm; pH 6.0 to 7.0. Abrupt or clear to -

A2j or e: Very dark grey-brown, dark brown, brown, light olive-brown or dark yellow-brown (10YR 4/2, 4/3, 5/3, 6/2, 3/3, 4/4, 5/4), with a white or light grey, dry bleach colour (10YR 8/1, 7/2, 7/1, 8/2); sandy loam, sandy or fine sandy clay loam or clay loam sandy or fine sandy texture; massive or occasionally weak, 2-10 mm, subangular blocky structure; weak to very firm dry consistence; <2-20%, quartz, ironstones or silcrete gravels, 2-60 mm; occasionally 2-90%, nodules of ferruginous, manganese or ferro-manganese segregations, 2-20 mm; pH 6.0 to 7.0. Sharp or abrupt to -

B21: Dark grey-brown, brown, dark yellow-brown, yellow-brown or occasionally dark grey-brown, light olive-brown, dark brown or red-brown (10YR 4/2, 5/3, 4/4, 5/4, 5/6, 3/2; 2.5Y 5/4; 7.5YR 4/4; 5YR 4/3); usually 2-50%, grey, brown or red mottles; <5-15 mm; fine sandy light medium or medium clay texture; strong, 100-500 mm, columnar structure; strong or very strong dry consistence; sometimes <2-20%, quartz, silcrete or ironstone gravels, 2-60 mm; occasionally <2-20%, soft or nodular, manganese or ferruginous segregations, <2-20 mm; pH 6.0 to 8.5. Clear or gradual to –

B22: Dark brown, yellow-brown, dark yellow-brown, dark grey-brown or occasionally strong brown or red-brown (10YR 4/3, 5/4, 4/4, 4/2; 7.5YR 4/4, 4/6; 5YR 4/4); usually <2-50%, dark, grey or red mottles, <5-30 mm; fine sandy light medium or medium clay texture; strong, 20 to 100 mm, prismatic structure often parting to weak, 10-50 mm, lenticular primary peds; strong or very strong dry consistence; sometimes <2-10%, ironstone or quartz gravels, 2-60 mm; often <2-20%, soft or nodular, calcareous or manganese segregations, <2-20 mm; pH 5.5 and 9.0. Gradual or diffuse to -

B23: (when present) Similar to above except yellow-brown, brown, light olive-brown or occasionally red-brown (10YR 5/4, 5/3; 2.5Y 5/4; 5YR 4/4), and usually 2-50%, grey, red or brown mottles, <5-15 mm.

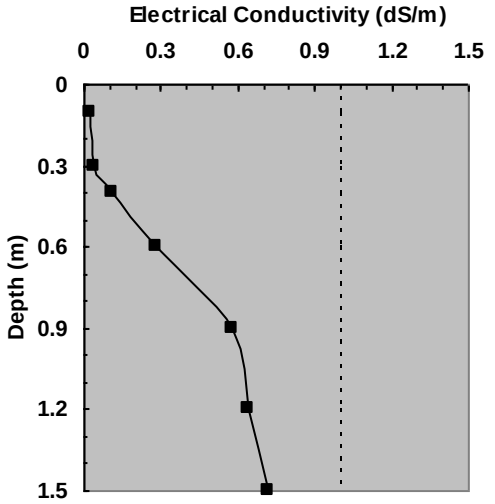
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.4	.02	.001	12	61	15	16	4.7	3.1	1.2	.07	.31	2.6			
A_{2j}	0.3	6.7	.04	.001	13	61	15	17	3.6	1.1	2.0	.38	.16	.55			
B_{21}	0.4	6.4	.11	.009	10	49	14	30	8.0	1.3	5.0	1.6	.12	.26	20	1.0	.27
B_{21}	0.6	6.9	.28	.030	8	47	12	38	11	1.6	6.5	2.8	.12	.25	25	.97	.30
B_{22}	0.9	7.7	.58	.070	6	47	12	36	12	1.6	6.9	3.7	.10	.23	31	1.0	.34
B_{22}	1.2	7.8	.64	.083	5	49	17	40	11	1.4	6.0	3.2	.09	.23	30	.99	.28
B_{22}	1.5	6.8	.72	.095	6	36	20	41	11	1.2	6.2	3.6	.11	.19	33	.99	.27

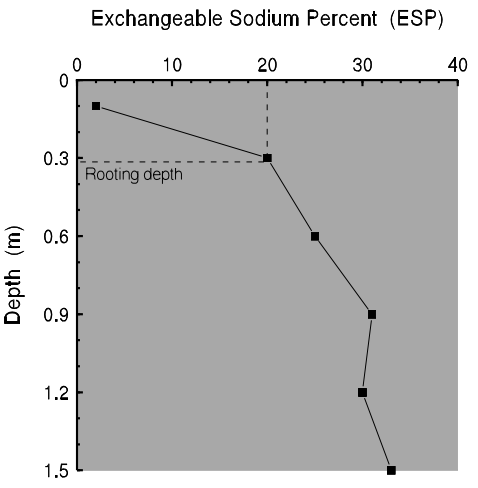
[1] Cations extracted with aqueous 1M NH_4Cl at pH 7.0

The topsoil is typically slightly acid or neutral (pH 6.0-7.0), while the subsoil varies from strongly acid to strongly alkaline depending upon source materials (pH 5.5-9.0). The surface soil has a very high fine sand content (61%), with moderate levels of silt (15%) and clay (16-17%) which make it hard setting, crusting and surface sealing. There is a significant increase in clay content of the subsoil (38-40%, underestimated at 0.4 m) showing the strong texture contrast. The topsoil Has a low CEC of only 3.6 to 4.7 cmol[+] kg^{-1} as it is sandy, and increases to only 8.2 to 12 cmol[+] kg^{-1} in the subsoil which indicates a weathered soil. The subsoil cations are dominated by magnesium with very low Ca/Mg ratios of 0.26 to 0.19 and very low calcium concentrations of only 1.2 to 1.6 cmol[+] kg^{-1}. The subsoil is very strongly sodic throughout (ESP 20-33) and exchangeable sodium exceeds calcium over the entire subsoil. The subsoil is therefore highly dispersive, which is indicated by complete dispersion with dispersion ratios of 0.97 to 1.0, with impeded subsoil drainage. Subsoil salts however only accumulate to moderate levels (0.58-0.72 dS/m), possibly due to removal of salts in subsurface flow of perched watertables. The subsoil CEC:clay ratios of 0.27 to 0.34 indicate a kaolinite dominant, mixed clay mineralogy.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Ulogie has a rooting depth of only 0.15 to 0.5 m, as it is limited to the topsoil by an extremely dense and strongly sodic subsoil that has an ESP of 20 in the upper 10 cm. Therefore the subsoil does not contribute plant available water. Ulogie therefore has only a very low to low PAWC of 22 to 50 mm, depending upon the thickness, texture and stone content of the topsoil. The salt graph shows also *<insert later when graph is done>*

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	9	0.06	1.3	0.28	4	3.1	1.2
Range	5-14	.04-.08	1.0-1.9	.16-.53	2-6		
No of samples	11	11	11	7	9	1	1
Rating	Low	Low	Low	Low	Low	Low	Low

Ulogie has low surface soil fertility as all nutrients measured had low mean concentrations. However, half of the phosphorous results were at moderate levels (10-14 mg/kg), as Ulogie is often in a depositional landscape close to the sandstone plateaus, which is thought to result in slightly higher phosphorous levels. Total nitrogen and sulphur levels are always low as mobile nutrients such as nitrogen and sulphur are readily leached from the sandy topsoil, while the low organic carbon and total nitrogen levels are also typical of sandy surfaced duplex soils with eucalypt woodlands, particularly those with poplar box, gum-topped box and narrow-leaved ironbark.

Wandoo (Wd)

Concept: Wandoo is a shallow to moderately deep (0.4-1.0 m), red, duplex soil, with a thin to moderately thick (0.05-0.2 m), clay loamy topsoil that overlies a blocky or prismatic structured, light medium or medium clay subsoil. Wandoo has a neutral to alkaline soil reaction trend, depending upon soil depth, and is formed on Permian, sedimentary rocks.

Geology: Little weathered, Permian siltstones and sandstones of the Flat Top (Puf), Gyranda (Puy) and Barfield (Pur) formations of the Bowen basin.

Aust Class: Red Chromosol

PPF: Dr2.12, Dr2.13

Landform: Crests and hillslopes of gently undulating rises formed on Permian sedimentary rocks, that have slopes of 1 to 6% and a relief of 15 to 30m. In the Baralaba-Banana road area, Wandoo occurs on the crests and upper slopes of the rises, and often forms a catenary sequence with the Banana and Mungi soils on the mid and lower slopes respectively. Whereas to the west of Banana township, Wandoo is formed on sandstones of the Gyranda formation and occurs in the mid to lower slope positions.

Vegetation: Mid-high (6-12 m), woodlands or open woodlands of silver-leaved ironbark and gum-topped bloodwood. There is a sparse, widely spaced, shrubby understorey, usually <4m high, of whitewood, pretty wattle, soap bush and *Maytanus cunninghamii*, and the native pastures consist mainly of forest bluegrass, Queensland bluegrass and black speargrass.

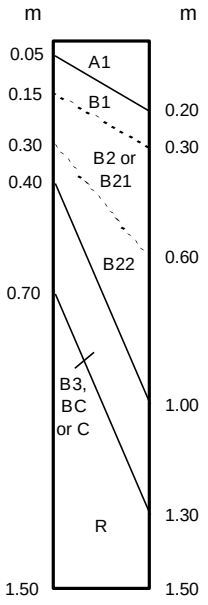
Runoff: Slow to moderately rapid

Permeability: Moderately permeable

Drainage: Moderately well drained

Surface cond: Hard setting or occasionally firm; with <2-20%, sandstone, siltstone or quartz, gravels and cobbles, 2-200 mm.

Profile Description



A1: Dark brown or dark red-brown (10YR 3/3; 7.5YR 3/3, 3/2, 3/4; 5YR 3/3); fine sandy clay loam, clay loam or clay loam fine sandy texture; massive, or weak or moderate, 2 to 20 mm, subangular blocky structure; firm or very firm dry consistence; <2-10%, sandstone, siltstone or quartz gravels, 2-20 mm; pH 6.5 to 7.5. Abrupt or clear to either a B1 or B21 horizon -

B1: (when present) Dark brown or dark red-brown (5YR 3/3; 7.5YR 3/3); light or light medium clay texture; moderate or strong, 2 to 10 mm, subangular blocky structure; very firm dry consistence; <2-10%, sandstone, siltstone or quartz gravels, 2-20 mm; pH 6.5 to 7.5. Clear or gradual to -

B2 or B21: Red-brown, dark red-brown or dark brown (5YR 4/4, 3/3, 3/4; 2.5YR 3/4; 7.5YR 3/4); sometimes <2-10%, dark or red mottles, <5-15 mm; light medium or medium clay texture; strong, 10 to 50 mm, prismatic or subangular blocky structure, often parts to moderate or strong, 2 to 10 mm, subangular blocky primary peds; very firm or strong dry consistence; usually <2-10%, sandstone or siltstone gravels, 2-20 mm; pH 7.5 to 8.0. Clear or gradual to -

B22: (when present) Dark red-brown, dark red or dark brown (2.5YR 3/4, 3/6; 5YR 3/3, 3/4; 7.5YR 3/3); occasionally <2-10%, dark, red, yellow or brown mottles, <5 mm; light medium or medium clay texture; strong, 2 to 20 mm, lenticular or occasionally subangular blocky structure; very firm or strong dry consistence; usually <2-10%, sandstone, siltstone or quartz gravels, 2-20 mm; <2-50%, soft or nodular, calcareous segregations, 2-20 mm; pH 7.5 to 8.5. Abrupt or clear to -

B3 or BC: Dark brown, brown or light olive-brown (7.5YR 4/4, 3/4; 5YR 4/3, 4/4; 10YR 4/3, 5/4; 2.5Y 5/4); usually <2-10%, yellow or dark mottles, < 5mm; light, light medium or sandy medium clay texture; massive or weak or moderate, 2 to 10 mm, subangular blocky structure; very firm dry consistence; 20-90%, weathered sandstone, or siltstone fragments; occasionally <2-10%, soft, calcareous segregations, <2-6 mm; Abrupt or clear to -

C: Weathered sandstone or siltstone fragments, sometimes 2-90%, soft or nodular, calcareous segregations, <2-20 mm.

R: Hard, unweathered sandstone, siltstone or mudstone.

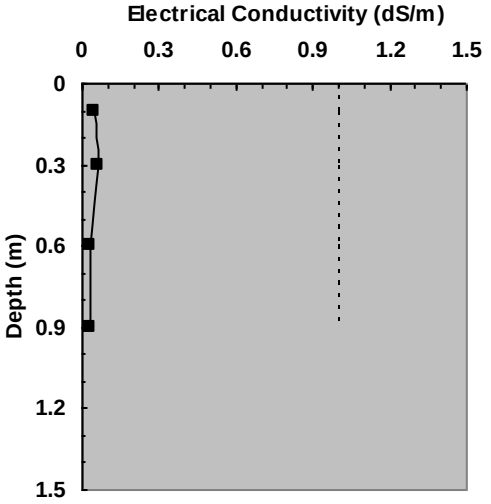
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[(1)] ECEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1	0.1	6.8	.05	.001	14	36	15	34	14	10	2.5	.15	1.0	4.0	1	.42	.41
B_1/B_{21}	0.3	7.0	.06	.001	5	14	5	76	19	15	3.3	.15	.81	4.5	0.8	.26	.25
B_{21}	0.6	7.2	.03	.001	5	15	6	75	19	15	3.2	.34	.53	4.7	2	.24	.23
B_{22}	0.9	7.5	.03	.001	4	18	7	70	19	15	3.3	.55	.47	4.5	3	.27	.27

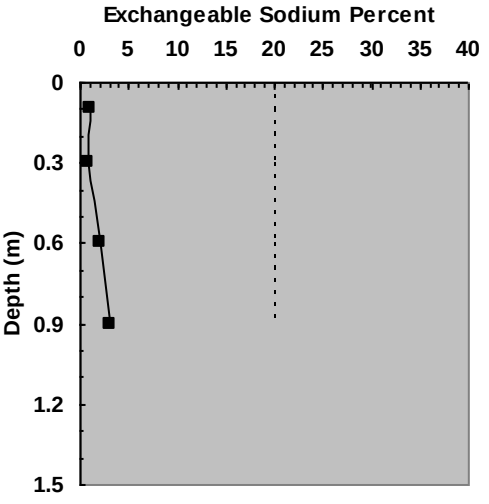
[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0. ECEC = Ca + Mg + Na + K

The topsoil is typically neutral (pH 6.5-7.5), with a neutral to alkaline subsoil depending upon soil depth (pH 7.0-8.5). The surface soil has a moderate clay content (34%) and high fine sand content (36%), which makes it hard setting, crusting and surface sealing. There is a large increase in clay content in the subsoil (76%), therefore showing the strong texture contrast. The CEC is only moderate throughout the profile (14-19 cmol[+] kg^{-1}) which indicates a moderately weathered profile given the extremely high clay content. The cations are very strongly dominated by calcium (Ca/Mg ratios 4-4.7) which is also at moderate levels (10-15 cmol[+] kg^{-1}). The subsoil is non-sodic throughout (ESP <1-3) and is therefore structurally stable, as indicated by the very low dispersion ratios (0.24-0.27), and well drained with very low levels of soluble salts (0.03-0.06 dS/m) due to significant deep drainage. The subsoil CEC:clay ratios of 0.23 to 0.27 indicate a mixed clay mineralogy with significant kaolinite.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Wandoo has a rooting depth range of 0.7 to 1.3 m that is limited only by hard, unweathered bedrock, as subsoil salinity and sodicity are very low and not limiting (see above graphs). These rooting depths result in a PAWC that varies from 80 to 150 mm. The salt graph shows also that there is significant deep drainage below the soil profile as the salt content is very low and has not reached equilibrium (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

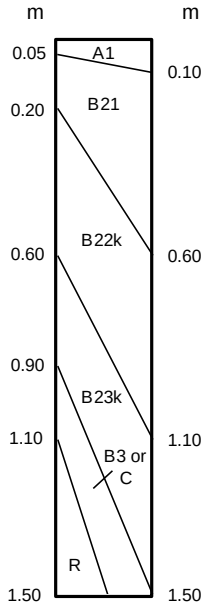
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	11	0.11	1.7	0.93	5	11	3.7
Range	6-19	.08-.17	1.3-2.3	.86-1.0	4-6	10-12	2.4-5.9
No of samples	4	4	4	2	2	4	4
Rating	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate

Although limited by the low number of samples, the trend of these data indicates a moderate fertility. Three of the four phosphorous samples were greater than 10mg/kg, while nitrogen was less consistent, varying from low to high. The mean organic carbon content is also moderate and again demonstrates that lower levels of organic matter accumulate in the topsoil of eucalypt woodland soils compared to softwood scrub or brigalow soils (compare to Mapala and Thalberg soils). Of the other nutrients measured, only sulphur is low (5 mg/kg), but this is based on only two samples.

Woolein (Wn)

Concept: Woolein is a deep or very deep (1.1->1.5 m), red, cracking clay soil with a fine, self-mulching, light or light medium clay topsoil, that overlies a fine, lenticular structured, light medium or medium clay subsoil. Woolein has a neutral or alkaline soil reaction trend and is essentially a deeper, cracking variant of Santo.
Geology: Little weathered, Permian, andesite and spilite of the Camboon andesite (Pln) and Rookwood volcanics (Pr).
Aust Class: Red Vertosol
PPF: Ug5.37, Ug5.39
Landform: Footslopes and pediments with slopes of 1 to 6% of the undulating rises and low hills formed on intermediate volcanic rocks.
Vegetation: Mid-high (6-12 m), open woodland of a silver-leaved ironbark – gum-topped bloodwood association, that has a lower stratum of forest bluegrass, black speargrass and kangaroo grass. Native legumes such as rhynchosia and *Indigofera pratensis* are also present in the ground layer, but only as a minor component. A mid-stratum is normally absent, while corkwood wattle becomes a minor regrowth problem following clearing.
Runoff: Slow to moderately rapid
Permeability: Moderately permeable
Drainage: Moderately well drained
Surface cond: Fine self-mulching (peds 1-2 mm) and periodic cracking; with 2-20%, andesite and quartz, gravels and cobbles, 6-200 mm.

Profile Description



A1: Dark red-brown or dark brown (5YR 3/2, 3/3; 7.5YR 3/4); light or light medium clay texture; strong, 1-2 mm, granular or subangular blocky structure; loose dry consistence; <2-10%, andesite, spilite or quartz gravels, 2-20 mm; pH 6.5 to 8.0. Abrupt to -
B21: Dark red-brown (5YR 3/3, 3/4); light medium or medium clay texture; strong, 5 to 50 mm, subangular blocky or angular blocky structure, sometimes parting to strong, <2-5 mm, primary peds; firm or very firm dry consistence; <2-10%, andesite, spilite or quartz gravels, 2-20 mm; pH 6.5 to 8.0. Gradual to -
B22k: Dark red-brown (2.5YR 3/4; 5YR 3/3, 3/4); light medium or medium clay texture; strong, 2 to 10 mm, lenticular structure; very firm dry consistence; <2%, andesite or spilite gravels, 2-20 mm; usually <2-10%, nodular or soft, calcareous segregations, <2-6 mm; pH 7.5 to 8.5. Gradual to -
B23k: As above except the colour sometimes becomes weak red or dark brown in the lower subsoil (2.5YR 3/4, 4/2; 5YR 3/4, 4/4; 10YR 4/3). Clear to -
B3 or BC: Red-brown, dark red-brown or brown (2.5YR 3/4, 4/4; 5YR 4/4; 7.5YR 5/2); occasionally 10-20%, pale mottles, 5-15 mm; light to medium clay texture; moderate, 2 to 5 mm, subangular blocky or lenticular structure; 10-50%, weathered fragments of andesite or spilite; <2-50%, nodular or soft, calcareous segregations, <2-20 mm; pH 8.0 to 8.5. Abrupt to -
C: The C horizons are composed entirely of weathered andesite or spilite, sometimes 10-20%, soft or nodular, calcareous segregations, 2-6 mm. Abrupt to -
R: Hard, unweathered andesite or spilite.

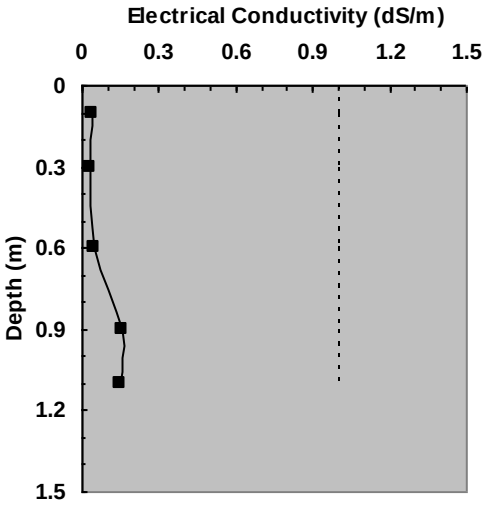
Soil Chemistry

Horizon	Depth (m)	pH 1:5, soil:water	EC dS/m	Cl^- %	Particle Size CS %	FS %	S %	C %	Exchangeable Cations[1] CEC cmol[+] kg^{-1}	Ca	Mg	Na	K	Ca/Mg ratio	ESP	R1 Disp. ratio	CEC: clay ratio
A_1/ B_{21}	0.1	7.3	.04	.001	11	21	15	51	31[2]	17	9.1	.18	.50	1.9	0.6	.41	.60
B_{21}	0.3	7.5	.03	.001	8	18	16	57	29[2]	18	10	.37	.16	1.8	1	.43	.51
B_{22}	0.6	8.1	.05	.001	8	19	14	57	31[2]	17	13	.56	.16	1.3	2	.54	.54
B_{23}	0.9	8.7	.16	.001	10	16	16	58	38	19	15	.68	.12	1.3	2	.49	.66
B_3	1.1	9.0	.15	.002	13	16	13	57	32	17	15	.69	.12	1.1	2	.47	.56

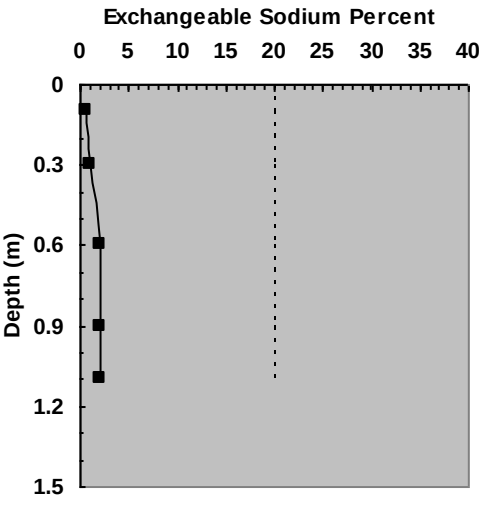
[1] Cations extracted with alcoholic 1M NH_4Cl at pH 8.5 [2] ECEC used to estimate the CEC

The surface soil is typically neutral (pH 6.5-7.5), with an alkaline subsoil (pH 7.5-9.0). Woolein has a very high clay content (51-55%) throughout the profile with also moderate silt (13-16%) and fine sand contents (16-21%). The CEC is high (29-38 cmol[+] kg^{-1}) and is dominated by calcium (Ca/Mg ratios 1.9-1.1), which is also at consistent high levels (17-19 cmol[+] kg^{-1}). The subsoil is non-sodic (ESP <1-2) and is therefore structurally stable, as indicated by the low dispersion ratios (0.41-0.54), and well drained with low levels of soluble salts throughout the profile (0.04-0.16 dS/m) due to significant deep drainage. The CEC:clay ratios of 0.51 to 0.66 indicate a mixed clay mineralogy with significant smectite clay minerals.

Plant Available Water Capacity



Mean profile salt graph



Profile sodicity graph

Woolein has a rooting depth range of 1.1 to 1.5 m, that is limited only by hard, unweathered bedrock, as subsoil salinity and sodicity are very low and not limiting (see above graphs). These rooting depths result in a moderate to high PAWC of 120 to 150 mm. Woolein has also a high water holding capacity per unit depth of soil due to its high clay content. The salt graph shows also that there is significant deep drainage below the soil profile, as soluble salts have not accumulated in the subsoil (i.e. a "salt bulge" is absent due to leaching of salts by deep drainage).

Surface Soil Fertility

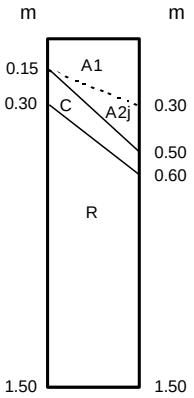
	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Nutrient content	6	0.10	1.5	0.57	16	8.7
No of samples	1	1	1	1	1	1
Rating	Low	Low	Low	Moderate	High	High

The interpretation of these data is limited as Woolein was sampled only at one location. The phosphorous, total nitrogen and organic carbon contents are all significantly lower than the mean levels of Santo, which is a similar soil with identical vegetation on the same parent material. All that can be said is that at this site, Woolein has a low fertility due to its low phosphorous (6 mg/kg) and total nitrogen (0.1%) contents. However, as for all soils formed on intermediate volcanic rocks, Woolein is well supplied with calcium and magnesium (16 and 8.7 cmol[+] kg^{-1} respectively), while the potassium concentration is moderate (0.57 meq%).

Youlambie (Ym)

Concept: Youlambie is a stony, shallow (0.15-0.5 m), black or dark brown, uniform clay loamy soil, occasionally with a sporadically bleached A2 horizon, that directly overlies weathered conglomerate, siltstone or tuff. Youlambie has a neutral soil reaction trend.
Geology: Little weathered, folded, Permian, interbedded conglomerates, siltstones and acid volcanic rocks of the Youlambie conglomerate formation (Ply) of the Yarrol basin.
Aust Class: Leptic Tenosol or Rudosol
PPF: Um1.4, Um3.12
Landform: Crests and hillslopes of the rolling to steep hills that form the foothills of the Calliope Range in the north-eastern area of the Banana study area. These hills have slopes of 5 to 40% and a relief of 40 to 80 m.
Vegetation: Tall (12-20 m), woodland or open woodland of narrow-leaved ironbark, with an open or sparse, low tree (3-6 m), understorey of pretty wattle, quinine berry, canthium and dead finish. The native pastures consist of black speargrass, purple wiregrass and other *Aristida spp.* (wiregrasses).
Runoff: Very rapid
Permeability: Moderately permeable
Drainage: Rapidly drained
Surface cond: Hard setting; with 20-90%, conglomerate, siltstone or tuff, gravels, cobbles and stones, 6-600 mm, and <2-10% rock outcrop.

Profile Description



A1: Black, very dark grey-brown or dark brown (10YR 2/1, 3/2, 3/3, 4/3); fine sandy clay loam, sandy clay loam, clay loam fine sandy or occasionally coarse sand texture; massive or weak, 2 to 5 mm, subangular blocky or polyhedral structure, or single grain for the coarse sands; loose to firm dry consistence;.20-90%, conglomerate, siltstone and tuff, gravels and cobbles, 2-200 mm; pH 6.0 to 7.0. Abrupt to either a C or A2j horizon -
A2j: (when present) Dark grey-brown, dark brown or light grey-brown (10YR 4/2, 4/3; 2.5Y 6/2), with a white dry bleach colour (10YR 8/1); sandy clay loam, fine sandy clay loam or clay loam fine sandy texture; massive structure; firm dry consistence; 20-90%, conglomerate, siltstone or tuff, gravels and cobbles, 2-200 mm; pH 6.5 to 7.0. Abrupt to -
C: The C horizons are composed entirely of weathered conglomerate, siltstone or tuff fragments. Sharp or abrupt to -
R: Hard, unweathered bedrock.

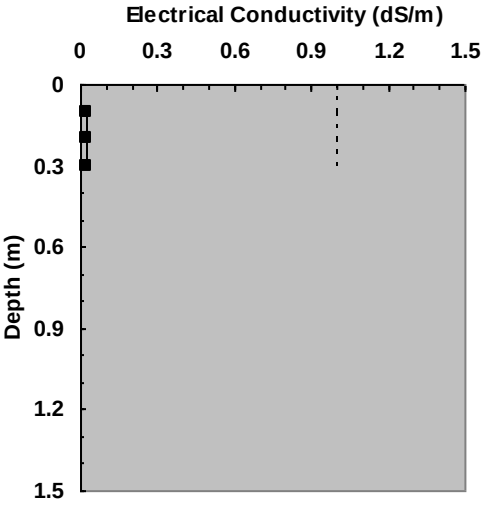
Soil Chemistry

Horizon	Depth (m)	pH EC Cl^- dS/m % 1:5, soil:water	Particle Size CS FS S C %	Exchangeable Cations[(1)] ECEC Ca Mg Na K cmol[+] kg^{-1}	Ca/Mg ratio
A_{11}	0.1	6.5 .02 .001	41 28 9 20	11 6.4 4.1 .07 .54	1.6
$A_{11/12}$	0.2	6.5 .02 .001			
A_{12}	0.3	6.7 .02 .001	40 29 11 20	9 4.6 4.1 1.3 .19	1.1

[(1)] Cations extracted with aqueous 1M NH_4Cl at pH 7.0 ECEC= Ca + Mg + Na +K

Youlambie is typically slightly acidic throughout (pH6.5-7.0), as it a light textured, sandy profile with a clay content of only 20%. It is therefore freely draining and leached with very low levels of soluble salts (0.02 dS/m). The CEC is moderate (9-11 cmol[+] kg^{-1}), which gives Youlambie a moderate capacity to hold nutrients, and the cations are dominated by calcium (Ca/Mg ratios 1.6-1.1) which is also at moderate levels (4.6-6.4 cmol[+] kg^{-1}). The ESP, dispersion and CEC:clay ratios are not relevant at these clay contents.

Plant Available Water Capacity



Mean profile salt graph

Youlambie has a rooting depth range of 0.3 to 0.6 m that is limited only by shallow bedrock as soil salinity and sodicity are negligible (see above graph). The PAWC varies from only 20 to 25 mm for these rooting depths. However the water holding capacity is significantly reduced by the high profile sand and stone contents. The very low salt levels throughout the profile indicate that nearly all water that infiltrates this soil is lost to deep drainage as it is freely draining with a low water holding capacity. The salt profile is therefore typical of a recharge soil.

Surface Soil Fertility

	Bicarb P mg/kg	Total N %	Organic C %	Potassium meq%	Sulphate S mg/kg	Calcium cmol[+] kg^{-1}	Magnesium cmol[+] kg^{-1}
Mean	12	0.11	1.8	0.70	4	6.3	4.0
Range	6-26	.09-.13	1.5-2.6	.62-.79	3-5		
No of samples	7	7	7	7	7	1	1
Rating	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low

Youlambie has moderate surface soil fertility due to its moderate mean phosphorous and total nitrogen contents (12 mg/kg and 0.11% respectively). The mean organic carbon concentration is also moderate (1.8%), which again demonstrates that eucalypt woodland soils accumulate lower levels of organic matter in the surface soil compared to a softwood or brigalow scrub forest (compare to Rundull). Youlambie has also moderate mean potassium (0.7 meq%), calcium (6.3 cmol[+] kg^{-1}) and magnesium (4.0 cmol[+] kg^{-1}) contents, but has consistently low sulphur levels (3-5 mg/kg).

APPENDIX 2. Morphological and analytical data for representative soil profiles

Soil Name: Annandale (An)

Site No: S1 (Ban 2600) **Date Sampled:** 20 October 1996

Location: 238 840 mE 7 338 040 mN ZONE 56

Landscape:

Geology: Tertiary olivine basalt (Tb) **Substrate Lithology:** Basalt

Landform Pattern: Gently undulating rises **Element:** Hillslope

Runoff: Slow **Slope:** 1 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Self-mulching, periodic cracking

Surface Coarse Fragments: Very few (<2%), cobbles (60-200 mm),subrounded, basalt

Classifications:

ASC: Endocalareous, Self-mulching, Black, VERTOSOL **PPF:** Ug5.12

GSG: Black earth

Vegetation:

Upper Stratum: Isolated tall shrubs (regrowth) (1-3 m)
Alstonia constricta (bitter bark); Capparis lasiantha (wait-a-while)

Lower Stratum: Panicum maximum var. maximum

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Black (10YR2/1) moist; medium heavy clay; weak, 5-10mm, polyhedral largest peds parting to weak, 2-5mm, polyhedral next size peds parting to strong, <2mm, polyhedral next size peds; dry; loose; non-calcareous. clear to-
B2	0.05 to 0.45	Black (10YR2/1) moist; medium heavy clay; very few <2%, medium pebbles 6-20mm, subrounded basalt; strong, 10-20mm, lenticular largest peds, parting to strong, 2-5mm, lenticular next size peds; slickensides; moderately moist; firm; non-calcareous. clear to-
BC	0.45 to 0.60	Dark brown (10YR3/3) moist; light clay; abundant 50-90%, large pebbles 20-60 mm, subangular basalt; massive; moderately moist; weak; few 2-20%, medium 2-6 mm, calcareous nodules; abrupt to -
C	0.60 to 0.85	Very abundant >90%, basalt fragments; common 10-20%, coarse 6-20mm, calcareous soft segregations; very highly calcareous. abrupt to –
R	0.85	Hard, unweathered basalt

Effective rooting depth (ERD): 0.85m (bedrock)

Plant Available Water Capacity PAWC): 110 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B2	0	0.1	7.6	0.12	10	3	10	12	71	82	68	13	0.70	0.99			0.9	5.2	0.30	38	1.2	0.058	0.342	0.052
B2	0.1	0.2	7.8	0.18	100																			
	0.2	0.3	7.9	0.12	80	2	13	12	71	87	73	13	0.61	0.33			0.7	5.6	0.30	38	1.2	0.040	0.279	0.035
	0.3	0.4	7.7	0.13	100																			
B2/BC	0.4	0.5	8.0	0.07	10																			
BC	0.5	0.6	8.3	0.19	100	23	36	14	29	63	54	10	0.68	0.17			1	5.4	0.41	22	2.2	0.105	0.510	0.029

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2600	0	0.10B	7.4	2.9	0.28	10	34	25	0.95	26	36	3.7	0.70	18	

Oven dry data @ 105 C

Soil Name: Banana (Bn)

Site No: S2 (BAN 2257) **Date Sampled:** 18 August 1992

Location: 197 225 mE 7 306 780 mN ZONE 56

Landscape:

Geology: Permian siltstone, sandstone and mudstone of the Flat Top Formation (Puf)

Substrate Lithology: Mudstone

Landform Pattern: Gently undulating rises

Element: Plain

Runoff: Slow

Slope: 2.5 %

Drainage: Moderately well drained

Permeability: Slowly permeable

Microrelief: Linear gilgai

Microrelief Component: Mound

Horizontal Interval: 9 m

Vertical Interval: 0.25 m

Surface Coarse Fragments: Common 10-20%, calcareous nodules, 2-6 mm

Surface Condition: Periodic cracking, self-mulching

Classifications:

ASC: Epicalcareous, Self-mulching, Black, VERTOSOL **PPF:** Ug5.12

GSG: Black earth

Vegetation:

Upper Stratum: Mid-high open woodland (6-12 m)
Eucalyptus melanophloia (silver-leaved ironbark)

Lower Stratum: Bothriochloa bladhii (forest bluegrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Black (10YR2/1) moist; medium clay; strong, <2mm, granular; dry; loose; few 2-10%, medium 2-6mm, calcareous nodules. clear to-
B2k	0.05 to 0.90	Very dark grey (10YR3/1) moist; medium clay; few 2-10%, medium pebbles 6-20mm, subangular mudstone; strong, 2-5mm, lenticular; Slickensides; common 10-20%, medium 2-6mm, calcareous nodules. abrupt to-
C	0.90 to 1.30	Very abundant >90%, mudstone fragments.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 200 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
				@40 C	@105 C		@ 105 C				@ 105 C				@ 105 C					@ 105 C		@ 80 C		
A1	0	0.05	7.9	0.18	10	5	18	14	61	63	47	6.9	0.25	1.0			0.4	6.8	0.24	28	1.0	0.030	0.424	0.037
B2k	0.2	0.3	8.4	0.14	10	6	14	14	63	67	53	8.1	0.62	0.41			0.9	6.5	0.24	32	1.1	0.020	0.334	0.028
	0.5	0.6	8.6	0.18	10	7	14	11	66	64	51	10	1.6	0.29			3	5.1	0.33	31	1.0	0.018	0.324	0.023
	0.8	0.9	8.6	0.26	70	6	14	13	65	65	48	11	2.5	0.27			4	4.4	0.32	32	1.0	0.018	0.328	0.022

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2257	0	0.10B	8.2	1.5	0.09	17		6	0.68	13	9.7	1.2	0.90		

Oven dry data @ 105 C

Soil Name: Banana (Bn)

SiteNo: S2 (BAN 859) **Date Sampled:** 09 June 1992

Location: 197 220 mE 7 306 780 mN ZONE 56

Landscape:

Geology: Permian siltstone, sandstone and mudstone of the Flat Top Formation (Puf)

Substrate Lithology: Mudstone

Landform Pattern: Gently undulating rises

Element: Plain

Runoff: Slow

Slope: 2.5 %

Drainage: Moderately well drained

Permeability: Slowly permeable

Microrelief: Linear gilgai

Microrelief Component: Depression

Horizontal Interval: 9 m

Vertical Interval: 0.25 m

Surface Coarse Fragments: No coarse fragments

Surface Condition: Periodic cracking, self-mulching

Classifications:

ASC: Endocalcareous, Self-mulching, Black, VERTOSOL **PPF:** Ug5.12

GSG: Black earth

Vegetation:

Upper Stratum: Mid-high open woodland (6-12 m)

Eucalyptus melanophloia (silver-leaved ironbark); Eucalyptus erythrophloia (gum-topped bloodwood)

Lower Stratum: Bothriochloa bladhii (forest bluegrass); Heteropogon contortus (black speargrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.04	Black (10YR2/1) moist; medium clay; weak, 2-5mm, polyhedral largest peds, parting to strong, <2mm, polyhedral next size peds; dry; loose; non-calcareous. abrupt to-
B21	0.04 to 0.40	Black (7.5YR2/0) moist; medium clay; very few <2%, medium pebbles 6-20mm, subrounded quartz; strong, 2-5mm, lenticular; moist; very weak. diffuse to-
B22	0.40 to 0.70	Black (7.5YR2/0) moist; medium clay; strong, 5-10mm, lenticular; moderately moist; moderately firm. gradual to-
B23	0.70 to 0.90	Black (7.5YR2/0) moist; medium clay; strong, 5-10mm, lenticular; moderately moist; moderately firm; few 2-10%, medium 2-6mm, calcareous nodules, slightly calcareous. gradual to-
B3k	0.90 to 1.10	Very dark grey (10YR3/1) moist; many 20-50%, medium 5-15mm, prominent brown mottles; light medium clay; few 2-10%, medium pebbles 6-20mm, subangular mudstone; strong, 5-10mm, lenticular; dry; very firm; many 20-50%, medium 2-6mm, calcareous nodules, highly calcareous. gradual to-
C	1.10 to 1.40	Very abundant >90%, mudstone fragments; very highly calcareous.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 200 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.04	6.9	0.10	30	4	15	17	63	61	41	8.5	0.35	1.3			0.6	4.8	0.35	30	1.0	0.036	0.558	0.040
B21	0.2	0.3	7.5	0.07	30	1	13	17	67	68	57	8.8	1.3	0.73			2	6.5	0.40	33	1.0	0.022	0.398	0.027
B22	0.5	0.6	7.4	0.36	470	1	13	15	69	69	57	8.3	2.0	0.68			3	6.9	0.36	33	1.0	0.021	0.406	0.030
B23	0.8	0.9	7.9	0.65	800	2	11	16	68	68	55	9.0	2.7	0.72			4	6.1	0.38	34	1.0	0.020	0.426	0.027
C	1.1	1.2	8.5	0.34	180	5	12	13	69	67	51	12	3.1	0.27			5	4.3			1.0	0.017	0.341	0.021

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
859	0	0.10B	7.0	1.7	0.09	19		14	1.3	28	67	2	1.1		

Oven dry data @ 105 C

Soil Name: Bauhinia (Ba)

Site No: S3 (BAN 2263) **Date Sampled:** 30 January 1992

Location: 201 305 mE 7 295 200 mN ZONE 56

Landscape:

Geology: Permian siltstone, sandstone and mudstone of the Gyranda formation (Puy) **Substrate Lithology:** Siltstone

Landform Pattern: Gently undulating plains **Element:** Plain

Runoff: Slow **Slope:** 1.5 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Linear gilgai **Microrelief Component:** Depression

Horizontal Interval: 7 m **Vertical Interval:** 0.10 m

Surface Coarse Fragments: Very few <2%, small pebbles 2-6mm, subrounded quartz **Surface Condition:** Periodic cracking, self-mulching

Classifications:

ASC: Endocalcareous, Self-mulching, Black VERTOSOL **PPF:** Ug5.12

GSG: Black earth

Vegetation:

Upper Stratum: Mid-high (6-12 m) isolated clumps of trees

Lysiphyllum hookeri (white flowered bauhinia); Geijera parviflora (wilga)

Lower Stratum: Bothriochloa decipiens (pitted bluegrass); Digitaria species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Very dark grey (10YR3/1) moist; medium clay; strong, <2mm, granular.
B2	0.05 to 1.20	Very dark grey (10YR3/1) moist; medium clay; strong, 2-5mm, lenticular; very few <2%, calcium carbonate nodules, 2-6 mm.
B3	1.20 to 1.45	Very dark grey (10YR3/1) moist; light medium clay; many 20-50%, medium pebbles 6-20mm, angular siltstone.
C	1.45 to 1.55	Very abundant >90%, weathered siltstone fragments.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 145 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.05	8.4	0.09	10	10	26	19	47	36	28	8.8	0.35	0.74			1	3.2	0.49	17	0.77	0.030	0.182	0.031
B2	0.2	0.3	8.4	1.60	90	7	22	22	50	37	27	10	1.8	0.15			5	2.7	0.44	20	0.74	0.026	0.175	0.354
	0.5	0.6	8.3	0.36	370	6	20	21	55	43	31	14	3.9	0.34			9	0.2	0.54	23	0.78	0.022	0.134	0.027
	0.8	0.9	8.7	0.58	700	6	20	21	56	43	28	14	4.7	0.29			11	2.0	0.60	23	0.77	0.020	0.132	0.034
	1.1	1.2	8.8	0.62	710	5	20	18	60	39	28	15	5.2	0.18			13	1.9			0.65	0.020	0.143	0.031
B3/C	1.4	1.5	8.7	0.51	560	2	23	22	54	44	26	14	5.1	0.07			12	1.9	0.79	19	0.81	0.013	0.407	0.022

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2263	0	0.10B	7.9	1.3	0.10	13		2	0.47	7.2	17	1.2	0.25		5

Oven dry data @ 105 C

Soil Name: Bauhinia (Ba)

Site No: S3 (BAN 474) **Date Sampled:** 24 July 1991

Location: 201 300 mE 7 295 200 mN ZONE 56

Landscape:

Geology: Permian siltstone, sandstone and mudstone of the Gyranda formation (Puy) **Substrate Lithology:** Siltstone

Landform Pattern: Gently undulating rises **Element:** Plain

Runoff: Slow **Slope:** 1.5 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Linear gilgai **Microrelief Component:** Mound

Horizontal Interval: 7 m **Vertical Interval:** 0.10 m

Surface Coarse Fragments: Very few <2%, small pebbles 2-6mm, subrounded quartz **Surface Condition:** Periodic cracking, surface flake

Classifications:

ASC: Epicalcareous, Self-mulching, Black, VERTOSOL **PPF:** Ug5.12

GSG: Black earth

Vegetation:

Upper Stratum: Mid-high (6-12 m) isolated clumps of trees

Lysiphyllum hookeri (white flowered bauhinia); Geijera parviflora (wilga)

Lower Stratum: Bothriochloa decipiens (pitted bluegrass); Digitaria species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Very dark grey (10YR3/1) moist; medium clay; very few <2%, small pebbles 2-6mm, subrounded quartz; strong, <2mm, subangular blocky; dry; loose; very few <2%, medium 2-6mm, calcareous nodules, non-calcareous. abrupt to-
B21	0.05 to 0.50	Very dark grey (10YR3/1) moist; medium clay; very few <2%, small pebbles 2-6mm, subrounded quartz, very few <2%, medium pebbles 6-20mm, subrounded quartz; strong, 2-5mm, lenticular; moderately moist; moderately weak; very few <2%, medium 2-6mm, calcareous nodules, non-calcareous. diffuse to-
B22	0.50 to 1.16	Very dark grey (10YR3/1) moist; medium heavy clay; very few <2%, small pebbles 2-6mm, subrounded quartz; strong, 5-10mm, lenticular; moderately moist; moderately firm; few 2-10%, medium 2-6mm, calcareous nodules and very few <2%, coarse 6-20mm, calcareous nodules, slightly calcareous. gradual to-
B3	1.16 to 1.46	Light olive brown (2.5Y5/4) moist; medium clay; many 20-50%, medium pebbles 6-20mm, angular siltstone; weak, 5-10mm, subangular blocky; dry; very firm; very few <2%, medium 2-6mm, calcareous soft segregations, non-calcareous. abrupt to –
C	1.46 to 1.55	Very abundant >90%, weathered siltstone fragments.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 145 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.05	7.9	0.07	10	11	27	18	44	33	28	10	0.41	0.65			1	2.8	0.44	16	0.75	0.028	0.154	0.029
B21	0.2	0.3	9.0	0.16	10	10	22	17	49	36	31	12	2.0	0.54			6	2.6	0.51	20	0.73	0.021	0.108	0.021
B22	0.5	0.6	9.0	0.34	180	10	23	17	51	38	26	15	4.0	0.18			11	1.7	0.62	21	0.75	0.021	0.114	0.024
	0.8	0.9	9.0	0.46	300	9	21	19	52	40	24	16	4.9	0.19			12	1.5	0.63	21	0.77	0.021	0.123	0.032
B22/B3	1.1	1.2	9.0	0.47	330	6	22	20	56	40	26	16	5.5	0.17			14	1.6			0.71	0.021	0.673	0.029
B3/C	1.4	1.5	9.2	0.37	290	4	34	22	41	33	21	10	4.8	0.03			15	2.1	0.71	16	0.80	0.015	0.670	0.018

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
474	0	0.10B	7.9	1.0	0.07	14		2		7.7	19	1.2	0.52		4

Oven dry data @ 105 C

Soil Name: Belldeen (Bd)

Site No: S4 (BAN 190) **Date Sampled:** 02 November 1990

Location: 219 800 mE 7 300 800 mN ZONE 56

Landscape:

Geology: Permian andesite, basaltic and trachytic lava, tuff etc of the Camboon Andesite (Pln) **Substrate Lithology:** Andesite

Landform Pattern: Gently undulating rises **Element:** Hillslope

Runoff: Moderately rapid **Slope:** 3 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Linear gilgai **Microrelief Component:** Depression

Horizontal Interval: 5 m **Vertical Interval:** 0.10 m

Surface Coarse Fragments: Very few <2%, medium pebbles 6-20mm, subangular andesite **Surface Condition:** Surface flake, periodic cracking

Classifications:

ASC: Endocalcareous, Epipedal, Black, VERTOSOL **PPF:** Ug5.13

GSG: Black earth

Vegetation:

Upper Stratum: Mid-high open woodland (6-12 m)

Eucalyptus melanophloia (silver-leaved ironbark); Eucalyptus erythrophloia (gum-topped bloodwood)

Lower Stratum: Bothriochloa bladhii (forest bluegrass); Heterpogon contortus (black speargrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.04	Very dark grey (10YR3/1) moist, dark grey (10YR4/1) dry; no mottles; light medium clay; strong, 2-5mm, subangular blocky; dry; firm; non-calcareous. clear to-
B21	0.04 to 0.25	Very dark grey (10YR3/1) moist; medium clay; very few <2%, medium pebbles 6-20mm, subangular andesite; strong, 10-20mm, subangular blocky; dry; very firm; few 2-10%, fine <2mm, manganiferous nodules, non-calcareous.gradual to-
B22	0.25 to 0.60	Black (7.5YR2/0) moist; medium clay; few 2-10%, small pebbles 2-6mm, subangular andesite; strong, 2-5mm, lenticular; dry; very firm; very few <2%, fine <2mm, manganiferous nodules, non-calcareous. diffuse to-
B23	0.60 to 0.90	Very dark grey (10YR3/1) moist; medium clay; few 2-10%, small pebbles 2-6mm, subangular andesite; strong, 2-5mm, lenticular; dry; very firm; few 2-10%, medium 2-6mm, calcareous concretions, non-calcareous. clear to-
B24	0.90 to 1.00	Dark brown (7.5YR3/4) moist; common 10-20%, medium 5-15mm, distinct, dark mottles; medium clay; few 2-10%, medium pebbles 6-20mm, subangular andesite; strong, 5-10mm, lenticular; dry; moderately strong; few 2-10%, medium 2-6mm, calcareous concretions, moderately calcareous. clear to-
B3k	1.00 to 1.12	Dark yellowish brown (10YR4/4) moist; medium heavy clay; many 20-50%, large pebbles 20-60mm, subangular andesite; moderate, 2-5mm, subangular blocky; moderately moist; very firm; common 10-20%, medium 2-6mm, calcareous nodules, moderately calcareous, common 10-20%, medium 2-6mm, manganiferous soft segregations. gradual to-
C	1.12 to 1.50	Very abundant >90%, andesite fragments.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 180 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.05	7.2	0.06	10	5	18	23	52	54	24	17	0.37	1.3			0.7	1.4	0.56	22	1.0	0.052	0.526	0.044
B21/B22	0.2	0.3	8.4	0.06	10	3	13	21	63	56	32	20	1.0	0.30			2	1.6	0.53	26	0.89	0.030	0.399	0.024
B22	0.5	0.6	8.6	0.20	170	3	12	21	63	58	29	26	2.3	0.28			4	1.1	0.58	27	0.92	0.025	0.371	0.025
B23	0.8	0.9	8.8	0.43	400	7	13	23	57	51	24	25	2.6	0.27			5	1.0	0.59	25	0.89	0.032	0.347	0.023

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
190	0	0.10B	7.2	2.4	0.17	14		4	0.91	22	52	2.0	4		7

Oven dry data @ 105 C

Soil Name: Belldeen (Bd)

Site No: S4 (BAN 189) **Date Sampled:** 02 November 1990

Location: 219 800 mE 7 300 800 mN ZONE 56

Landscape:

Geology: Permian andesite, basaltic and trachytic lava, tuff etc of the Camboon Andesite **Substrate Lithology:** Andesite

Landform Pattern: Gently undulating rises **Element:** Hillslope

Runoff: Moderately rapid **Slope:** 3 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Linear gilgai **Microrelief Component:** Mound

Horizontal Interval: 5 m **Vertical Interval:** 0.10 m

Surface Coarse Fragments: Few 2-10 %, large pebbles 20-60 mm, subangular andesite; few 2-10%, 2-6 mm, calcareous nodules **Surface Condition:** Periodic cracking, self-mulching

Classifications:

ASC: Epicalcareous, Self-mulching, Black, VERTOSOL **PPF:** Ug5.12

GSG: Black earth

Vegetation:

Upper Stratum: Mid-high open woodland (6-12 m)
Eucalyptus melanophloia (silver-leaved ironbark); Eucalyptus erythrophloia (gum-topped bloodwood)

Lower Stratum: Bothriochloa bladhii (forest bluegrass); Heterpogon contortus (black speargrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Very dark grey (10YR3/1) moist; medium clay; very few <2%, small pebbles 2-6mm, subangular andesite; moderate, 5-10mm, subangular blocky largest peds, parting to strong, <2mm, subangular blocky next size peds; dry; loose; few 2-10%, medium 2-6mm, calcareous nodules. abrupt to-
B21	0.05 to 0.20	Very dark grey (10YR3/1) moist; medium clay; very few <2%, medium pebbles 6-20mm, subangular andesite; strong, 2-5mm, lenticular; dry; moderately strong; few 2-10%, medium 2-6mm, calcareous nodules. gradual to-
B22k	0.20 to 0.90	Very dark grey (10YR3/1) moist; medium clay; few 2-10%, medium pebbles 6-20mm, subangular andesite; strong, 5-10mm, lenticular; moderately moist; very firm; common 10-20%, medium 2-6mm, calcareous nodules. Clear to –
C	0.90 to 1.50	Very abundant >90%, weathered andesite fragments.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 180 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.05	8.6	0.16	10	7	15	19	57	53	31	17	1.0	1.1			2	1.8	0.50	22	0.93	0.043	0.474	0.034
B22k	0.2	0.3	8.9	0.15	20	5	14	19	61	54	27	22	1.1	0.26			2	1.2	0.50	25	0.89	0.031	0.386	0.025
	0.5	0.6	9.0	0.27	170	6	14	19	60	51	22	28	2.4	0.20			5	0.8	0.56	26	0.85	0.027	0.384	0.022
	0.8	0.9	8.9	0.49	500	8	13	19	58	49	18	27	3.0	0.23			6	0.7	0.55	25	0.84	0.029	0.367	0.023

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
189	0	0.10B	8.6	1.5	0.12	13		2	0.64	7.2	6.9	1.3	4.7		7

Oven dry data @ 105 C

Soil Name: Benn (Be)

Site No: S5 (BAN 584) **Date Sampled:** 01 November 1991

Location: 219 720 mE 7 291 920 mN ZONE 56

Landscape:

Geology: Permian sandstone, siltstone and mudstone of the Barfield Formation (Pur)

Substrate Lithology: Sandstone

Landform Pattern: Rolling low hills

Element: Hillslope

Runoff: Rapid

Slope: 8 %

Drainage: Moderately well drained

Permeability: Very slowly permeable

Microrelief: Zero or none

Surface Condition: Hard setting

Surface Coarse Fragments: Common 10-20%, cobbles 60-200mm, subangular sandstone

Classifications:

ASC: Eutrophic, Mottled-Subnatric, Black, SODOSOL **PPF:** Dd2.32

GSG: Affinities with solodized solonetz

Vegetation:

Upper Stratum: Mid-high open woodland (6-12 m)
Eucalyptus melanophloia (silver-leaved ironbark)

Mid Stratum: Acacia decora (pretty wattle); Archidendropsis basaltica (dead finish)

Lower Stratum: Bothriochloa decipiens (pitted bluegrass); Brachiaria gilesii

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.14	Dark brown (10YR3/3) moist; sandy loam; few 2-10%, medium pebbles 6-20mm, subangular sandstone; massive; dry; weak; non-calcareous. clear to-
A2j	0.14 to 0.20	Brown (10YR5/3) moist, white (10YR8/1) dry; sandy loam; common 10-20%, medium pebbles 6-20mm, subangular sandstone; weak, 2-5mm, subangular blocky; dry; weak; non-calcareous. sharp to-
B2	0.20 to 0.50	Very dark greyish brown (2.5Y3/2) moist; many 20-50%, medium 5-15mm, distinct dark mottles; medium clay; few 2-10%, small pebbles 2-6mm, subangular sandstone; strong, 50-100mm, columnar largest peds, parting to strong, 10-20mm, angular blocky next size peds; dry; very strong; non-calcareous. clear to-
C	0.50 to 0.75	Very abundant >90%, weathered sandstone fragments. abrupt to-
R	0.75	Hard, unweathered sandstone parent material.

Effective rooting depth (ERD): 0.7 m (bedrock)

Plant Available Water Capacity PAWC): 70 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.9	0.04	20	24	53	10	15	9	5.7	1.8	0.24	1.1			3	3.2	0.58	7	0.60	0.040	1.890	0.032
B2	0.2	0.3	7.9	0.11	50	9	27	10	56	20	8.0	7.1	2.7	1.6			14	1.1	0.85	19	0.36	0.029	2.820	0.024

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
584	0	0.10B	6.6	1.2	0.08	15		2	1	27	7.0	0.16	1		2

Oven dry data @ 105 C

Soil Name: Bertha (Bt)

Site No: S6 (BAN 1481) **Date Sampled:** 19 August 1993

Location: 228 000 mE 7 293 160 mN ZONE 56

Landscape:

Geology: Granodiorite, tonalite, adamellite and diorite of the Glandore Granodiorite (Cul)

Substrate Lithology: Adamellite

Landform Pattern: Steep hills

Element: Hillslope

Runoff: Rapid

Slope: 15 %

Drainage: Well drained

Permeability: Highly permeable

Microrelief: Zero or none

Surface Condition: Firm

Surface Coarse Fragments: Many 20-50%, cobbles 60-200mm, angular adamellite

Classifications:

ASC: Basic, Paralithic, Orthic, TENOSOL **PPF:** Um5.51

GSG: No suitable group

Vegetation:

Upper Stratum: Tall open forest (12-20 m)
Eucalyptus crebra (narrow-leaved ironbark)

Mid Stratum: Acacia leiocalyx (black wattle)

Lower Stratum: Eragrostis tenufolia; Cymbopogon refractus (barbwire grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.26	Very dark brown (10YR2/2) moist; sandy clay loam; common 10-20%, large pebbles 20-60mm, angular adamellite, common 10-20%, medium pebbles 6-20mm, subangular adamellite; weak, 5-10mm subangular blocky; dry; moderately weak; non-calcareous. clear to-
B2	0.26 to 0.47	Dark yellowish brown (10YR4/4) moist, light yellowish brown (10YR6/4) dry; sandy clay loam; few 2-10%, cobbles 60-200mm, angular adamellite; massive; dry; moderately firm; non-calcareous. diffuse to-
BC1	0.47 to 0.76	Light brown (7.5YR6/4) moist, very pale brown (10YR8/3) dry; many 20-50%, fine <5mm, prominent, brown mottles; sandy clay loam; many 20-50%, medium pebbles 6-20mm, subangular adamellite; massive; dry; very firm; non-calcareous. clear to-
BC2	0.76 to 0.90	Light yellowish brown (10YR6/4) moist, very pale brown (10YR8/3) dry; common 10-20%, fine <5mm, prominent, brown mottles; sandy clay loam; common 10-20%, medium pebbles 6-20mm, subangular adamellite; massive; dry; very firm; non-calcareous.

Effective rooting depth (ERD): 0.5 m (Ca < 0.2cmol[+] kg-1)

Plant Available Water Capacity PAWC): 35 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.1	0.03	10	40	24	21	16	7	4.8	1.6	0.08	0.60			1	3.0	0.73	8	0.44	0.024	3.09	0.039
A1/B2	0.2	0.3	5.8	0.01	10	30	25	27	20	4	0.61	1.9	0.12	0.23	1.1	1.2	3	0.32	0.76	8	0.20	0.019	2.84	0.024
BC1	0.5	0.6	5.9	0.01	10	20	23	31	27	6	0.22	3.0	0.25	0.18	2.5	2.7	4	0.07	0.79	10	0.22	0.018	2.77	0.022
BC2	0.8	0.9	6.2	0.02	10	25	25	24	27	8	0.15	7.6	0.69	0.26			9	0.02	0.68	10	0.30	0.017	4.04	0.020

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1481	0	0.10B	6.6	2.7	0.12	23		4	0.60	28	31	0.14	0.67		

Oven dry data @ 105 C

Soil Name: Bluff (Bf)

Site No: S7 (BAN 1818) **Date Sampled:** 24 May 1994

Location: 220 140 mE 7 317 540 mN ZONE 56

Landscape:

Geology: Deeply weathered undifferentiated Tertiary sandstones and siltstones (Ta)

Substrate Lithology: Siltstone

Landform Pattern: Rolling low hills

Element: Hillslope

Runoff: Moderately rapid

Slope: 25 %

Drainage: Moderately well drained

Permeability: Slowly permeable

Microrelief: Zero or none

Surface Condition: Firm

Surface Coarse Fragments: Many 20-50%, cobbles 60-200mm, subangular siltstone

Classifications:

ASC: Reticulate, Magnesic-Natric, Red, KUROSOL **PPF:** Dr5.11

GSG: No suitable group

Vegetation:

Upper Stratum: Very tall woodland (20-35 m)

Eucalyptus crebra (narrow-leaved ironbark); Acacia rhodoxlon (rosewood)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.13	Very dark brown (10YR2/2) moist; loam, fine sandy; common 10-20%, cobbles 60-200mm, subangular siltstone, common 10-20%, medium pebbles 6-20mm, subangular siltstone; weak, 5-10mm, subangular blocky; dry; moderately firm; non-calcareous. abrupt to-
B1	0.13 to 0.24	Dark greyish brown (10YR4/2) moist; light medium clay; common 10-20%, cobbles 60-200mm, subangular siltstone, common 10-20%, medium pebbles 6-20mm, subangular siltstone; moderate, 5-10mm, polyhedral; dry; moderately firm; non-calcareous. abrupt to-
B2	0.24 to 0.56	Reddish brown (5YR4/4) moist; many 20-50%, medium 5-15mm, distinct dark mottles; medium clay; common 10-20%, medium pebbles 6-20mm, subangular siltstone; strong, 2-5mm, polyhedral; dry; moderately weak; non-calcareous. gradual to-
BC	0.56 to 0.95	Pinkish grey (7.5YR7/2) moist; many 20-50%, medium 5-15mm, prominent brown mottles; light medium clay; common 10-20%, medium pebbles 6-20mm, angular siltstone; dry; non-calcareous. clear to-
C	0.95 to 1.10	White (5Y8/1) moist; common 10-20%, medium 5-15mm, prominent red mottles, few 2-10%, fine <5mm, prominent brown mottles; very abundant >90%, siltstone fragments; non-calcareous.

Effective rooting depth (ERD): 0.1 m (pH < 5.0)

Plant Available Water Capacity PAWC): 15 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	4.3	0.09	30	34	29	17	19	6	0.70	1.3	0.15	0.40	2.9	3.2	3	0.54	0.51	10	0.32	0.032	0.455	0.069
A1/B1	0.1	0.2	4.7	0.03	10																			
B1/B2	0.2	0.3	4.7	0.07	40	9	20	15	60	10	0.07	2.9	0.53	0.19	6.7	6.7	5	0.02	0.64	19	0.17	0.025	0.832	0.048
B2	0.3	0.4	4.6	0.14	130	12	14	14	63	11	0.03	3.3	0.99	0.13	6.6	6.6	9	0.009	0.69	19	0.17	0.024	0.821	0.053
	0.4	0.5	4.4	0.24	260																			
B2/BC	0.5	0.6	4.3	0.38	440	2	4	4	89	15	0.02	4.7	2.5	0.10	7.3	7.4	17	0.004	0.57	24	0.17	0.026	1.010	0.054
BC	0.6	0.7	4.3	0.43	510																			
	0.7	0.8	4.2	0.47	500																			
	0.8	0.9	4.1	0.49	550	1	2	7	89	13	0.02	4.0	3.0	0.14	6.0	6.0	23	0.005	0.50	24	0.15	0.035	1.010	0.065
BC/C	0.9	1.0	4.1	0.54	630																			

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1818	0	0.10B	5.3	4.6	0.15	31		9	0.47	237	4.5	0.28	1		

Oven dry data @ 105 C

Soil Name: Bonwell (Bw)

Site No: S8 (BAN 511) **Date Sampled:** 13 February 1992

Location: 204 000 mE 7 299 500 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial sediments (Cza) **Substrate Lithology:** Unconsolidated Cainozoic alluvial-colluvial sediments

Landform Pattern: Gently undulating rises **Element:** Hillslope

Runoff: Slow **Slope:** 2 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Firm

Surface Coarse Fragments: Few 2-10%, medium pebbles 6-20 mm, subangular quartz

Classifications:

ASC: Haplic, Calcic, Red, DERMOSOL **PPF:** Uf6.31

GSG: Affinities with a Euchrozem

Vegetation:

Upper Stratum: Remnant trees only
Eucalyptus cambageana (coowarra box)

Mid Stratum: Acacia harpophylla (brigalow); Alectryon diversifolium (holly bush)

Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.15	Dark reddish brown (5YR3/3) moist; light clay; few 2-10%, small pebbles 2-6mm, subangular quartz, very few <2%, small pebbles 2-6mm, subangular detrital sedimentary rock (unidentified); strong, 2-5mm, subangular blocky; dry; moderately firm; non-calcareous. gradual to-
B21	0.15 to 0.35	Dark reddish brown (5YR3/4) moist; light clay; common 10-20%, medium pebbles 6-20mm, subangular quartz, common 10-20%, large pebbles 20-60mm, subangular quartz; strong, 2-5mm, subangular blocky; dry; very firm; non-calcareous. gradual to-
B22	0.35 to 0.60	Dark reddish brown (5YR3/4) moist; light medium clay; very few <2% small pebbles 2-6mm, subangular siltstone; strong, 10-20mm, prismatic largest peds, parting to strong, 10-20mm, angular blocky next size peds; dry; moderately strong; non-calcareous. gradual to-
B23k	0.60 to 1.00	Brown (7.5YR4/4) moist; light clay; few 2-10%, medium pebbles 6-20mm, subangular quartz; strong, 2-5mm, subangular blocky; dry; moderately strong; common 10-20%, coarse 6-20mm, calcareous soft segregations, common 10-20%, coarse 6-20mm, calcareous nodular segregations, very highly calcareous.
B23k	1.00	Auger refusal due to calcareous nodules.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 120 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water pH @40 C	1:5 Soil/Water EC (dS/m) @40 C	1:5 Soil/Water Cl⁻ (mg/kg) @105 C	Particle Size (%) Coarse Sand @ 105 C	Fine Sand @ 105 C	Silt @ 105 C	Clay @ 105 C	Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg⁻¹) CEC @ 105 C	Ca @ 105 C	Mg @ 105 C	Na @ 105 C	K @ 105 C	Exchange Acidity (meq/100g) Al @ 105 C	Exchange Acidity (meq/100g) H⁺ @ 105 C	Cation Dominance ESP (%)	Cation Dominance Ca/Mg Ratio	Dispersion R1 Ratio	Moisture (%) 15 Bar @ 105 C	Clay Mineralogy CEC/Clay Ratio	Total Elements (%) P @ 80 C	K @ 80 C	S @ 80 C
A1	0	0.1	8.3	0.11	20	11	36	17	41	25	20	3.8	0.14	1.5			0.6	5.3	0.33	14	0.61	0.083	0.856	0.065
B21	0.2	0.3	8.6	0.09	10	9	29	13	53	25	20	6.3	0.18	1.0			0.7	3.2	0.35	16	0.47	0.042	0.758	0.026
B22	0.5	0.6	9.0	0.13	10	12	24	22	43	20	10	9.4	0.26	0.57			1.3	1.1	0.43	13	0.47	0.043	0.639	0.044
B23k	0.8	0.9	9.2	0.15	10	11	26	24	41	17	6.6	11	0.38	0.60			2.2	0.6	0.58	11	0.41	0.041	0.728	0.027

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg) Acid P	Extr. P (mg/kg) Bicarb. P	Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg) Fe	Mn	Cu	Zn	Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
511	0	0.10B	8.1	2.5	0.19	13		44	1.4	11	23	1.7	2.0		2

Oven dry data @ 105 C

Soil Name: Bundalba (Bb)

Site No: S9 (BAN 2502) **Date Sampled:** 13 June 1995

Location: 241 070 mE 7 342 710 mN ZONE 56

Landscape:

Geology: Undifferentiated, Devonian andesitic lava, tuff and siltstone (Du)

Substrate Lithology: Acid volcanic rock (unidentified)

Landform Pattern: Gently undulating rises

Element: Hillslope

Runoff: Slow

Slope: 3 %

Drainage: Imperfectly drained

Permeability: Very slowly permeable

Microrelief: Zero or none

Surface Condition: Hard setting

Surface Coarse Fragments: Few 2-10 % cobbles 60-200mm, subangular volcanic rocks (unidentified)

Classifications:

ASC: Vertic, Mottled-Mesonatric, Grey, SODOSOL **PPF:** Dy3.33

GSG: Solodized solonetz

Vegetation:

Upper Stratum: Eucalyptus populnea (poplar box); Eucalyptus melanophloia (silver-leaved ironbark)

Mid Stratum: Canthium oleifolium (myrtle tree); Eremophila mitchellii (false sandalwood)

Lower Stratum: Bothriochloa decipiens (pitted bluegrass); Bothriochloa bladhii (forest bluegrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.15	Dark brown (10YR3/3) moist; clay loam, fine sandy; few 2-10%, small pebbles 2-6mm, subangular acid volcanic rocks, few 2-10%, medium pebbles 6-20mm, subangular acid volcanic rocks; weak, 2-5mm, subangular blocky. clear to-
A2j	0.15 to 0.20	Brown (10YR5/3) moist, white (10YR8/2) dry; clay loam, fine sandy; common 10-20%, medium pebbles 6-20mm, subangular acid volcanic rocks, few 2-10%, large pebbles 20-60mm, subrounded quartz; weak, 2-5mm, subangular blocky. sharp to-
B21	0.20 to 0.40	Dark greyish brown (2.5Y4/2) moist; many 20-50%, medium 5-15mm, prominent brown mottles; medium clay; very few <2%, medium pebbles 6-20mm, subangular acid volcanic rocks; strong, columnar, largest peds, parting to strong, 10-20mm, lenticular next size peds. clear to-
B22	0.40 to 0.60	Brown (7.5YR4/4) moist; medium clay; very few <2%, small pebbles 2-6mm, angular acid volcanic rocks; strong, 10-20mm, lenticular; very few <2%, coarse 6-20mm, calcareous soft segregations. abrupt to -
C	0.60 to 0.70	Very abundant >90%, acid volcanic rock fragments; few 2-10%, coarse 6-20mm, calcareous soft segregations. sharp to-
R	0.70	Hard, unweathered acid volcanic rock (unidentified).

Effective rooting depth (ERD): 0.7 m (bedrock)

Plant Available Water Capacity PAWC): 80 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.4	0.03	10	30	35	12	23	13	9.3	1.4	0.05	0.21			0.4	6.6	0.57	7	0.57	0.025	0.506	0.019
A1/A2j	0.1	0.2	8.0	0.04	10																			
B21	0.2	0.3	8.6	0.10	20	11	11	7	68	30	15	10	2.2	0.13			7	1.5	0.47	24	0.44	0.012	0.358	0.017
	0.3	0.4	8.8	0.12	20	10	11	7	69	27	14	12	2.6	0.13			10	1.2	0.54	23	0.39	0.014	0.370	0.019
B22	0.4	0.5	8.9	0.17	30																			
	0.5	0.6	9.0	0.28	40	15	15	10	58	27	11	11	3.0	0.11			11	1.0	0.61	19	0.47	0.013	0.435	0.039

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2502	0	0.10B	6.5	1.5	0.09	17	11	8	0.56	27	38	0.80	1.1	4	

Oven dry data @ 105 C

Soil Name: Callide (Cd)

Site No: S10 (BAN 2099) **Date Sampled:** 08 March 1995

Location: 241 580 mE 7 307 090 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa)

Substrate Lithology: Unconsolidated Quaternary alluvium

Landform Pattern: Level plain

Element: Plain

Runoff: Very slow

Slope: 0 %

Drainage: Moderately well drained

Permeability: Slowly permeable

Microrelief: Zero or none

Surface Condition: Surface crust, hard setting

Surface Coarse Fragments: No coarse fragments

Classifications:

ASC: Melanic, Hypocalcic, Black, DERMOSOL **PPF:** Dd1.12

GSG: No suitable group

Vegetation: Cleared

Profile Morphology:

Horizon	Depth (m)	Description
AP	0.00 to 0.20	Very dark brown (10YR2/2) moist; silty clay loam; massive; moist; moderately weak; non-calcareous. abrupt to-
B21	0.20 to 0.40	Black (10YR2/1) moist; silty light medium clay; strong, 5-10mm, subangular blocky largest peds, parting to strong, 2-5mm subangular blocky next size peds; dry; very firm; non-calcareous. clear to-
B22	0.40 to 0.95	Very dark brown (10YR2/2) moist; silty light medium clay; strong, 10-20mm, angular blocky; dry; moderately strong; non-calcareous. gradual to-
B3	0.95 to 1.35	Very dark greyish brown (10YR3/2) moist; silty light medium clay; massive; moderately moist; moderately weak; very few <2%, fine <2mm, calcareous soft segregations, non-calcareous. clear to-
D	1.35 to 1.55	Brown (10YR4/3) moist; clay loam, fine sandy; massive; moderately moist; moderately weak; very few <2%, fine <2mm, calcareous soft segregations, non-calcareous.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 120 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
AP	0	0.1	7.0	0.21	70	2	34	35	32	26	14	6.0	0.53	0.22			2	2.3	0.61	13	0.81	0.076	1.23	0.022
	0.1	0.2	7.3	0.19	60																			
B21	0.2	0.3	7.5	0.13	30	2	35	30	40	29	16	6.9	0.80	0.57			3	2.3	0.54	15	0.73	0.068	1.21	0.023
	0.3	0.4	7.6	0.10	30																			
B22	0.4	0.5	7.7	0.10	40																			
	0.5	0.6	7.7	0.11	50	2	39	23	40	28	18	7.0	1.4	0.26			5	2.6	0.64	15	0.70	0.076	1.13	0.020
	0.6	0.7	7.7	0.13	70																			
	0.7	0.8	7.7	0.14	90																			
	0.8	0.9	7.8	0.18	140	10	43	19	33	25	17	6.4	1.0	0.20			4	2.7	0.56	12	0.76	0.064	1.12	0.015
B22/B3	0.9	1.0	7.8	0.27	230																			
B3	1.0	1.1	8.1	0.35	300																			
	1.1	1.2	8.3	0.33	290	5	44	19	33	23	15	5.8	0.80	0.20			3	2.6			0.70	0.051	1.07	0.013
	1.2	1.3	8.3	0.37	350																			
D	1.3	1.4	8.2	0.37	410																			
	1.4	1.5	8.2	0.31	350																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2099	0	0.10B	7.1	1.7	0.11	15		124	1.5	13	32	2.3	1.5	9	

Oven dry data @ 105 C

Soil Name: Caroline (Cl)

Site No: S11 (BAN 1184) **Date Sampled:** 02 February 1993

Location: 209 300 mE 7 335 150 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa)

Substrate Lithology: Unconsolidated Quaternary alluvium

Landform Pattern: Level plain

Element: Plain

Runoff: Very slow

Slope: 0.2 %

Drainage: Imperfectly drained

Permeability: Very slowly permeable

Microrelief: Zero or none

Surface Condition: Surface flake, firm

Surface Coarse Fragments: No coarse fragments

Classifications:

ASC: Melanic-Vertic, Eutrophic, Black, DERMOSOL **PPF:** Uf6.32

GSG: No suitable group

Vegetation:

Upper Stratum: Tall woodland (12-20 m)
Eucalyptus coolabah (coolibah)

Mid Stratum: Acacia salicina (sally wattle)

Lower Stratum: Bothriochloa bladhii (forest bluegrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.18	Very dark brown (10YR2/2) moist; silty light medium clay; strong, 5-10mm, subangular blocky; dry; very firm; non-calcareous. gradual to-
B21	0.18 to 0.50	Black (10YR2/1) moist; silty light medium clay; strong, 5-10mm, angular blocky; dry; moderately strong; non-calcareous. diffuse to-
B22	0.50 to 0.90	Black (10YR2/1) moist; silty light medium clay; strong, 5-10mm, prismatic largest peds, parting to strong, 5-10mm, angular blocky next size peds; moderately moist; very firm; non-calcareous. diffuse to-
B23	0.90 to 1.60	Black (10YR2/1) moist; silty light medium clay; strong, 10-20mm, prismatic largest peds, parting to moderate, 2-5mm, lenticular next size peds; slickensides; moderately moist; moderately firm; non-calcareous.

Effective rooting depth (ERD): 0.75 m (EC ≥ 1.0 dS/m)

Plant Available Water Capacity PAWC): 110 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.7	0.18	30	4	14	40	42	34	15	10	0.69	0.70			2	1.5	0.54	16	0.81	0.094	0.800	0.056
B21	0.2	0.3	7.7	0.42	310	2	11	30	56	45	22	15	2.7	0.23			6	1.5	0.56	20	0.80	0.52	0.661	0.036
B22	0.5	0.6	8.1	1.50	1820	2	11	28	57	43	20	17	6.0	0.19			14	1.2	IS	20	0.75	0.051	0.628	0.055
	0.8	0.9	8.1	1.70	2080	2	12	30	56	42	20	18	8.1	0.17			19	1.1	0.71	22	0.75	0.044	0.618	0.065
B23	1.1	1.2	8.0	1.70	2210	1	13	30	55	41	19	18	8.2	0.20			20	1.1			0.75	0.034	0.621	0.051
	1.4	1.5	8.1	1.80	2230																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1184	0	0.10B	6.6	3.3	0.22	15		109	1	137	84	58	8.5		

Oven dry data @ 105 C

Soil Name: Clancy (Cc)

Site No: S12 (BAN 1321) **Date Sampled:** 12 May 1993

Location: 215 100 mE 7 321 430 mN ZONE 56

Landscape:

Geology: Tertiary olivine basalt (Tb) **Substrate Lithology:** Basalt

Landform Pattern: Gently undulating plains **Element:** Hillslope

Runoff: Very slow **Slope:** 1 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Periodic cracking, self-mulching

Surface Coarse Fragments: No coarse fragments

Classifications:

ASC: Epicalcareous, Self-mulching, Black VERTOSOL **PPF:** Ug5.12

GSG: Black earth

Vegetation:

Upper Stratum: Mid-high isolated trees (6-12 m)

Lysiphyllum hookeri (white flowered bauhinia); Brachychiton rupestris (narrow-leaved bottletree); Brachychiton australis (broad-leaved bottletree);

Mid Stratum: Cassia tomentella (velvet cassia)

Lower Stratum: Sorghum halepense (johnson grass); Aristida species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Dark brown (7.5YR3/2) moist; medium heavy clay; weak, 5-10mm, polyhedral largest peds, parting to strong, 2-5mm polyhedral next size peds, parting to strong, <2mm polyhedral next size peds; dry; non-calcareous. abrupt to-
B21	0.05 to 0.40	Very dark grey (5YR3/1) moist; medium heavy clay; very few <2%, small pebbles 2-6mm, angular quartz; strong, 10-20mm, lenticular largest peds, parting to strong, <2mm lenticular next size peds; moderately moist; very firm; very few <2%, medium 2-6mm, calcareous concretions, non-calcareous. abrupt to-
B22	0.40 to 0.65	Very dark grey (5YR3/1) moist; very few <2%, fine <5mm, faint red mottles; medium heavy clay; common 10-20%, medium pebbles 6-20mm, subangular basalt, very few <2%, small pebbles 2-6mm, angular quartz; strong, 5-10mm, lenticular; moderately moist; moderately firm; very few <2%, medium 2-6mm, calcareous concretions, moderately calcareous. gradual to-
BC	0.65 to 1.20	Light clay; common 10-20%, medium pebbles 6-20mm, subangular basalt; massive; moderately moist; moderately weak; few 2-10%, coarse 6-20mm, calcareous soft segregations, very highly calcareous.
R	1.20	Hard, unweathered basalt.

Effective rooting depth (ERD): 1.2 m (bedrock)

Plant Available Water Capacity PAWC): 140 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	7.1	0.07	10	3	7	12	78	78	46	29	0.38	0.62			0.5	1.6	0.45	35	1.0	0.077	0.186	0.036
B21	0.2	0.3	7.5	0.06	10	3	7	12	78	82	49	31	0.66	0.36			0.8	1.6	0.45	36	1.1	0.068	0.174	0.031
B22	0.5	0.6	8.2	0.15	70	3	7	11	76	85	50	31	0.94	0.31			1	1.6	0.46	36	1.1	0.075	0.193	0.032

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1321	0	0.10B	7.3	1.2	0.08	15		31	0.60	20	50	2.0	0.51		

Oven dry data @ 105 C

Soil Name: Collins (Cn)

Site No: S13 (BAN 1719) **Date Sampled:** 28 February 1994

Location: 233 160 mE 7 310 230 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial sediments (Cza)

Substrate Lithology: Unconsolidated Cainozoic alluvial-colluvial sediments

Landform Pattern: Gentle undulating plain

Element: Hillslope

Runoff: Moderately rapid

Slope: 6 %

Drainage: Moderately well drained

Permeability: Slowly permeable

Microrelief: Zero or none

Surface Condition: Hard setting

Surface Coarse Fragments: No coarse fragments

Classifications:

ASC: Eutrophic, Mottled-Subnatric, Brown, SODOSOL **PPF:** Dy3.42

GSG: No suitable group

Vegetation:

Upper Stratum: Cleared paddock, sown to introduced grasses

Brachychiton australis (broad-leaved bottletree); Acacia fasciulifera (scrub ironbark)

Lower Stratum: Cenchrus ciliaris (buffel grass); Panicum maximum var. trichoglume (green panic)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.35	Brown (10YR4/3) moist; loamy fine sand; massive; moderately moist; moderately weak; non-calcareous. gradual to-
A2e	0.35 to 0.70	Dark greyish brown (10YR4/2) moist, light brownish grey (10YR6/2) dry, light brownish grey (10YR6/2) moist, white (10YR8/1) dry; fine sandy loam; common 10-20%, cobbles 60-200mm, subrounded silcrete, common 10-20%, large pebbles 20-60mm, subrounded ferruginous siltstones; massive; dry; firm; common 10-20%, medium 2-6mm, ferruginous nodules, and few 2-10% coarse 6-20mm, ferruginous nodules, non-calcareous. clear to-
B2	0.70 to 1.50	Yellowish brown (10YR5/8) moist; many 20-50%, medium 5-15mm, prominent grey mottles; sandy light clay; strong, 100-200mm, prismatic largest peds, parting to moderate, 20-50mm, angular blocky next size peds; dry; very strong; few 2-10%, fine <2mm, ferruginous nodules, non-calcareous.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 85 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0.0	0.1	6.7	0.02	10	35	50	6	9	6	1.5	0.65	0.06	0.46			1	2.3	0.56	3	0.67	0.047	0.321	0.016
	0.1	0.2	7.2	0.02	10																			
	0.2	0.3	7.5	0.02	10	30	53	8	9	5	2.0	0.54	0.01	0.44			0.2	3.7	0.55	3	0.56	0.030	0.283	0.012
A1/A2e	0.3	0.4	7.5	0.02	10																			
A2e	0.4	0.5	7.7	0.02	10																			
	0.5	0.6	7.6	0.03	20	34	54	6	6	4	2.0	0.57	0.01	0.22			0.3	3.5	0.82	2	0.67	0.023	0.242	0.009
	0.6	0.7	7.5	0.04	40																			
B2	0.7	0.8	7.6	0.16	160	28	38	9	26	9.2	4.6	2.8	0.74	0.39			8	1.6	0.30	7	0.35	0.021	0.512	0.017
	0.8	0.9	8.0	0.19	180	22	42	7	27	10	4.7	3.0	0.86	0.47			9	1.6	0.54	8	0.37	0.022	0.545	0.013
	0.9	1.0	8.2	0.23	230																			
	1.0	1.1	8.2	0.27	270																			
	1.1	1.2	8.2	0.26	250	19	41	7	34	11	4.4	3.9	1.4	0.54			13	1.1			0.32	0.028	0.641	0.015
	1.2	1.3	8.3	0.26	250																			
	1.3	1.4	8.3	0.27	260																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1719	0	0.10B	7.2	0.49	0.03	16	49	32	0.49	19	25	0.93	2.9	2	

Oven dry data @ 105 C

Soil Name: Cooper (Cp)

Site No: S14 (BAN 957) **Date Sampled:** 29 July 1992

Location: 196 500 mE 7 319 800 mN ZONE 56

Landscape:

Geology: Cretaceous intrusive rhyolite, syenite and quartz and feldspathic porphyry (Ki)

Substrate Lithology: Rhyolite

Landform Pattern: Steep hills

Element: Hillcrest

Runoff: Slow

Slope: 0 %

Drainage: Well drained

Permeability: Highly permeable

Microrelief: Zero or none

Surface Condition: Firm

Surface Coarse Fragments: Many 20-50%, medium pebbles 6-20mm, angular rhyolite

Classifications:

ASC: Haplic, Eutrophic, Brown, KANDOSOL **PPF:** Um5.51

GSG: No suitable group

Vegetation:

Upper Stratum: Tall woodland (12-20 m)
Eucalyptus crebra (narrow-leaved ironbark); Eucalyptus erythrophloia (gum-topped bloodwood)

Mid Stratum: Acacia decora (pretty wattle); Cassia brewsteri (leichhardt bean)

Lower Stratum: Themeda triandra (kangaroo grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.12	Very dark brown (7.5YR2/2) moist; fine sandy clay loam; many 20-50%, medium pebbles 6-20mm, angular rhyolite, few 2-10%, small pebbles 2-6mm, angular rhyolite; weak, 2-5mm, subangular blocky; dry; moderately weak. diffuse to-
B2	0.12 to 0.31	Dark brown (7.5YR3/4) moist; clay loam, fine sandy; many 20-50%, medium pebbles 6-20mm, angular rhyolite; weak, 2-5mm, subangular blocky; dry; moderately weak. abrupt to-
C	0.31 to 0.50	Very abundant >90%, weathered rhyolite fragments. abrupt to-
R	0.50	Hard, unweathered rhyolite.

Effective rooting depth (ERD): 0.5 m (bedrock)

Plant Available Water Capacity PAWC): 35 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.5	0.06	10	29	35	20	22	15	12	2.0	0.05	1.2			0.3	6.0	0.53	11	0.68	0.107	2.67	0.042
B2	0.2	0.3	7.5	0.03	10	22	42	19	22	12	9.4	2.2	0.08	0.56			0.7	4.3	0.52	10	0.55	0.083	2.43	0.040

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
957	0	0.10B	6.9	2.0	0.09	22		46	0.98	25	58	1.2	1.1		1

Oven dry data @ 105 C

Soil Name: Cottonham (Ch)

Site No: S15 (BAN 339) **Date Sampled:** 24 January 1991

Location: 209 375 mE 7 306 000 mN ZONE 56

Landscape:

Geology: Permian siltstone, mudstone and sandstone of the Back Creek Group (undifferentiated) (Pb)

Substrate Lithology: Mudstone

Landform Pattern: Gentle undulating rises

Element: Hillslope

Runoff: Slow

Slope: 3 %

Drainage: Moderately well drained

Permeability: Slowly permeable

Microrelief: Zero or none

Surface Condition: Periodic cracking, surface flake

Surface Coarse Fragments: Few 2-10%, medium pebbles 6-20mm, subangular quartz

Classifications:

ASC: Epicalcareous, Self-mulching, Red VERTOSOL **PPF:** Ug5.3

GSG: Red clay

Vegetation:

Upper Stratum: Acacia harpophylla (brigalow)

Mid Stratum: Alectryon diversifolium (holly bush)

Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.06	Dark brown (7.5YR3/2) moist; light medium clay; very few <2%, medium pebbles 6-20mm, subangular quartz; strong, <2mm, subangular blocky; dry; firm; non-calcareous. abrupt to-
B21	0.06 to 0.40	Reddish brown (5YR4/4) moist; medium clay; few 2-10%, medium pebbles 6-20mm, subangular quartz; strong, 10-20mm, subangular blocky largest peds, parting to strong, 2-5mm, lenticular next size peds; moderately moist; moderately firm; very few <2%, fine <2mm, calcareous concretions, highly calcareous. gradual to-
B22	0.40 to 0.65	Strong brown (7.5YR4/6) moist; medium clay; few 2-10%, medium pebbles 6-20mm, subangular mudstone; strong, <2mm, lenticular; moderately moist; moderately firm; few 2-10%, medium 2-6mm, calcareous soft segregations and very few <2%, fine <2mm, calcareous concretions, very highly calcareous. gradual to-
B3	0.65 to 0.85	Strong brown (7.5YR4/6) moist; light clay; common 10-20%, medium pebbles 6-20mm, mudstone; strong, <2mm, lenticular; moderately moist; moderately firm; common 10-20%, coarse 6-20mm, calcareous soft segregations, very highly calcareous. gradual to-
C	0.85 to 1.20	Very abundant >90%, mudstone fragments; very highly calcareous.
R	1.20	Hard, unweathered mudstone.

Effective rooting depth (ERD): 1.2 m

Plant Available Water Capacity PAWC): 120 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water pH @40 C	1:5 Soil/Water EC (dS/m) @40 C	1:5 Soil/Water Cl⁻ (mg/kg) @105 C	Particle Size (%) Coarse Sand @ 105 C	Fine Sand @ 105 C	Silt @ 105 C	Clay @ 105 C	Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1}) CEC @ 105 C	Ca @ 105 C	Mg @ 105 C	Na @ 105 C	K @ 105 C	Exchange Acidity (meq/100g) Al @ 105 C	Exchange Acidity (meq/100g) H$^+$ @ 105 C	Cation Dominance ESP (%)	Cation Dominance Ca/Mg Ratio	Dispersion R1 Ratio	Moisture (%) 15 Bar @ 105 C	Clay Mineralogy CEC/Clay Ratio	Total Elements (%) P @ 80 C	Total Elements (%) K @ 80 C	Total Elements (%) S @ 80 C
A1	0	0.05	7.7	0.14	20	10	27	19	43	29	20	4.0	0.13	2.6			0.4	5.0	0.28	17	0.67	0.144	1.78	0.077
B21	0.2	0.3	7.9	0.06	10	5	21	17	60	29	20	4.4	0.30	0.90			1	4.5	0.33	17	0.48	0.048	1.95	0.030
B22	0.5	0.6	8.8	0.15	10	16	20	23	45	21	14	5.3	0.71	0.30			3	2.6	0.38	15	0.47	0.042	2.17	0.033

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg) Acid P	Extr. P (mg/kg) Bicarb. P	Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg) Fe	Mn	Cu	Zn	Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
339	0	0.10B	7.9	3.1	0.25	12		36	1.9	15	35	1.1	3		

Oven dry data @ 105 C

Soil Name: Desdemona (Dd)

Site No: S16 (BAN 2028) **Date Sampled:** 11 October 1994

Location: 231 660 mE 7 342 940 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial colluvial sediments (Cza)

Substrate Lithology: Unconsolidated Cainozoic alluvial-sediments

Landform Pattern: Gentle undulating plains

Element: Plain

Runoff: Slow

Slope: 3 %

Drainage: Moderately well drained

Permeability: Slowly permeable

Microrelief: Zero or none

Surface Condition: Firm

Surface Coarse Fragments: Few 2-10%, small pebbles 2-6mm, subrounded ferruginous siltstones

Classifications:

ASC: Eutrophic, Subnatric, Brown, SODOSOL **PPF:** Dy4.32

GSG: No suitable group

Vegetation:

Upper Stratum: Predominantly cleared
Eucalyptus crebra (narrow-leaved ironbark)

Mid Stratum: Capparis lasiantha (nipan)

Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.50	Brown (10YR4/3) moist; fine sandy loam; very few <2%, small pebbles 2-6mm, subrounded ferruginous siltstones; weak, 5-10mm, platy; dry; moderately firm; non-calcareous. clear to-
A2j	0.50 to 0.60	Dark yellowish brown (10YR4/4) moist, white (10YR8/2) dry; fine sandy clay loam; few 2-10%, small pebbles 2-6mm, subrounded ferruginous siltstones; massive; dry; moderately firm; non-calcareous. sharp to-
B21t	0.60 to 1.35	Yellowish brown (10YR5/6) moist; few 2-10%, medium 5-15mm, faint dark mottles; fine sandy light medium clay; strong, 10-20mm, subangular blocky; dry; moderately strong; very few <2%, fine <2mm, manganiferous soft segregations; non-calcareous. gradual to-
B22t	1.35 to 1.60	Yellowish brown (10YR5/6) moist; common 10-20%, medium 5-15mm, prominent grey mottles; light medium clay; strong, 20-50mm, prismatic largest peds, parting to strong, 20-50mm, subangular blocky next size peds; dry; moderately strong; very few <2%, fine <2mm, manganiferous soft segregations; non-calcareous.

Effective rooting depth (ERD): 1.3 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 95 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl^- (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H^+	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.6	0.02	10	34	40	10	16	8	3.2	0.93	0.01	0.16			0.1	3.4	0.99	1	0.50	0.039	0.200	0.017
	0.1	0.2	7.1	0.02	10																			
	0.2	0.3	7.2	0.02	20	33	39	13	16	6	4.1	0.86	0.01	0.05			0.2	4.8	0.56	4	0.38	0.030	0.189	0.013
	0.3	0.4	7.1	0.02	10																			
	0.4	0.5	7.2	0.01	10																			
A2j	0.5	0.6	7.5	0.02	10	33	40	13	17	5	1.5	1.1	0.03	0.02			0.6	1.4	0.99	4	0.29	0.021	0.172	0.009
B21t	0.6	0.7	8.1	0.05	30	22	26	10	43	8	2.3	3.2	0.76	0.05			10	0.72	0.35	10	0.19	0.029	0.265	0.015
	0.7	0.8	8.2	0.07	50	20	21	12	51	9	2.7	4.2	1.2	0.05			13	0.64	0.38	12	0.18	0.030	0.284	0.014
	0.8	0.9	8.1	0.09	70	20	20	7	54	13	5.4	4.9	1.6	0.18			12	1.1	0.56	14	0.24	0.030	0.296	0.012
	0.9	1.0	7.9	0.13	90																			
	1.0	1.1	7.7	0.14	110																			
	1.1	1.2	7.4	0.17	140	37	9	3	50	12	3.5	4.8	2.1	0.04			18	0.73			0.24	0.024	0.291	0.015
	1.2	1.3	6.8	0.20	160																			
B21t / B22t	1.3	1.4	6.5	0.20	150																			
B22t	1.4	1.5	6.4	0.22	190																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2028	0	0.10B	6.5	0.91	0.06	15	20	16	0.38	21	40	0.98	1.2	5	

Oven dry data @ 105 C

Soil Name: Drumberle (Db)

Site No: S17 (BAN 49) **Date Sampled:** 11 August 1993

Location: 225 550 mE 7 303 050 mN ZONE 56

Landscape:

Geology: Carboniferous acid and intermediate lava (Ct) **Substrate Lithology:** Acid igneous rock (unidentified)

Landform Pattern: Rolling hills **Element:** Hillslope

Runoff: Moderately rapid **Slope:** 6%

Drainage: Moderately well drained **Permeability:** Very slowly permeable

Microrelief: Zero or none **Surface Condition:** Hard setting

Surface Coarse Fragments: Few 2-10%, cobbles 60-200mm, angular igneous rock (unidentified)

Classifications:

ASC: Vertic, Subnatric, Black, SODOSOL **PPF:** Dd1.33

GSG: Solodic

Vegetation:

Upper Stratum: Mid-high woodland (6-12 m)
Eucalyptus crebra (narrow-leaved ironbark)

Mid Stratum: Acacia bidwillii (corkwood wattle)

Lower Stratum: Bothriochloa bladhii (forest bluegrass); Heterpogon contortus (black speargrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.14	Very dark grey (10YR3/1) moist; fine sandy clay loam; few 2-10%, medium pebbles 6-20mm, subangular igneous rock (unidentified), very few <2%, large pebbles 20-60mm, subangular igneous rock; weak, 2-5mm, subangular blocky; dry; moderately weak; non-calcareous. abrupt to-
A2j	0.14 to 0.20	Greyish brown (10YR5/2) moist, light grey (10YR7/2) dry; sandy clay loam; few 2-10%, medium pebbles 6-20mm, subangular igneous rock (unidentified); massive; dry; moderately weak; non-calcareous. abrupt to-
B21	0.20 to 0.40	Black (10YR2/1) moist; medium clay; few 2-10%, medium pebbles 6-20mm, angular igneous rock (unidentified); strong, 50-100mm, prismatic largest peds, parting to strong, 20-50mm, angular blocky next size peds; moderately moist; very firm; non-calcareous. clear to-
B22	0.40 to 0.60	Very dark greyish brown (2.5Y3/2) moist; common 10-20%, medium 5-15mm, distinct, yellow mottles; light clay; few 2-10%, small pebbles 2-6mm, angular igneous rock (unidentified); strong, 10-20mm, lenticular; dry; moderately strong; non-calcareous. abrupt to-
C	0.60 to 0.80	Very abundant >90%, igneous rock (unidentified) fragments.
R	0.80	Hard, unweathered acid igneous rock (unidentified).

Effective rooting depth (ERD): 0.9 m (bedrock)

Plant Available Water Capacity PAWC): 85 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.9	0.04	10	28	27	23	20	16	6.0	4.0	0.07	0.80			0.4	1.5	0.73	10	0.80	0.043	0.838	0.045
B21	0.2	0.3	7.7	0.05	10	11	18	15	54	24	6.0	9.2	1.4	0.20			6	0.65	0.68	18	0.44	0.025	0.663	0.031
	0.3	0.4	8.0	0.06	10	11	19	17	52	25	6.5	9.9	1.8	0.19			7	0.66	0.71	18	0.48	0.021	0.673	0.030
B22	0.5	0.6	8.6	0.09	10	21	15	13	49	22	5.9	11	2.0	0.18			9	0.54	0.80	17	0.45	0.025	0.751	0.027

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
49	0	0.10B	6.8	1.9	0.13	15		8	1.3	25	16	0.69	0.56		

Oven dry data @ 105 C

Soil Name: Earlsfield (Ef)

Site No: S18 (BAN 185) **Date Sampled:** 31 October 1990

Location: 234 175 mE 7 324 670 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial colluvial sediments (Cza)

Substrate Lithology: Unconsolidated Cainozoic alluvial-sediments

Landform Pattern: Level plain

Element: Plain

Runoff: Very slow

Slope: 0.3 %

Drainage: Imperfectly drained

Permeability: Very slowly permeable

Microrelief: Zero or none

Surface Condition: Periodic cracking, self-mulching

Surface Coarse Fragments: Very few <2%, medium pebbles, subrounded ferruginous siltstones

Classifications:

ASC: Epicalcareous-Endohypersodic, Self-mulching, Black, VERTOSOL

PPF: Ug5.15P

GSG: Black earth

Vegetation: Cleared

Profile Morphology:

Horizon	Depth (m)	Description
AP	0.00 to 0.05	Very dark grey (10YR3/1) moist; medium heavy clay; strong, <2mm, granular; dry; loose; few 2-10%, fine <2mm calcareous concretions, moderately calcareous. abrupt to-
B21k	0.05 to 0.75	Very dark grey (10YR3/1) moist; heavy clay; very few <2%, small pebbles 2-6mm, subrounded ferruginous siltstones; strong, 2-5mm, lenticular; moist; moderately weak; common 10-20%, medium 2-6mm, calcareous concretions and very few <2%, medium 2-6mm, calcareous soft segregations, moderately calcareous. gradual to-
B22k	0.75 to 1.00	Very dark grey (10YR3/1) moist; common 10-20%, medium 5-15mm, distinct brown mottles; medium heavy clay; strong, 2-5mm, lenticular; moist; moderately weak; few 2-10%, medium 2-6mm, calcareous concretions, slightly calcareous. gradual to-
B23y	1.00 to 1.50	Strong brown (7.5YR4/5) moist; common 10-20%, medium 5-15mm, prominent brown mottles; medium heavy clay; moist; moderately weak; very few <2%, medium 2-6mm, gypseous crystals, non-calcareous.

Effective rooting depth (ERD): 0.9 m (EC ≥ 1.0 dS/m)

Plant Available Water Capacity PAWC): 140 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
AP / B21k	0	0.1	8.6	0.13	30	14	18	12	55	50	32	9.2	1.5	0.90			3	3.5	0.60	24	0.91	0.030	0.404	0.037
B21k	0.1	0.2	8.7	0.15	30																			
	0.2	0.3	8.8	0.19	50	15	15	18	53	48	27	12	3.5	0.50			7	2.3	0.60	24	0.91	0.028	0.398	0.036
	0.3	0.4	8.8	0.25	120																			
	0.4	0.5	8.6	0.35	290																			
	0.5	0.6	8.6	0.56	570	13	18	13	58	49	25	14	6.5	0.57			13	1.8	0.87	26	0.84	0.027	0.429	0.048
	0.6	0.7	8.4	0.79	770																			
B21k / B22k	0.7	0.8	8.4	0.97	930																			
B22k	0.8	0.9	8.4	1.10	1110	12	17	12	60	45	20	15	8.0	0.64			18	1.3	0.91	23	0.75	0.024	0.474	0.061
	0.9	1.0	8.2	1.10	1030																			
B23y	1.0	1.1	7.7	1.80	970																			
	1.1	1.2	7.6	1.80	1020	13	16	15	56	40	18	13	7.5	0.52			19	1.4	0.82	21	0.71	0.021	0.569	0.142
	1.2	1.3	7.1	1.60	920																			
	1.3	1.4	6.2	1.60	940																			
	1.4	1.5	5.7	0.97	890	16	19	14	54	35	15	10	6.1	0.45			17	1.5	0.97	19	0.65	0.019	0.670	0.058

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
185	0	0.10B	8.4	1.0	0.05	20		8	1.0	6.8	11	2.7	0.50		

Oven dry data @ 105 C

Soil Name: Eugene (Eg)

Site No: S19 (BAN 2562) **Date Sampled:** 10 August 1995

Location: 244 160 mE 7 322 080 mN ZONE 56

Landscape:

Geology: Permian to Triassic diorite, gabbro of the Mount Gerard Complex (Prf?)

Substrate Lithology: Granite

Landform Pattern: Undulating rises

Element: Hillslope

Runoff: Slow

Slope: 2 %

Drainage: Moderately well drained

Permeability: Moderately permeable

Microrelief: Zero or none

Surface Condition: Hard setting

Surface Coarse Fragments: Many 20-50%, small pebbles 2-6mm, angular granite

Classifications:

ASC: Eutrophic, Mottled-Mesonatric, Grey, SODOSOL **PPF:** Dy3.32

GSG: Solodised solonetz

Vegetation:

Upper Stratum: Open forest
Eucalyptus cambageana (coowarra box)

Mid Stratum: Acacia harpophylla (brigalow); Carissa ovata (currantbush)

Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.18	Very dark brown (10YR2/2) moist; sandy loam; few 2-10%,small pebbles 2-6mm, angular granite, very few <2%, medium pebbles 6-20mm, angular granite; massive; dry; firm; non-calcareous. abrupt to-
A2j	0.18 to 0.30	Dark greyish brown (10YR4/2) moist, white (10YR8/1) dry; sandy loam; common 10-20%, small pebbles 2-6mm, angular granite, few 2-10%, medium pebbles 6-20mm, angular granite; massive; dry; firm; non-calcareous. abrupt to-
B2	0.30 to 0.50	Dark greyish brown (10YR4/2) moist; many 20-50%, medium 5-15mm, distinct brown mottles; fine sandy light clay; few 2-10%, medium pebbles 6-20mm, angular granite; strong, 50-100mm, columnar largest peds, parting to strong, 10-20mm, angular blocky next size peds; dry; very strong; non-calcareous. abrupt to -
C	0.50 to 0.60	Very many >90%, weathered granite fragments. sharp to -
R	0.60	Hard, unweathered granite.

Effective rooting depth (ERD): 0.6 m (bedrock)

Plant Available Water Capacity PAWC): 50 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.9	0.03	10	39	36	9	17	13	8.0	1.5	0.11	0.21			0.8	5.3	0.50	7	0.76	0.039	1.070	0.022
A1/A2j	0.1	0.2	7.3	0.03	10																			
A2j	0.2	0.3	7.5	0.04	10	45	34	9	12	9	4.6	1.9	0.37	0.11			4	2.4	0.75	6	0.75	0.022	1.200	0.013
B2	0.3	0.4	7.4	0.15	50	35	25	9	29	19	5.4	9.2	3.0	0.09			16	0.6	0.93	12	0.66	0.013	0.985	0.023
	0.4	0.5	7.8	0.19	60	30	29	9	30	20	5.1	11	3.8	0.09			19	0.5	0.99	13	0.67	0.015	0.944	0.027

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2562	0	0.10B	7.2	1.7	0.14	12		30	0.80	29	31	0.92	1.40	4	

Oven dry data @ 105 C

Soil Name: Fairview (Fv)

Site No: S20 (BAN 858) **Date Sampled:** 09 June 1992

Location: 199 300 mE 7 303 750 mN ZONE 56

Landscape:

Geology: Permian siltstone, sandstone and mudstone of the Flat Top Formation (Puf) **Substrate Lithology:** Mudstone

Landform Pattern: Gentle undulating rises **Element:** Plain

Runoff: Very slow **Slope:** 1.5 %

Drainage: Imperfectly drained **Permeability:** Very slowly permeable

Microrelief: Zero or none **Surface Condition:** Periodic cracking, self-mulching

Surface Coarse Fragments: No coarse fragments

Classifications:

ASC: Epicalcareous-Epihypersodic, Self-mulching, Black, VERTOSOL **PPF:** Ug5.13

GSG: Black earth

Vegetation:

Upper Stratum: Mid-high open forest (6-12 m)

Acacia harpophylla (brigalow); Eromophila mitchellii (false sandalwood)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0. 05	Dark brown (10YR3/3) moist; light medium clay; strong, 2-5mm, granular largest peds, parting to strong, <2mm, granular next size peds; dry; loose; non-calcareous. abrupt to-
B21	0.05 to 0.20	Very dark grey (10YR3/1) moist; light medium clay; strong, 10-20mm, subangular blocky largest peds, parting to strong, 2-5mm, lenticular next size peds; moderately moist; moderately firm; non-calcareous. clear to-
B22	0.20 to 0.70	Very dark greyish brown (2.5Y3/2) moist; medium clay; very few <2%, medium pebbles 6-20mm, subrounded quartz; strong, 2-5mm, lenticular; moist; moderately firm; very few <2%, medium 2-6mm, calcareous nodules, and very few <2%, fine <2mm, calcareous soft segregations, slightly calcareous. diffuse to-
B23	0.70 to 1.25	Strong brown (7.5YR4/6) moist; common 10-20%, fine <5mm, prominent dark mottles; medium clay; few 2-10%, small pebbles 2-6mm, subangular mudstone; strong, 5-10 mm, lenticular; moderately moist; moderately strong; common 10-20%, fine <2mm, manganiferous soft segregations, non-calcareous. clear to-
C	1.25 to 1.55	Very abundant >90%, mudstone fragments.

Effective rooting depth (ERD): 0.6 m (EC ≥ 1.0 dS/m)

Plant Available Water Capacity PAWC): 95 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.05	8.0	0.18	20	8	24	23	47	40	34	4.0	0.19	1.60			0.5	8.5	0.28	20	0.85	0.091	0.692	0.084
B22	0.2	0.3	8.7	0.50	400	4	18	20	61	38	22	13	4.0	0.30			11	1.7	0.53	21	0.62	0.030	0.510	0.049
	0.5	0.6	8.7	1.10	1380	5	18	20	60	36	16	13	7.7	0.20			21	1.2	0.76	21	0.60	0.025	0.519	0.034
B23	0.8	0.9	7.4	1.00	1590	2	18	22	60	35	12	13	8.5	0.26			24	0.9	0.97	22	0.58	0.022	0.563	0.024
	1.1	1.2	5.0	0.99	1600	2	14	27	60	34	9.0	11	7.7	0.23			23	0.8			0.57	0.024	0.889	0.019
C	1.4	1.5	5.4	0.87	1140																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
858	0	0.10B	7.9	2.9	0.22	13		33	1.00	18	34	1.9	1.4		

Oven dry data @ 105 C

Soil Name: Ferguson (Fg)

Site No: S21 (BAN 1485) **Date Sampled:** 24 August 1993

Location: 223 860 mE 7 296 450 mN ZONE 56

Landscape:

Geology: Carboniferous acid and intermediate lava (Ct) **Substrate Lithology:** Acid volcanic rock (unidentified)

Landform Pattern: Undulating rises **Element:** Hillslope

Runoff: Moderately rapid **Slope:** 7 %

Drainage: Moderately well drained **Permeability:** Very slowly permeable

Microrelief: Zero or none **Surface Condition:** Hard setting

Surface Coarse Fragments: Common 10-20%, cobbles 60-200mm, angular volcanic rocks (unidentified)

Classifications:

ASC: Calcic, Subnatric, Black, SODOSOL **PPF:** Dd1.33

GSG: Solodic

Vegetation:

Upper Stratum: Acacia fasciulifera (scrub ironbark); Eucalyptus cambageana (coowarra box)

Mid Stratum: Archidendropsis basaltica (dead finish); Carissa ovata (currantbush)

Lower Stratum: Cenchrus ciliaris (buffel grass); Bothriochloa bladhii (forest bluegrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.11	Very dark brown (10YR2/2) moist; sandy clay loam; few 2-10%, large pebbles 20-60mm, angular volcanic rock, many 20-50%, medium pebbles 6-20mm, angular volcanic rock; weak, 5-10mm subangular blocky; dry; firm. abrupt to-
A2j	0.11 to 0.19	Dark greyish brown (10YR4/2) moist, light grey (10YR7/1) dry; clay loam, fine sandy; common 10-20%, large pebbles 20-60mm, angular volcanic rock, many 20-50%, medium pebbles 6-20mm, angular volcanic rock; massive; dry. firm; abrupt to-
B21	0.19 to 0.39	Very dark grey (10YR3/1) moist; few 2-10%, medium 5-15mm, distinct brown mottles; medium clay; few 2-10%, large pebbles 20-60mm, angular volcanic rock; strong, 50-100mm prismatic; dry; strong. gradual to-
B22	0.39 to 0.55	Light olive brown (2.5Y5/4) moist; common 10-20%, coarse 15-30mm, distinct dark mottles; medium clay; common 10-20%, large pebbles 20-60mm, angular volcanic rock; strong, 20-50mm angular blocky; dry; strong. abrupt to-
B23k	0.55 to 0.75	Light olive brown (2.5Y5/6) moist; light medium clay; few 2-10%, medium pebbles 6-20mm, angular volcanic rock; strong, 10-20mm lenticular; slickensides; dry; strong; few 2-10%, fine <2mm, calcareous soft segregations, slightly calcareous. abrupt to-
BCk	0.75 to 0.90	Light olive brown (2.5Y5/6) moist; sandy light clay; abundant 50-90%, large pebbles 20-60mm, angular volcanic rock; common 10-20%, medium 2-6mm, calcareous soft segregations, highly calcareous. sharp to-
R	0.90	Hard, unweathered acid volcanic rock (unidentified).

Effective rooting depth (ERD): 0.9 m (bedrock)

Plant Available Water Capacity PAWC): 80 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.0	0.06	10	38	28	15	19	13	6.0	2.9	0.15	0.99			1	2.1	0.99	8	0.68	0.034	1.810	0.033
B21	0.2	0.3	7.4	0.10	50	16	16	11	55	29	8.2	12	2.2	0.39			8	0.7	0.84	19	0.53	0.018	1.420	0.030
	0.3	0.4	8.0	0.15	120	13	19	11	55	29	9.1	14	2.7	0.30			9	0.7	0.86	19	0.53	0.015	1.430	0.034
B22	0.4	0.5	8.3	0.17	110																			
B22 / B23k	0.5	0.6	8.9	0.45	290	13	19	13	52	30	10	16	4.4	0.26			15	0.6	0.88	18	0.58	0.014	1.520	0.043
B23k	0.6	0.7	9.2	0.48	330																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1485	0	0.10B	6.9	1.9	0.12	16		17	1.60	27	29	0.93	3		

Oven dry data @ 105 C

Soil Name: Flat Top (Ft)

Site No: S22 (BAN 1152) **Date Sampled:** 06 January 1993

Location: 200 995 mE 7 333 880 mN ZONE 56

Landscape:

Geology: Permian siltstone, mudstone, chert and sandstone of the Rannes Beds (Pw)

Substrate Lithology: Sandstone

Landform Pattern: Undulating rises

Element: Hillcrest

Runoff: Slow

Slope: 1.5 %

Drainage: Well drained

Permeability: Highly permeable

Microrelief: Zero or none

Surface Condition: Hard setting

Surface Coarse Fragments: Common 10-20%, small pebbles 2-6mm, subangular sandstone

Classifications:

ASC: Basic, Paralithic, Bleached-Leptic, TENOSOL **PPF:** Um2.12

GSG: No suitable group

Vegetation:

Upper Stratum: Tall woodland (12-20 m)
Eucalyptus crebra (narrow-leaved ironbark)

Mid Stratum: Canthium oleifolium (myrtle tree)

Lower Stratum: Bothriochloa species; Aristida species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.15	Dark brown (7.5YR3/3) moist; fine sandy clay loam; few 2-10%, small pebbles 2-6mm, subangular sandstone; massive; dry; very firm; non-calcareous. gradual to-
A2e	0.15 to 0.35	Light brownish grey (2.5Y6/3) moist, white (10YR8/1) dry; fine sandy clay loam; many 20-50%, small pebbles 2-6mm, subangular sandstone, few 2-10%, medium pebbles 6-20mm, subangular sandstone; massive; dry; very firm; non-calcareous. abrupt to-
C	0.35 to 0.50	Very abundant >90%, weathered sandstone fragments.
R	0.50	Hard, unweathered sandstone.

Effective rooting depth (ERD): 0.4 m (bedrock)

Plant Available Water Capacity PAWC): 20 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.5	0.03	BL	36	18	18	26	11	4.2	6.0	0.13	0.30			1	0.7	0.78	9	0.42	0.041	0.640	0.030
A2e	0.2	0.3	6.9	0.02	BL	46	15	16	22	10	2.3	7.3	0.27	0.10			3	0.3	0.69	7	0.45	0.029	0.681	0.022

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

BL = below limit of quantification

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1152	0	0.10B	6.4	1.7	0.11	15		5	0.50	41	58	1.8	2.3		

Oven dry data @ 105 C

Soil Name: Foster (Fs)

Site No: S23 (BAN 1203) **Date Sampled:** 12 February 1993

Location: 207 100 mE 7 333 300 mN ZONE 56

Landscape:

Geology: Permian siltstone, mudstone, chert and sandstone of the Rannes Beds (Pw)

Substrate Lithology: Siltstone

Landform Pattern: Undulating rises

Element: Hillslope

Runoff: Moderately rapid

Slope: 4.5 %

Drainage: Well drained

Permeability: Moderately permeable

Microrelief: Zero or none

Surface Condition: Firm

Surface Coarse Fragments: Common 10-20%, medium pebbles 6-20mm, angular quartz

Classifications:

ASC: Vertic, Eutrophic, Red, DERMOSOL **PPF:** Gn3.12

GSG: No suitable group

Vegetation:

Upper Stratum: Mid-high open woodland (6-12 m)
Eucalyptus melanophloia (silver-leaved ironbark)

Lower Stratum: Bothriochloa bladhii (forest bluegrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.10	Dark brown (7.5YR3/3) moist; clay loam; few 2-10%, medium pebbles 6-20mm, angular quartz; weak, 5-10mm, subangular blocky; dry; very firm; non-calcareous. gradual to-
B1	0.10 to 0.25	Dark reddish brown (2.5YR3/4) moist; light clay; few 2-10%, medium pebbles 6-20mm, angular quartz; strong, 5-10mm, subangular blocky largest peds, parting to strong, 2-5mm, subangular blocky next size peds; dry; very firm; non-calcareous. gradual to-
B21	0.25 to 0.50	Dark reddish brown (2.5YR3/4) moist; light medium clay; very few <2%, small pebbles 2-6mm, angular siltstone; strong, 2-5mm, subangular blocky; dry; very firm; non-calcareous. clear to-
B22	0.50 to 0.80	Dark reddish brown (2.5YR3/4) moist; light medium clay; strong, 5-10mm, lenticular; dry; very firm; non-calcareous. abrupt to-
C	0.80 to 0.95	Very abundant >90%, weathered siltstone fragments. sharp to-
R	0.95	Hard, unweathered siltstone.

Effective rooting depth (ERD): 0.95 m (bedrock)

Plant Available Water Capacity PAWC): 105 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.5	0.07	10	16	14	32	35	13	8.4	4.7	0.10	0.58			0.8	1.8	0.59	13	0.37	0.058	0.926	0.044
B1/B21	0.2	0.3	6.9	0.04	10	17	14	20	47	13	7.7	5.6	0.18	0.20			1	1.4	0.66	14	0.28	0.036	0.999	0.030
B22	0.5	0.6	7.4	0.04	10	11	6	14	70	18	8.4	8.6	0.44	0.22			2	1.0	0.34	20	0.26	0.024	1.170	0.026
	0.7	0.8	7.5	0.05	20	12	8	14	65	19	8.8	9.2	0.60	0.20			3	1.0	0.53	18	0.29	0.019	1.150	0.024

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1203	0	0.10B	6.5	1.7	0.13	13		32	0.73	36	143	2.1	4.6		

Oven dry data @ 105 C

Soil Name: Garden (Gd)

Site No: S24 (BAN 1251) **Date Sampled:** 04 March 1993

Location: 196 900 mE 7 340 150 mN ZONE 56

Landscape:

Geology: Permian siltstone, mudstone, chert and shale of the Rannes Beds (Pw)

Substrate Lithology: Shale

Landform Pattern: Undulating low hills

Element: Hillslope

Runoff: Rapid

Slope: 7 %

Drainage: Well drained

Permeability: Moderately permeable

Microrelief: Zero or none

Surface Condition: Hard setting

Surface Coarse Fragments: Many 20-50%, medium pebbles 6-20mm, angular shale

Classifications:

ASC: Palic, Paralithic, Leptic, TENOSOL **PPF:** Um3.12

GSG: No suitable group

Vegetation:

Upper Stratum: Mid-high woodland (6-12 m)
Eucalyptus crebra (narrow-leaved ironbark)

Mid Stratum: Acacia rhodoxylon (rosewood); Citriobatus spinescens (wallaby apple)

Lower Stratum: Aristida species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.25	Very dark greyish brown (10YR3/2) moist; sandy clay loam; many 20-50%, medium pebbles 6-20mm, angular shale; weak, 2-5mm, subangular blocky; dry; very firm; non-calcareous. clear to-
A2j	0.25 to 0.40	Brown (10YR5/3) moist, white (10YR8/2) dry; clay loam, fine sandy; many 20-50%, medium pebbles 6-20mm, angular shale; weak, 2-5mm, subangular blocky; dry; very firm; non-calcareous. abrupt to-
C	0.40 to 0.50	Very abundant >90%, large pebbles 20-60mm, weathered angular shale; non-calcareous. sharp to-
R	0.50	Hard, unweathered shale.

Effective rooting depth (ERD): 0.5 m (bedrock)

Plant Available Water Capacity PAWC): 35 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.0	0.16	10	36	18	14	32	12	6.0	5.6	0.16	0.39			1	1.1	0.70	12	0.38	0.061	1.660	0.035
A2j	0.25	0.35	7.1	0.16	10	36	17	12	34	10	1.2	8.7	0.53	0.10			5	0.14	0.71	11	0.29	0.033	1.760	0.022

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1251	0	0.10B	6.9	2.2	0.18	12		13	0.74	21	56	0.75	1.1		

Oven dry data @ 105 C

Soil Name: Goovigen (Gv)

Site No: S25 (BAN 507) **Date Sampled:** 06 September 1991

Location: 205 650 mE 7 293 280 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa) **Substrate Lithology:** Quaternary alluvium

Landform Pattern: Level plain **Element:** Plain

Runoff: Very slow **Slope:** 0 %

Drainage: Imperfectly drained **Permeability:** Very slowly permeable

Microrelief: Melonhole gilgai **Microrelief Component:** Mound

Horizontal Interval: 30 m **Vertical Interval:** 1.20 m

Surface Coarse Fragments: Few 2-10%, small pebbles 2-6mm, subrounded quartz **Surface Condition:** Surface flake, firm

Classifications:

ASC: Melanic-Vertic, Hypocalcic, Black, DERMOSOL **PPF:** Uf6.32

GSG: No suitable group

Vegetation:

Upper Stratum: Tall open forest (12-20 m)

Acacia harpophylla (brigalow); Eucalyptus moluccana (gum-topped box)

Mid Stratum: Apophyllum anomalum (broom bush); Capparis lasiantha (nipan)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Very dark grey (10YR3/1) moist; light medium clay; few 2-10%, small pebbles 2-6mm, subrounded quartz; weak, 5-10mm, subangular blocky largest peds, parting to strong, 2-5mm, subangular blocky next size peds; dry; moderately weak; non-calcareous. abrupt to-
B21	0.05 to 0.60	Very dark grey (10YR3/1) moist; light medium clay; few 2-10%, small pebbles 2-6mm, subrounded quartz, very few <2%, medium pebbles 6-20mm, subrounded siltstone; strong, 5-10mm, subangular blocky; dry; moderately strong; non-calcareous. diffuse to-
B22k	0.60 to 1.10	Very dark grey (10YR3/1) moist; medium clay; few 2-10%, small pebbles 2-6mm, subrounded quartz, very few <2%, medium pebbles 6-20mm, subrounded siltstone; strong, 5-10mm, subangular blocky; dry; moderately strong; few 2-10%, medium 2-6mm, calcareous nodules, few 2-10%, medium 2-6mm, gypsum crystals; non-calcareous. diffuse to-
B23k	1.10 to 1.55	Very dark grey (10YR3/1) moist; medium clay; few 2-10%, small pebbles 2-6mm, subrounded quartz, very few <2%, medium pebbles 6-20mm, subrounded siltstone; moderate, 5-10mm, lenticular; moderately moist; very firm; common 10-20%, medium 2-6mm, calcareous nodules, slightly calcareous.

Effective rooting depth (ERD): 0.4 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 65 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.05	7.5	0.09	20	15	20	23	43	30	22	9.7	1.0	1.70			3	2.3	0.46	16	0.70	0.068	1.550	0.038
B21	0.2	0.3	9.1	0.42	230	23	17	19	45	27	14	13	6.2	0.41			23	1.1	0.84	18	0.60	0.042	1.510	0.031
	0.5	0.6	8.6	2.20	760	13	21	24	47	26	12	15	11	0.37			42	0.8	0.90	18	0.55	0.050	1.380	0.219
B22k	0.8	0.9	8.4	4.40	1110	5	16	17	62	35	12	20	15	0.50			43	0.6	0.93	24	0.56	0.044	1.160	1.170
B23k	1.1	1.2	9.2	1.70	1120	5	23	22	55	32	8.4	17	15	0.74			47	0.5	0.97	24	0.58	0.043	1.190	0.117
	1.4	1.5	9.3	1.50	1080	6	23	21	52	33	8.1	15	13	0.59			39	0.5	0.99	25	0.63	0.035	1.120	0.097

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
507	0	0.10B	7.7	2.1	0.15	14		53	1.10	15	18	2.2	0.54		3

Oven dry data @ 105 C

Soil Name: Goovigen (Gv)

Site No: S25 (BAN 508) **Date Sampled:** 06 September 1991

Location: 205 650 mE 7 293 280 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa)

Substrate Lithology: Unconsolidated Quaternary alluvium

Landform Pattern: Level plain

Element: Plain

Runoff: Very slow

Slope: 0 %

Drainage: Poorly drained

Permeability: Very slowly permeable

Microrelief: Melonhole gilgai

Microrelief Component: Depression

Horizontal Interval: 30 m

Vertical Interval: 1.20 m

Surface Coarse Fragments: Few 2-10%, small pebbles 2-6mm, subrounded quartz

Surface Condition: Periodic cracking, surface flake

Classifications:

ASC: Endocalcareous-Endohypersodic, Epipedal, Black, VERTOSOL

PPF: Ug5.1

GSG: Black earth

Vegetation:

Upper Stratum: Tall open forest (12-20 m)

Acacia harpophylla (brigalow); Eucalyptus moluccana (gum-topped box)

Mid Stratum: Apophyllum anomalum (broom bush); Capparis lasiantha (nipan)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Very dark greyish brown (10YR3/2) moist; fine sandy light clay; few 2-10%, medium pebbles 6-20mm, subrounded quartz; weak, 5-10mm, subangular blocky largest peds, parting to strong, 2-5mm, subangular blocky next size peds; dry; loose; non-calcareous. abrupt to-
B21	0.05 to 0.65	Very dark grey (10YR3/1) moist; light medium clay; very few <2%, medium pebbles 6-20mm, subrounded quartz, few 2-10%, small pebbles 2-6mm, subrounded quartz; strong, 10-20mm, subangular blocky; dry; moderately strong; non-calcareous. gradual to-
B22	0.65 to 1.26	Very dark grey (10YR3/1) moist; common 10-20%, medium 5-15mm, distinct pale mottles; light clay; few 2-10%, small pebbles 2-6mm, subrounded quartz, strong, 2-5mm, lenticular; dry; moderately strong; non-calcareous. gradual to-
B23k	1.26 to 1.55	Very dark greyish brown (10YR3/2) moist; sandy light medium clay; common 10-20%, small pebbles 2-6mm, subrounded quartz, few 2-10%, small pebbles 2-6mm, rounded siltstone; moderate, 5-10mm, lenticular; moderately moist; very firm; few 2-10%, medium 2-6mm, calcareous nodules, very few <2%, fine <2mm, gypsum crystals; slightly calcareous.

Effective rooting depth (ERD): 0.7 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 110 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.05	7.0	0.07	10	5	12	28	57	40	27	11	0.50	2.00			1	2.5	0.53	22	0.70	0.084	1.430	0.043
B21	0.2	0.3	8.7	0.17	100	8	15	21	61	42	33	11	3.0	0.89			7	3.0	0.68	23	0.69	0.063	1.430	0.028
	0.5	0.6	9.2	0.50	300	19	16	20	51	31	19	13	7.2	0.72			23	1.5	0.89	20	0.61	0.057	1.480	0.033
B22	0.8	0.9	9.3	0.86	610	13	19	18	52	33	15	15	11	0.53			33	1.0	0.98	21	0.63	0.053	1.39	0.058
	1.1	1.2	8.9	1.70	780	13	21	17	50	25	12	15	12	0.51			48	0.8	0.98	23	0.50	0.051	1.310	0.177
B23k	1.4	1.5	9.2	1.30	800	11	23	19	48	32	9.9	14	11	0.36			34	0.7	0.99	25	0.67	0.043	1.220	0.089

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
508	0	0.10B	7.2	1.9	0.16	12		141	1.50	79	26	4.3	0.87		17

Oven dry data @ 105 C

Soil Name: Greycliffe (Gc)

Site No: S28 (BAN 1648) **Date Sampled:** 15 December 1993

Location: 234 010 mE 7 297 570 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial sediments (Cza) **Substrate Lithology:** Unconsolidated Cainozoic alluvial-sediments

Landform Pattern: Gentle undulating plains **Element:** Plain

Runoff: Very slow **Slope:** 1 %

Drainage: Imperfectly drained **Permeability:** Very slowly permeable

Microrelief: Melonhole gilgai **Microrelief Component:** Mound

Horizontal Interval: 15 m **Vertical Interval:** 0.20 m

Surface Coarse Fragments: Common 10-20%, large pebbles 20-60mm, subrounded silcrete **Surface Condition:** Recently cultivated, periodic cracking

Classifications:

ASC: Epihypersodic-Endoacidic, Self-mulching, Grey VERTOSOL **PPF:** Ug5.24

GSG: Grey clay

Vegetation:

Upper Stratum: Acacia harpophylla (brigalow)

Lower Stratum: Eriochloa pseudoacrotricha (early spring grass); Brachiaria gilesii

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.02	Very dark greyish brown (10YR3/2) moist; medium clay; weak, 2-5mm, subangular blocky largest peds, parting to strong, <2mm, granular next size peds; dry; loose; non-calcareous. abrupt to-
B21	0.02 to 0.25	Dark greyish brown (10YR4/2) moist; medium clay; few 2-10%, medium pebbles 6-20mm, subrounded ironstones, few 2-10%, small pebbles 2-6mm, subangular quartz; strong, 10-20mm, angular blocky; moderately moist; very firm; non-calcareous. diffuse to-
B22	0.25 to 0.70	Brown (7.5YR4/2) moist; medium heavy clay; very few <2%, small pebbles 2-6mm, subangular quartz; strong, 5-10mm, lenticular; moderately moist; moderately firm; non-calcareous. diffuse to-
B23t	0.70 to 1.60	Greyish brown (10YR5/2) moist; heavy clay; moderate, 2-5mm, lenticular; slickensides; moist; moderately firm; non-calcareous.

Effective rooting depth (ERD): 0.5 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 70 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	6.4	0.42	530	21	20	16	46	25	8.7	12	2.70	0.44			11	0.73	0.57	16	0.54	0.028	0.453	0.056
B21	0.1	0.2	5.9	0.52	680																			
B21/B22	0.2	0.3	5.8	0.60	800	21	21	15	47	24	4.8	13	4.6	0.27	0.20	0.20	19	0.37	0.89	18	0.51	0.022	0.437	0.045
B22	0.3	0.4	5.3	0.93	1460																			
	0.4	0.5	5.0	1.20	1530																			
	0.5	0.6	4.9	1.30	1640	18	19	14	50	29	2.9	15	10	0.27	0.50	0.50	34	0.19	1.00	20	0.58	0.017	0.450	0.040
	0.6	0.7	4.7	1.50	2300																			
B23t	0.7	0.8	4.7	1.60	2360																			
	0.8	0.9	4.6	1.70	2740	11	14	17	58	33	2.3	17	13	0.30	0.40	0.60	39	0.14	1.00	22	0.57	0.015	0.456	0.036
	0.9	1.0	4.6	1.90	3080																			
	1.0	1.1	4.6	2.00	3160																			
	1.1	1.2	4.5	2.00	3070	9	13	18	60	35	2.0	17	16	0.33	0.50	0.70	46	0.12	1.00	22	0.58	0.015	0.468	0.034
	1.2	1.3	4.5	2.20	3400																			
	1.3	1.4	4.6	2.10	3340																			
	1.4	1.5	4.5	2.20	3400	7	14	15	64	40	2.0	18	20	0.39	0.50	0.60	50	0.11	1.00	22	0.63	0.015	0.490	0.031

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1648	0	0.10B	7.1	1.9	0.14	14		39	1.10	38	53	4.3	1.5		

Oven dry data @ 105 C

Soil Name: Greycliffe (Gc)

Site No: S28 (BAN 2015) **Date Sampled:** 28 September 1994

Location: 234 010 mE 7 297 570 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial colluvial sediments (Cza) **Substrate Lithology:** Unconsolidated Cainozoic alluvial-sediments

Landform Pattern: Gentle undulating plains **Element:** Plain

Runoff: No runoff **Slope:** 1 %

Drainage: Poorly drained **Permeability:** Very slowly permeable

Microrelief: Melonhole gilgai **Microrelief Component:** Depression

Horizontal Interval: 15 m **Vertical Interval:** 0.20 m

Surface Coarse Fragments: Common 10-20%, large pebbles 20-60mm, subrounded silcrete **Surface Condition:** Periodic cracking, self-mulching

Classifications:

ASC: Episodic-Endoacidic, Self-mulching, Grey, VERTOSOL **PPF:** Ug5.24

GSG: Grey clay

Vegetation:

Lower Stratum: Cleared and sown to introduced grasses

Eriochloa pseudoacrotricha (early spring grass); Brachiaria gilesii

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.04	Dark grey (10YR4/1) moist; light medium clay; few 2-10%, small pebbles 2-6mm, subrounded quartz; weak, 2-5mm, subangular blocky largest peds, parting to strong, <2mm subangular blocky next size peds; dry; loose; non-calcareous. clear to-
B21	0.04 to 0.40	Dark greyish brown (10YR4/2) moist; light medium clay; common 10-20%, small pebbles 2-6mm, subrounded quartz, and few 2-10%, small pebbles 2-6mm, subrounded ironstones; strong, 2-5mm, lenticular; dry; moderately strong; non-calcareous. diffuse to-
B22t	0.40 to 1.60	Greyish brown (10YR5/2) moist; medium clay; moderate, 5-10 mm, lenticular; moderately moist; moderately firm; non-calcareous.

Effective rooting depth (ERD): 0.6 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 75 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	6.3	0.16	160	20	18	19	46	23	7.0	12	2.3	0.48			10	0.58	0.65	17	0.50	0.032	0.456	0.043
B21	0.1	0.2	5.7	0.44	610																			
	0.2	0.3	5.6	0.48	660	23	19	19	42	23	4.5	12	5.3	0.25	0.20	0.20	23	0.38	0.88	17	0.55	0.021	0.427	0.037
	0.3	0.4	5.1	0.90	1470																			
B22t	0.4	0.5	4.9	1.10	1600																			
	0.5	0.6	4.7	1.30	2030	17	19	14	50	27	2.4	13	10	0.29	0.40	0.50	37	0.18	0.98	19	0.54	0.016	0.436	0.030
	0.6	0.7	4.7	1.50	2320																			
	0.7	0.8	4.6	1.70	2760																			
	0.8	0.9	4.6	1.70	2460	14	21	15	53	30	2.0	14	12	0.33	0.30	0.50	40	0.14	0.98	19	0.57	0.014	0.451	0.029
	0.9	1.0	4.6	1.70	2660																			
	1.0	1.1	4.6	1.80	2890																			
	1.1	1.2	4.6	1.90	2890	9	17	16	58	31	1.9	16	12	0.33	0.40	0.60	39	0.12	1.00	21	0.53	0.019	0.474	0.029
	1.2	1.3	4.6	1.90	3120																			
	1.3	1.4	4.6	2.00	3130																			
	1.4	1.5	4.6	2.00	3380	6	16	18	60	38	1.9	17	19	0.46	0.30	0.50	50	0.11	1.00	22	0.63	0.014	0.489	0.031

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2015	0	0.10B	6.5	2.6	0.16	16		118	1.1	119	87	5.5	2.8		

Oven dry data @ 105 C

Soil Name: Greycliffe, melonhole phase (GcMp)

Site No: S29 (BAN 2597) **Date Sampled:** 18 March 1996

Location: 198 310 mE 7 294 350 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial colluvial sediments (Cza) **Substrate Lithology:** Unconsolidated Cainozoic alluvial-sediments

Landform Pattern: Level plain **Element:** Plain

Runoff: Very slow **Slope:** 0 %

Drainage: Imperfectly drained **Permeability:** Very slowly permeable

Microrelief: Melonhole gilgai **Microrelief Component:** Mound

Horizontal Interval: 25 m **Vertical Interval:** 1.00 m

Surface Coarse Fragments: No coarse fragments **Surface Condition:** Periodic cracking, weakly self-mulching

Classifications:

ASC: Epihypersodic-Endoacidic, Self-mulching, Grey, VERTOSOL **PPF:** Ug5.24

GSG: Grey clay

Vegetation:

Upper Stratum: Mid-high open forest (6-12 m)
Acacia harpophylla (brigalow); Santalum lanceolatum (sandalwood)

Lower Stratum: Cenchrus ciliaris (buffel grass); Atriplex muelleri (annual saltbush)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Very dark greyish brown (10YR3/2) moist; medium clay; weak, 2-5mm, subangular blocky largest peds, parting to moderate, <2mm, subangular blocky next size peds; dry; loose; non-calcareous. abrupt to-
B21	0.05 to 0.25	Dark grey (10YR4/1) moist; medium clay; strong, 10-20mm, subangular, blocky largest peds, parting to strong, 2-5mm, lenticular next size peds; moderately moist; very firm; non-calcareous. gradual to-
B22	0.25 to 0.80	Dark greyish brown (10YR4/2) moist; medium heavy clay; moderate, 20-50mm, lenticular; slickensides; moderately moist; very firm; non-calcareous. diffuse to-
B23	0.80 to 1.55	Greyish brown (10YR5/2) moist; medium heavy clay; moderate, 20-50mm, lenticular; slickensides; moderately moist; very firm; non-calcareous.

Effective rooting depth (ERD): 0.5 m (EC ≥ 1.0 dS/m)

Plant Available Water Capacity PAWC): 75 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	6.7	0.15	60	12	23	17	46	30	18	9.0	0.84	1.40			3	2.0	0.42	19	0.65	0.041	0.384	0.046
B21	0.1	0.2	7.0	0.22	180																			
B21/B22	0.2	0.3	6.7	0.55	650	6	17	20	56	34	13	14	5.9	0.60			17	0.93	0.79	22	0.61	0.018	0.322	0.021
B22	0.3	0.4	5.7	0.81	1150																			
	0.4	0.5	5.3	1.00	1460																			
	0.5	0.6	5.2	1.20	1730	3	16	20	60	35	9.8	14	10	0.37			29	0.70	0.90	24	0.58	0.013	0.309	0.015
	0.6	0.7	5.0	1.10	1840																			
	0.7	0.8	4.9	1.20	1900																			
B23	0.8	0.9	4.8	1.20	1890	2	14	21	61	33	7.4	13	11	0.35			33	0.57	0.96	24	0.54	0.012	0.305	0.011
	0.9	1.0	4.8	1.20	2040																			
	1.0	1.1	4.7	1.20	2000																			
	1.1	1.2	4.7	1.20	1910	2	16	20	61	33	6.4	13	12	0.36			36	0.49			0.54	0.011	0.307	0.009
	1.2	1.3	4.7	1.30	2090																			
	1.3	1.4	4.7	1.30	2080																			
	1.4	1.5	4.7	1.30	2070																			

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2597	0	0.10B	7.4	2.3	0.18	13	75	44	1.1	23	47	1.5	1.3	25	

Oven dry data @ 105 C

Soil Name: Greycliffe, melonhole phase (GcMp)

Site No: S29 (BAN 2598) **Date Sampled:** 01 April 1996

Location: 198 310 mE 7 294 350 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial colluvial sediments (Cza) **Substrate Lithology:** Unconsolidated Cainozoic alluvial-sediments

Landform Pattern: Level plain **Element:** Plain

Runoff: No runoff **Slope:** 0 %

Drainage: Poorly drained **Permeability:** Very slowly permeable

Microrelief: Melonhole gilgai **Microrelief Component:** Depression

Horizontal Interval: 25 m **Vertical Interval:** 1.00 m

Surface Coarse Fragments: Very few <2%, large pebbles 20-60mm, subrounded silcrete **Surface Condition:** Periodic cracking, surface crust

Classifications:

ASC: Endohypersodic, Pedal, Grey, VERTOSOL **PPF:** Ug5.24

GSG: Grey clay

Vegetation:

Upper Stratum: Mid-high open forest (6-12 m)
Acacia harpophylla (brigalow); Santalum lanceolatum (sandalwood)

Lower Stratum: Cenchrus ciliaris (buffel grass); Atriplex muelleri (annual saltbush)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.04	Dark grey (10YR4/1) moist; few <2-10%%, fine < 2mm, distinct orange mottles; medium clay; very few <2%, small pebbles 2-6mm, subangular quartz; moderate, 2-5mm, subangular blocky; dry; moderately firm; non-calcareous. clear to-
B21	0.04 to 0.30	Dark grey (10YR4/1) moist; medium clay; very few <2%, medium pebbles 6-20mm, subrounded silcrete, very few <2%, small pebbles 2-6mm, subangular quartz; strong, 20-50mm, subangular blocky; dry; very strong; non-calcareous. diffuse to-
B22	0.30 to 0.70	Dark grey (10YR4/1) moist; medium heavy clay; few 2-10%, medium pebbles 6-20mm, subrounded silcrete, few 2-10%, small pebbles 2-6mm, subangular quartz; weak, 20-50mm, lenticular; moderately moist; very firm; non-calcareous. diffuse to-
B23	0.70 to 1.55	Greyish brown (10YR5/2) moist; medium heavy clay; few 2-10%, small pebbles 2-6mm, subangular quartz; weak, 20-50mm, lenticular; moderately moist; moderately strong; non-calcareous.

Effective rooting depth (ERD): 0.9 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 110 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	7.0	0.10	60	8	18	19	53	32	20	10	1.1	0.80			3	2.0	0.81	20	0.60	0.032	0.413	0.021
B21	0.1	0.2	7.8	0.14	110																			
	0.2	0.3	7.8	0.18	190	8	17	20	56	34	21	9.7	3.0	0.60			9	2.2	0.70	22	0.61	0.030	0.322	0.020
B22	0.3	0.4	8.2	0.25	270																			
	0.4	0.5	8.5	0.33	340																			
	0.5	0.6	8.4	0.36	400	13	22	17	48	31	15	9.6	4.9	0.35			16	1.6	0.87	19	0.65	0.019	0.260	0.014
	0.6	0.7	8.3	0.39	470																			
B23	0.7	0.8	7.8	0.45	530																			
	0.8	0.9	7.6	0.46	610	15	24	18	44	26	9.1	10	6.5	0.27			25	0.91	0.93	17	0.59	0.016	0.238	0.012
	0.9	1.0	6.8	0.51	680																			
	1.0	1.1	6.1	0.57	780																			
	1.1	1.2	5.8	0.66	960	13	24	19	44	24	6.0	9.9	7.3	0.25			30	0.61			0.55	0.014	0.241	0.011
	1.2	1.3	5.8	0.69	980																			
	1.3	1.4	5.7	0.74	1090																			
	1.4	1.5	5.6	0.76	1120																			

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2598	0	0.10B	6.4	1.8	0.14	13	76	58	0.95	59	72	3.3	1.1	12	

Oven dry data @ 105 C

Soil Name: Granville (Gn)

Site No: S26 (BAN 1801) **Date Sampled:** 11 May 1994

Location: 223 850 mE 7 312 100 mN ZONE 56

Landscape:

Geology: Deeply weathered undifferentiated Tertiary sandstones and siltstones (Ta) **Substrate Lithology:** Sandstone

Landform Pattern: Undulating rises **Element:** Hillcrest

Runoff: Very slow **Slope:** 1.5 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Firm

Surface Coarse Fragments: Few 2-10%, small pebbles 2-6mm, subrounded ironstones

Classifications:

ASC: Calcic, Mesonatric, Brown, SODOSOL **PPF:** Db3.33

GSG: Solodic

Vegetation:

Upper Stratum: Remnant trees

Eucalyptus cambageana (coowarra box); Brachychiton rupestris (narrow-leaved bottletree)

Mid Stratum: Carissa ovata (currantbush)

Lower Stratum: Sown pasture

Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.25	Dark brown (7.5YR3/3) moist; fine sandy clay loam; few 2-10%, small pebbles 2-6mm, subrounded ironstones; weak, 2-5mm, subangular blocky; dry; moderately weak; non-calcareous. clear to-
A2j	0.25 to 0.30	Dark greyish brown (10YR4/2) moist, light grey (10YR7/2) dry; fine sandy clay loam; few 2-10%, small pebbles 2-6 mm, subrounded ironstones; massive; dry; firm; non-calcareous. abrupt to-
B21	0.30 to 0.50	Dark brown (7.5YR3/4) moist; fine sandy light medium clay; few 2-10%, medium pebbles 6-20mm, subrounded ironstones; strong, 20-50mm, prismatic largest peds, parting to strong, 10-20mm, subangular blocky next size peds; moderately moist; moderately strong; very few <2%, fine <2mm, manganiferous soft segregations, non-calcareous. clear to-
B22k	0.50 to 0.90	Yellowish brown (10YR5/4) moist; few 2-10%, fine <5mm, faint yellow mottles; fine sandy light medium clay; strong, 10-20mm, subangular blocky; moderately moist; very firm; common 10-20%, medium 2-6mm, calcareous soft segregations, few 2-10%, medium 2-6mm, calcareous nodules, few <2%, fine <2mm, manganiferous soft segregations, highly calcareous. clear to-
C	0.90 to 1.60	Yellow (2.5Y7/8) moist; very few <2%, medium 5-15mm, distinct brown mottles; very abundant >90%, weathered sandstone fragments; dry; very firm; few 2-10%, medium 2-6mm, calcareous soft segregations, and very few <2%, coarse 6-20mm, calcareous nodules.

Effective rooting depth (ERD): 0.7 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 70 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.8	0.06	40	15	63	7	13	13	6.8	1.5	0.10	0.74			0.8	4.5	0.49	6	1.0	0.067	0.337	0.042
	0.1	0.2	7.5	0.05	10																			
A1/A2j	0.2	0.3	7.6	0.05	20	16	60	9	15	12	6.5	1.7	0.60	0.36			5	3.8	0.54	6	0.80	0.056	0.331	0.045
B21	0.3	0.4	7.4	0.08	20	14	35	9	43	18	5.4	6.2	2.5	0.20			14	0.9	0.93	12	0.42	0.031	0.403	0.044
	0.4	0.5	7.7	0.12	40	10	40	10	41	22	5.4	9.5	3.6	0.20			16	0.57	1.1	14	0.54	0.025	0.472	0.045
B22k	0.5	0.6	9.1	0.26	80	8	43	10	40	23	6.4	11	4.3	0.17			19	0.58	0.95	14	0.58	0.025	0.522	0.050
	0.6	0.7	9.4	0.38	150																			
	0.7	0.8	9.4	0.46	250																			
	0.8	0.9	9.5	0.45	260	8	44	7	42	16	3.7	8.0	3.7	0.15			23	0.46	0.97	10	0.38	0.021	0.473	0.042

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1801	0	0.10B	6.6	2.2	0.13	17		70	1.60	54	49	0.99	4.1		

Oven dry data @ 105 C

Soil Name: Grevillea (Gv)

Site No: S27 (BAN 2298) **Date Sampled:** 27 February 1995

Location: 224 880 mE 7 336 400 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa)

Substrate Lithology: Unconsolidated Quaternary alluvium

Landform Pattern: Level plain

Element: Plain

Runoff: Very slow

Slope: 0 %

Drainage: Imperfectly drained

Permeability: Very slowly permeable

Microrelief: Zero or none

Surface Condition: Hard setting, poached

Surface Coarse Fragments: No coarse fragments

Classifications:

ASC: Vertic, Mesonatric, Black, SODOSOL **PPF:** Dd1.33

GSG: No suitable group

Vegetation:

Upper Stratum: Tall woodland (12-20 m)
Eucalyptus populnea (poplar box)

Mid Stratum: Acacia salicina (sally wattle); Acacia oswaldii (ram's horn wattle)

Lower Stratum: Chloris divaricata (windmill grass); Atriplex muelleri (annual saltbush)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Very dark greyish brown (10YR3/2) moist, light brownish grey (10YR6/2) dry; silty clay loam; platy; dry; moderately firm. abrupt to-
A2j	0.05 to 0.10	Very dark brown (10YR2/2) moist, light grey (10YR7/1) dry; silty clay loam; strong, 10-20mm, subangular blocky; dry; very firm. abrupt to-
B21	0.10 to 0.30	Black (10YR2/1) moist; light medium clay; strong, prismatic largest peds, parting to strong, 10-20mm, angular blocky next size peds, parting to strong, 2-5mm, subangular blocky next size peds; dry; very firm. gradual to-
B22	0.30 to 1.00	Black (10YR2/1) moist; medium clay; strong, 2-5mm, lenticular; slickensides; moderately moist; very firm; very few <2%, medium 2-6mm, calcareous concretions. gradual to-
B23	1.00 to 1.60	Very dark greyish brown (10YR3/2) moist; common 10-20%, fine <5mm, faint brown mottles; medium clay; strong, prismatic largest peds, parting to strong, lenticular next size peds; moderately moist; very firm; very few <2%, medium 2-6mm, calcareous concretions.

Effective rooting depth (ERD): 0.3 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 50 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/A2j	0	0.1	6.6	0.08	40	4	32	36	30	27	7.7	8.4	1.4	0.50			5	0.9	0.68	13	0.90	0.071	0.958	0.029
B21	0.1	0.2	7.3	0.34	390					35	14	14	5.9	0.20			17	1.0						
	0.2	0.3	7.9	0.74	910	3	22	27	52	41	13	17	9.3	0.20			23	0.8	0.79	21	0.79	0.041	0.786	0.034
B22	0.3	0.4	8.3	1.30	1710																			
	0.4	0.5	8.4	1.50	1920																			
	0.5	0.6	8.7	1.60	2060	3	17	25	60	44	13	19	14	0.25			32	0.7	0.93	23	0.73	0.034	0.720	0.049
	0.6	0.7	8.8	1.60	2020																			
	0.7	0.8	8.8	1.60	2010																			
	0.8	0.9	8.8	1.70	2130	4	20	21	58	40	10	18	13	0.30			33	0.6	0.98	22	0.69	0.034	0.786	0.043
	0.9	1.0	8.8	1.50	1900																			
B23	1.0	1.1	8.8	1.40	1770																			
	1.1	1.2	8.9	1.50	1790	3	20	22	55	36	9.2	16	11	0.35			31	0.6			0.65	0.035	0.836	0.040
	1.2	1.3	8.9	1.40	1730																			
	1.3	1.4	8.9	1.40	1730																			
	1.4	1.5	8.9	1.40	1750																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2298	0	0.10B	6.4	2.1	0.12	18	68	37	0.38	89	58	4.2	0.97	16	

Oven dry data @ 105 C

Soil Name: Harris (Hr)

Site No: S30 (BAN 682) **Date Sampled:** 22 January 1992

Location: 219 270 mE 7 299 780 mN ZONE 56

Landscape:

Geology: Permian andesite, basaltic and trachytic lava, tuff etc of the Camboon Andesite (Pln)

Substrate Lithology: Volcanic rocks (unidentified)

Landform Pattern: Undulating low hills

Element: Hillcrest

Runoff: Slow

Slope: 1.5 %

Drainage: Moderately well drained

Permeability: Slowly permeable

Microrelief: Zero or none

Surface Condition: Surface flake, self-mulching

Surface Coarse Fragments: Few 2-10%, medium pebbles 6-20mm, subangular volcanic rocks (unidentified)

Classifications:

ASC: Gypsic, Self-mulching, Brown, VERTOSOL **PPF:** Ug5.3

GSG: Brown clay

Vegetation:

Upper Stratum: Extremely tall woodland

Acacia harpophylla (brigalow); Brachychiton australis (broad-leaved bottletree); Brachychiton rupestris (narrow-leaved bottletree); Geijera parviflora (wilga)

Mid Stratum: Acalypha capillipes (crinkly leaf bush); Carissa ovata (currantbush)

Lower Stratum: Paspalidium gracile (slender panic)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Dark brown (7.5YR3/2) moist; light clay; few 2-10%, small pebbles 2-6mm, subangular quartz, very few <2%, medium pebbles 6-20mm, subangular volcanic rocks (unidentified); strong, <2mm, granular; dry; loose; non-calcareous. abrupt to-
B21	0.05 to 0.35	Dark brown (7.5YR3/3) moist; light medium clay; very few <2%, small pebbles 2-6mm, subangular volcanic rocks (unidentified); strong, 5-10mm, subangular blocky; dry; moderately firm; non-calcareous. gradual to-
B22k	0.35 to 0.75	Reddish brown (5YR4/3) moist; light medium clay; very few <2%, small pebbles 2-6mm, subangular volcanic rocks (unidentified); strong, lenticular; moderately moist; moderately firm; few 2-10%, medium 2-6mm, calcareous soft segregations, moderately calcareous. clear to-
B23y	0.75 to 1.20	Yellowish red (5YR5/6) moist; many 20-50%, coarse 15-30mm, prominent pale mottles, common 10-20%, medium 5-15mm, prominent red mottles; light clay; moderate, lenticular; moderately moist; moderately weak; few 2-10%, medium 2-6mm, calcareous soft segregations, many 20-50%, coarse 6-20mm, gypseous crystals; moderately calcareous. abrupt to-
BC	1.20 to 1.50	Dark brown (7.5YR 3/4) moist; many 20-50%, coarse 15-30 mm, distinct red mottles; fine sandy light medium clay; abundant 50-90% fragments, weathered volcanic rocks (unidentified), common 10-20%, medium 2-6 mm, gypseous crystals.

Effective rooting depth (ERD): 0.6 m (EC ≥ 1.0 dS/m)

Plant Available Water Capacity PAWC): 105 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	7.2	0.18	30	17	12	14	59	46	35	4.0	0.40	0.63			0.9	8.7	0.46	21	0.78	0.098	0.628	0.098
B21	0.2	0.3	7.4	0.22	200	11	11	10	69	44	33	7.1	1.9	0.19			4	4.6	0.42	21	0.64	0.070	0.605	0.069
B22	0.5	0.6	8.4	0.74	800	10	11	14	67	34	25	8.7	3.6	0.10			11	2.9	0.39	20	0.51	0.061	0.537	0.098
B23	0.8	0.9	7.9	3.00	830					22	19	6.8	2.8	0.02			13	2.8		19		0.059	0.745	4.4
	1.1	1.2	6.1	3.20	1100					19	16	7.5	3.1	0.02			16	2.1				0.062	1.0	6.2
BC	1.4	1.5	4.5	3.80	1760					26	13	9.2	3.0	0.01			12	1.4		21		0.063	0.860	3.6

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
682	0	0.10B	7.8	4.9	0.39	13		20	1.1	13	5.7	2.7	1.5		49

Oven dry data @ 105 C

Soil Name: Hodge (Hd)

Site No: S31 (BAN 2090) **Date Sampled:** 16 November 1994

Location: 242 400 mE 7 305 280 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa)

Substrate Lithology: Unconsolidated Quaternary alluvium

Landform Pattern: Level plain

Element: Levee

Runoff: Very slow

Slope: 0.7 %

Drainage: Well drained

Permeability: Moderately permeable

Microrelief: Zero or none

Surface Condition: Firm

Surface Coarse Fragments: No coarse fragments

Classifications:

ASC: Haplic, Eutrophic, Black, KANDOSOL **PPF:** Gn2.42

GSG: No suitable group

Vegetation: Cleared for irrigated cropping

Profile Morphology:

Horizon	Depth (m)	Description
AP	0.00 to 0.15	Very dark brown (10YR2/2) moist; fine sandy loam; massive; dry; moderately weak; non-calcareous. abrupt to-
B1	0.15 to 0.35	Black (10YR2/1) moist; few 2-10%, medium 5-15mm, distinct brown mottles; fine sandy clay loam; weak, 5-10mm, subangular blocky; moderately moist; moderately weak; non-calcareous. abrupt to-
B2	0.35 to 0.65	Black (10YR2/1) moist; few 2-10%, medium 5-15mm, distinct brown mottles; clay loam, fine sandy; weak, 20-50mm, prismatic; moderately moist; moderately weak; non-calcareous. abrupt to-
2D	0.65 to 1.25	Very dark greyish brown (10YR3/2) moist; few 2-10%, fine <5mm, distinct dark mottles; fine sandy loam; massive; moderately moist; moderately weak; non-calcareous. clear to-
3D	1.25 to 1.55	Dark brown (10YR3/3) moist; fine sandy clay loam; massive; moderately moist; moderately weak; non-calcareous.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 100 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl^- (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H^+	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
AP	0	0.1	6.2	0.12	10	12	63	11	16	16	7.0	2.5	0.06	1.30			0.4	2.8	0.57	7	1.0	0.071	1.35	0.021
B1	0.2	0.3	6.9	0.06	10	5	64	14	20	20	13	3.7	0.05	0.63			0.3	3.5	0.45	10	1.0	0.080	1.29	0.021
B2	0.5	0.6	7.7	0.07	10	3	49	24	29	26	20	5.0	0.15	0.37			0.6	4.0	0.51	12	0.90	0.072	1.16	0.020
2D	0.8	0.9	8.2	0.07	20	11	68	9	13	15	11	4.0	0.03	0.23			0.2	2.8	0.52	7	1.2	0.055	1.23	0.012
	1.1	1.2	8.3	0.08	10	22	57	8	14	15	10	4.4	0.07	0.25			0.5	2.3			1.1	0.049	1.19	0.011
3D	1.4	1.5	8.3	0.10	20																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2090	0	0.10B	6.5	1.2	0.08	15		71	1.7	44	19	1.1	1.4	7	

Oven dry data @ 105 C

Soil Name: Jambin (Jb)

Site No: S32 (BAN 835) **Date Sampled:** 19 May 1992
Location: 230 980 mE 7 320 050 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa)
Substrate Lithology: Unconsolidated Quaternary alluvium
Landform Pattern: Level plain
Element: Backplain
Runoff: Very slow
Slope: 0.5 %
Drainage: Imperfectly drained
Permeability: Slowly permeable
Microrelief: Normal gilgai
Microrelief Component: Depression
Horizontal Interval: 4 m
Vertical Interval: 0.10 m
Surface Coarse Fragments: No coarse fragments
Surface Condition: Periodic cracking, self-mulching

Classifications:

ASC: Epicalcareous-Endohypersodic, Self-mulching, Black, VERTOSOL
PPF: Ug5.1
GSG: Black earth

Vegetation:

Upper Stratum: Mid-high open woodland (6-12 m)
Acacia harpophylla (brigalow); Eremophila mitchellii (false sandalwood); Geijera parviflora (wilga)
Mid Stratum: Alectryon diversifolium (holly bush); Apophyllum anomalum (broom bush)
Lower Stratum: Panicum maximum var. trichoglume (green panic)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Very dark grey (10YR3/1) moist; light medium clay; strong, 2-5mm, polyhedral largest peds, parting to strong, <2mm, polyhedral next size peds; moist; very weak; non-calcareous. abrupt to-
B21	0.05 to 0.30	Very dark grey (10YR3/1) moist; medium heavy clay; strong, 10-20mm, subangular blocky largest peds, parting to strong, 2-5mm, lenticular next size peds; moist; moderately weak; very few <2%, fine <2mm, calcareous soft segregations, slightly calcareous.
B22	0.30 to 0.60	Very dark grey (10YR3/1) moist; medium clay; strong, 5-10mm, lenticular largest peds, parting to strong, 2-5mm, lenticular next size peds; moderately moist; moderately firm; few 2-10%, medium 2-6mm, calcareous soft segregations, slightly calcareous. diffuse to-
B23	0.60 to 1.10	Very dark grey (10YR3/1) moist; medium clay; strong, 5-10mm, lenticular largest peds, parting to strong, 2-5mm, lenticular next size peds; slickensides; moderately moist; very firm; very few <2%, medium 2-6mm, calcareous nodules, non-calcareous. diffuse to-
B24k	1.10 to 1.60	Very dark grey (10YR3/1) moist; light medium clay; strong, 5-10mm, lenticular largest peds, parting to strong, 2-5mm, lenticular next size peds; slickensides; moderately moist; very firm; common 10-20%, coarse 6-20mm, calcareous nodules, non-calcareous.

Effective rooting depth (ERD): 1.0 m (EC ≥ 1.0 dS/m)
Plant Available Water Capacity PAWC): 160 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	7.2	0.10	40	3	12	21	64	47	28	16	0.8	1.4			2	1.5	0.47	26	0.73	0.056	0.792	0.058
B21	0.1	0.2	8.0	0.30	250																			
	0.2	0.3	8.4	0.55	510	3	13	19	66	56	29	18	4.1	0.46			7	1.6	0.49	27	0.85	0.039	0.689	0.054
B22	0.3	0.4	8.4	0.75	700																			
	0.4	0.5	8.4	0.80	730																			
	0.5	0.6	8.3	0.78	700	2	12	19	68	57	24	21	6.8	0.32			12	1.1	0.65	26	0.84	0.037	0.668	0.055
B23	0.6	0.7	8.2	0.78	760																			
	0.7	0.8	8.0	0.79	800																			
	0.8	0.9	8.1	0.75	940	2	12	19	66	52	21	22	7.0	0.27			14	1.0	0.82	26	0.79	0.035	0.692	0.051
	0.9	1.0	7.6	0.80	900																			
	1.0	1.1	7.6	0.76	880																			
B24k	1.1	1.2	8.0	0.78	900	2	14	21	64	52	19	22	8.0	0.24			15	0.9	0.88	24	0.81	0.034	0.706	0.042
	1.2	1.3	8.2	0.82	960																			
	1.3	1.4	8.4	0.85	980																			
	1.4	1.5	8.5	0.81	1000	4	16	19	66	45	16	19	6.9	0.25			15	0.8	0.83	23	0.68	0.032	0.680	0.035

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
835	0	0.10B	7.9	2.2	0.13	17		56	1.0	24	9.5	3.8	1.2		

Oven dry data @ 105 C

Soil Name: Kianga (Kg)

Site No: S33 (BAN 536) **Date Sampled:** 16 October 1991

Location: 207 500 mE 7 287 400 mN ZONE 56

Landscape:

Geology: Permian siltstone, sandstone and mudstone of the Gyranda formation (Puy)

Substrate Lithology: Mudstone

Landform Pattern: Gentle undulating rises

Element: Hillslope

Runoff: Slow

Slope: 3 %

Drainage: Moderately well drained

Permeability: Moderately permeable

Microrelief: Zero or none

Surface Condition: Recently cultivated, soft

Surface Coarse Fragments: Very few <2%, large pebbles 20-60mm, subrounded mudstone

Classifications:

ASC: Vertic, Calcic, Brown, DERMOSOL **PPF:** Uf6.31

GSG: No suitable group

Vegetation:

Cleared for dryland cropping

Profile Morphology:

Horizon	Depth (m)	Description
AP	0.00 to 0.10	Dark brown (7.5YR3/4) moist; light clay; very few <2%, medium pebbles 6-20mm, subangular detrital sedimentary rock (unidentified); clods; dry; firm; non-calcareous. abrupt to-
B21	0.10 to 0.35	Dark brown (7.5YR3/4) moist; light medium clay; strong, 10-20mm, subangular blocky; moderately moist; firm; non-calcareous. gradual to-
B22	0.35 to 0.80	Dark reddish brown (5YR3/3) moist; medium clay; strong, 5-10mm, lenticular; moderately moist; firm; few 2-10%, medium 2-6mm, calcareous nodules, non-calcareous. gradual to-
B23k	0.80 to 1.10	Dark yellowish brown (10YR4/4) moist; common 10-20%, medium 5-15mm, prominent brown mottles; medium clay; strong, 20-50mm, prismatic largest peds, parting to strong, 5-10mm, lenticular next size peds; moist; firm; common 10-20%, medium 2-6mm, calcareous nodules, very highly calcareous. clear to-
B3	1.10 to 1.20	Brownish yellow (10YR6/6) moist; very few <2%, fine <5mm, prominent grey mottles; light medium clay; many 20-50%, medium pebbles 6-20mm, subangular mudstone; few 2-10%, medium 2-6mm, calcareous nodules, very highly calcareous. abrupt to-
C	1.20 to 1.40	Very abundant >90%, weathered mudstone fragments.

Effective rooting depth (ERD): 1.4 m (bedrock)

Plant Available Water Capacity PAWC): 135 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
AP	0	0.1	7.7	0.22	50	8	27	15	52	26	23	2.6	0.52	1.3			2	8.8	0.48	19	0.50	0.070	1.83	0.040
B21	0.2	0.3	8.6	0.11	10	8	21	10	62	28	28	1.9	0.45	0.59			2	15	0.38	19	0.45	0.055	1.74	0.028
B22	0.5	0.6	8.9	0.11	10	15	18	19	51	21	22	2.2	0.41	0.34			2	10	0.56	15	0.41	0.082	1.47	0.026
B23k	0.8	0.9	9.1	0.11	10	14	17	21	50	19	21	3.0	0.49	0.28			3	7.0	0.58	14	0.38	0.092	1.89	0.019
B3	1.1	1.2	9.1	0.10	10	18	33	15	36	17	16	3.0	0.44	0.22			3	5.3			0.47	0.092	1.47	0.018

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
536	0	0.10B	7.7	1.7	0.14	12		56	1.7	8.2	23	2	0.70		26

Oven dry data @ 105 C

Soil Name: Kilburnie (Kb)

Site No: S34 (BAN 2097) **Date Sampled:** 24 November 1994

Location: 244 220 mE 7 306 230 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial sediments (Cza) **Substrate Lithology:** Unconsolidated Cainozoic alluvial-colluvial sediments

Landform Pattern: Gentle undulating plains **Element:** Plain

Runoff: Slow **Slope:** 1.5 %

Drainage: Imperfectly drained **Permeability:** Slowly permeable

Microrelief: Linear gilgai **Microrelief Component:** Mound

Horizontal Interval: 4 m **Vertical Interval:** 0.05 m

Surface Coarse Fragments: Very few <2%, large pebbles 20-60mm, subrounded silcrete **Surface Condition:** Periodic cracking, self-mulching

Classifications:

ASC: Epicalcareous-Endohypersodic, Self-mulching, Black, VERTOSOL **PPF:** Ug5.15

GSG: Black earth

Vegetation:

Upper Stratum: Partially cleared Eucalyptus populnea (poplar box)

Mid Stratum: Eremocitrus glauca (limebush)

Lower Stratum: Urochloa mosambicensis (sabi grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Very dark grey (10YR3/1) moist; medium clay; strong, <2mm, granular; moist; very weak; non-calcareous. abrupt to-
B21k	0.05 to 0.60	Very dark grey (10YR3/1) moist; medium clay; strong, 2-5mm, lenticular; moist; very weak; few 2-10%, fine <2mm, calcareous nodules, slightly calcareous. gradual to-
B22	0.60 to 1.25	Brown (10YR4/3) moist; common 10-20%, medium 5-15mm, prominent dark mottles; medium clay; very few <2%, large pebbles 20-60mm, subrounded silcrete; strong, 2-5mm, lenticular; slickensides; moderately moist; very firm; non-calcareous. clear to-
B23	1.25 to 1.55	Yellowish brown (10YR5/4) moist; common 10-20%, medium 5-15mm, distinct grey mottles, few 2-10%, medium 5-15mm, distinct brown mottles; medium clay; strong, 5-10mm, lenticular; slickensides; moderately moist; very firm; non-calcareous.

Effective rooting depth (ERD): 0.6 m (EC ≥ 1.0 dS/m)

Plant Available Water Capacity PAWC): 85 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1 / B21k	0	0.1	8.5	0.19	60	16	21	14	47	37	24	10	1.8	0.48			5	2.4	0.53	17	0.79	0.021	0.380	0.026
B21k	0.1	0.2	8.8	0.28	130																			
	0.2	0.3	8.8	0.48	350	14	19	12	51	40	20	13	4.8	0.27			12	1.5	0.65	20	0.78	0.015	0.348	0.034
	0.3	0.4	8.7	0.72	670																			
	0.4	0.5	8.7	0.85	850																			
	0.5	0.6	8.6	0.94	860	12	18	15	52	37	16	14	6.5	0.24			18	1.1	0.78	21	0.71	0.014	0.388	0.034
B22	0.6	0.7	8.6	0.96	880																			
	0.7	0.8	8.4	0.95	960																			
	0.8	0.9	8.3	0.95	1020	9	20	15	53	36	14	13	7.0	0.29			19	1.1	1.00	20	0.68	0.014	0.581	0.027
	0.9	1.0	8.0	0.84	960																			
	1.0	1.1	7.9	0.77	840																			
	1.1	1.2	7.6	0.72	840	11	24	15	49	31	11	11	6.7	0.28			22	1.0			0.63	0.014	0.877	0.022
B22/B23	1.2	1.3	7.1	0.73	900																			
B23	1.3	1.4	6.2	0.73	920																			
	1.4	1.5	5.7	0.75	890																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2097	0	0.10B	8.3	1.3	0.08	16	20	16	0.65	16	14	1.7	0.58	5	

Oven dry data @ 105 C

Soil Name: Kilburnie (Kb)

Site No: S34 (BAN 2096) **Date Sampled:** 24 November 1994

Location: 244 220 mE 7 306 200 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial sediments (Cza) **Substrate Lithology:** Unconsolidated Cainozoic alluvial-colluvial sediments

Landform Pattern: Gentle undulating plains **Element:** Plain

Runoff: Slow **Slope:** 1.5 %

Drainage: Imperfectly drained **Permeability:** Slowly permeable

Microrelief: Linear gilgai **Microrelief Component:** Depression

Horizontal Interval: 4 m **Vertical Interval:** 0.05 m

Surface Coarse Fragments: Very few <2%, large pebbles 20-60mm, subrounded silcrete **Surface Condition:** Surface crust, firm

Classifications:

ASC: Melanic-Vertic, Calcic, Black, DERMOSOL **PPF:** Uf6.32

GSG: No suitable group

Vegetation:

Upper Stratum: Partially cleared
Eucalyptus populnea (poplar box)

Mid Stratum: Eremocitrus glauca (limebush)

Lower Stratum: Urochloa mosambicensis (sabi grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.10	Very dark grey (10YR3/1) moist; medium clay; strong, 5-10mm, subangular blocky; dry; very firm. clear to-
B21	0.10 to 0.65	Very dark grey (10YR3/1) moist; medium clay; strong, 2-5mm, lenticular; slickensides; moderately moist moderately firm; very few <2%, medium 2-6mm, calcareous nodules, very few <2%, medium 2-6mm, calcareous soft segregations. clear to-
B22k	0.65 to 1.10	Brown (10YR4/3) moist; common 10-20%, medium 5-15mm, prominent dark mottles; medium clay; strong, 2-5mm, lenticular; slickensides; moderately moist; very firm; common 10-20%, coarse 6-20mm, calcareous nodules, few 2-10%, medium 2-6mm, calcareous soft segregations. gradual to-
B23	1.10 to 1.55	Brown (10YR4/3) moist; medium clay; strong, 2-5mm, lenticular largest peds; slickensides; moderately moist; moderately firm; very few <2%, medium 2-6mm, calcareous nodules.

Effective rooting depth (ERD): 0.6 m (EC ≥ 1.0 dS/m)

Plant Available Water Capacity PAWC): 85 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.0	0.13	120	19	31	17	31	19	9.1	7.0	1.3	0.50			7	1.6	0.73	12	0.65	0.024	0.384	0.023
B21	0.1	0.2	7.0	0.28	320																			
	0.2	0.3	7.4	0.51	600	15	22	17	44	36	16	11	5.2	0.25			14	1.5	0.75	19	0.82	0.015	0.374	0.027
	0.3	0.4	7.8	0.78	1000																			
	0.4	0.5	8.1	0.93	1020																			
	0.5	0.6	8.5	1.00	1050	13	18	18	52	43	19	15	8.0	0.29			19	1.3	0.87	22	0.83	0.013	0.356	0.042
B21 / B22k	0.6	0.7	8.6	1.10	1030																			
B22k	0.7	0.8	8.6	1.10	1120																			
	0.8	0.9	8.5	1.10	1170	11	22	17	50	36	15	14	8.0	0.34			22	1.1	0.99	22	0.72	0.013	0.498	0.031
	0.9	1.0	8.0	1.00	1090																			
	1.0	1.1	7.7	0.91	1020																			
B23	1.1	1.2	7.4	0.87	890	9	28	17	47	30	11	11	6.9	0.23			23	1.0			0.64	0.013	0.845	0.027
	1.2	1.3	6.6	0.85	900																			
	1.3	1.4	6.0	0.87	930																			
	1.4	1.5	5.6	0.88	900																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2096	0	0.10B	7.0	1.8	0.11	16	14	27	0.65	36	67	2	0.90	6	

Oven dry data @ 105 C

Soil Name: Kokotungo (Kt)

Site No: S35 (BAN 1811) **Date Sampled:** 18 May 1994

Location: 218 470 mE 7 312 640 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial sediments (Cza) **Substrate Lithology:** Unconsolidated Cainozoic alluvial-sediments

Landform Pattern: Gently undulating plains **Element:** Plain

Runoff: Slow **Slope:** 1 %

Drainage: Imperfectly drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Firm

Surface Coarse Fragments: Very few <2%, medium pebbles 6-20mm, subrounded ironstone

Classifications:

ASC: Vertic, Subnatric, Brown, SODOSOL **PPF:** Db3.33

GSG: Solodic

Vegetation:

Upper Stratum: Mid-high open forest (6-12 m)
Eucalyptus cambageana (coowarra box); Brachychiton rupestris (narrow-leaved bottletree)

Mid Stratum: Acacia harpophylla (brigalow); Citriobatus spinescens (wallaby apple); Alectryon diversifolium (holly bush); Carissa ovata (currantbush)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.15	Brown (10YR4/3) moist; silty loam; very few <2%, small pebbles 2-6mm, subrounded quartz and ironstones; massive; dry; moderately weak; non-calcareous. abrupt to-
A2j	0.15 to 0.20	Brown (10YR4/3) moist, light grey (10YR7/1) dry; silty loam; very few <2%, small pebbles 2-6mm, subrounded quartz and ironstones; massive; dry; moderately firm; non-calcareous. abrupt to-
B21	0.20 to 0.50	Dark yellowish brown (10YR4/4) moist; light medium clay; strong, 20-50mm, prismatic largest peds, parting to strong, 2-5mm, subangular blocky next size peds; dry; very firm; non-calcareous. clear to-
B22	0.50 to 0.85	Strong brown (7.5YR4/6) moist; light medium clay; few 2-10%, medium pebbles 6-20mm, subrounded quartz and ironstones; strong, 5-10mm, subangular blocky; dry; very firm; non-calcareous. gradual to-
B23	0.85 to 1.50	Reddish brown (5YR4/4) moist; few 2-10%, medium 5-15mm, distinct grey mottles; light medium clay; few 2-10%, large pebbles 20-60mm, subrounded ironstones; strong, 2-5mm, lenticular; moderately moist; moderately firm; common 10-20%, fine <2mm, manganiferous soft segregations, and few 2-10%, fine <2mm, manganiferous nodules.

Effective rooting depth (ERD): 0.9 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 95 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.5	0.09	40	11	42	20	24	19	9.0	2.0	0.12	0.80			0.6	4.5	0.41	10	0.79	0.109	0.428	0.062
A1/A2j	0.1	0.2	6.8	0.06	110																			
B21	0.2	0.3	7.2	0.08	40	9	39	20	38	15	6.4	3.5	0.89	0.48			6	1.8	0.70	14	0.39	0.047	0.580	0.039
	0.3	0.4	7.7	0.13	80	7	35	19	42	15	6.0	4.4	1.4	0.48			9	1.4	0.73	14	0.36	0.039	0.636	0.039
	0.4	0.5	7.9	0.20	150																			
B22	0.5	0.6	7.9	0.27	240	5	35	18	43	14	5.4	5.7	1.8	0.44			13	0.9	0.82	14	0.33	0.036	0.680	0.047
	0.6	0.7	8.1	0.37	340																			
	0.7	0.8	8.1	0.41	430																			
B22/B23	0.8	0.9	8.1	0.48	520	12	40	12	35	11	3.9	5.0	2.3	0.40			21	0.8	0.92	12	0.25	0.040	0.654	0.047
B23	0.9	1.0	8.1	0.61	620																			
	1.0	1.1	8.1	0.70	730																			
	1.1	1.2	8.1	0.82	820	6	35	14	46	14	3.4	6.9	4.0	0.59			29	0.5	1.00	15	0.30	0.034	0.688	0.063
	1.2	1.3	8.1	0.78	790																			
	1.3	1.4	8.0	0.93	980																			
	1.4	1.5	8.7	0.98	1000	5	40	14	45	15	4.6	7.4	5.3	0.60			35	0.6	0.98	15	0.33	0.034	0.731	0.058

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1811	0	0.10B	7.1	4.6	0.31	15		83	0.97	113	49	1.3	12		

Oven dry data @ 105 C

Soil Name: Kooingal (Kn)

Site No: S36 (BAN 1601) **Date Sampled:** 16 November 1993

Location: 245 646 mE 7 288 770 mN ZONE 56

Landscape:

Geology: Tertiary olivine basalt (Tb) **Substrate Lithology:** Basalt

Landform Pattern: Plateau **Element:** Hillslope

Runoff: Very rapid **Slope:** 12 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Periodic cracking, self-mulching

Surface Coarse Fragments: Many 20-50%, stones 200-600mm, subangular basalt

Classifications:

ASC: Epicalcareous-Epihypersodic, Self-mulching, Black, VERTOSOL **PPF:** Ug5.16

GSG: Black earth

Vegetation:

Mid Stratum: Capparis lasiantha (nipan); Alectryon diversifolium (holly bush)

Lower Stratum: Panicum maximum var. trichoglume (green panic); Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.06	Black (10YR2/1) moist; medium heavy clay; strong, <2mm, granular; moist; very weak; non-calcareous. abrupt to-
B21	0.06 to 0.50	Dark brown (7.5YR3/2) moist; medium heavy clay; common 10-20%, large pebbles 20-60mm, subangular basalt; strong, 2-5mm, lenticular; moderately moist; moderately firm; few 2-10%, fine <2mm, calcareous soft segregations, and very few <2%, fine <2mm, calcareous nodules, highly calcareous. gradual to-
B22k	0.50 to 0.80	Dark greyish brown (2.5Y4/2) moist; few 2-10%, fine <5mm, faint yellow mottles, few 2-10%, fine <5mm, faint dark mottles; medium clay; few 2-10%, cobbles 60-200mm, subangular basalt; strong, 2-5mm, lenticular; slickensides; moderately moist; moderately firm; few 2-10%, fine <2mm, calcareous soft segregations, and common 10-20%, medium 2-6mm, calcareous nodules, highly calcareous. abrupt to-
BC	0.80 to 1.50	Light grey (10YR7/1) moist; many 20-50%, medium 5-15mm, distinct orange mottles, few 2-10%, medium 5-15mm, distinct red mottles; light medium clay; very few <2%, cobbles 60-200mm, subangular basalt; moderate, 5-10mm, lenticular; slickensides; dry; very firm; few 2-10%, medium 2-6mm, calcareous soft segregations, non-calcareous.

Effective rooting depth (ERD): 0.5 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 100 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	8.5	0.24	80	5	5	18	72	54	22	25	1.7	1.1			3	0.88	0.45	26	0.75	0.058	0.625	0.066
B21	0.1	0.2	8.7	0.36	230																			
	0.2	0.3	8.9	0.78	810	2	5	13	77	52	13	30	6.1	0.40			12	0.43	0.58	27	0.68	0.039	0.528	0.062
	0.3	0.4	8.9	1.10	1450																			
	0.4	0.5	8.9	1.50	1700																			
B22k	0.5	0.6	8.9	1.60	1870	1	6	11	78	47	7.8	29	12	0.21			26	0.27	0.73	26	0.60	0.028	0.452	0.065
	0.6	0.7	8.9	1.80	2190																			
	0.7	0.8	8.9	2.00	2350																			
BC	0.8	0.9	8.9	1.90	2150	1	3	14	80	48	6.0	28	13	0.23			27	0.21	0.71	26	0.60	0.027	0.426	0.074
	0.9	1.0	8.8	2.10	2520																			
	1.0	1.1	8.8	2.00	2530																			
	1.1	1.2	8.7	1.90	2390	1	4	14	80	46	5.2	29	13	0.15			28	0.18	0.85	26	0.58	0.025	0.396	0.067
	1.2	1.3	8.7	2.00	2750																			
	1.3	1.4	8.6	2.00	2820																			
	1.4	1.5	8.7	1.80	2620	1	4	10	81	40	3.7	27	11	0.07			28	0.14	0.87	25	0.49	0.021	0.520	0.050

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1601	0	0.10B	8.1	3.1	0.23	13		72	1.6	13	9.8	2	0.98		

Oven dry data @ 105 C

Soil Name: Koorngoo (Kr)

Site No: S37 (BAN 1868) **Date Sampled:** 28 June 1994

Location: 226 170 mE 7 318 120 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial colluvial sediments (Cza)

Substrate Lithology: Unconsolidated Cainozoic alluvial-sediments

Landform Pattern: Undulating rises

Element: Hillslope

Runoff: Slow

Slope: 5 %

Drainage: Well drained

Permeability: Moderately permeable

Microrelief: Zero or none

Surface Condition: Hard setting

Surface Coarse Fragments: Few 2-10%, small pebbles 2-6mm, subangular quartz

Classifications:

ASC: Haplic, Eutrophic, Red, KANDOSOL **PPF:** Gn2.12

GSG: Red earth

Vegetation:

Upper Stratum: Predominantly cleared
Flindersia australis (crow's ash); Eucalyptus citriodora (lemon-scented gum); Eucalyptus cambageana (coowarra box)

Mid Stratum: Alstonia constricta (bitter bark); Alectryon diversifolium (holly bush)

Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.13	Dark brown (7.5YR3/4) moist; fine sandy loam; massive; dry; moderately weak; non-calcareous. gradual to-
A3	0.13 to 0.37	Dark reddish brown (5YR3/4) moist; fine sandy clay loam; massive; dry; moderately weak; non-calcareous. gradual to-
B1	0.37 to 0.60	Dark red (2.5YR3/6) moist; clay loam, fine sandy; very few <2%, medium pebbles 6-20mm, subrounded ironstones; massive; dry; moderately weak; non-calcareous. clear to-
B2	0.60 to 1.50	Dark reddish brown (2.5YR3/4) moist; light clay; very few <2%, small pebbles 2-6mm, subrounded ironstones, very few <2%, small pebbles 2-6mm, subrounded quartz; massive; dry; moderately weak; non-calcareous.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 105 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.0	0.04	10	18	52	9	20	6	3.8	1.5	0.05	0.42			0.8	2.5	0.57	5	0.30	0.043	0.253	0.020
A1/A3	0.1	0.2	7.1	0.03	10																			
A3	0.2	0.3	7.5	0.03	10	16	50	11	23	5	3.3	1.2	0.05	0.36			1	2.8	0.58	5	0.22	0.035	0.290	0.012
A3/B1	0.3	0.4	7.7	0.03	10																			
B1	0.4	0.5	7.8	0.03	10																			
	0.5	0.6	7.8	0.03	10	13	38	10	39	7	3.1	2.8	0.08	0.79			1	1.1	0.46	9	0.18	0.044	0.433	0.012
B2	0.6	0.7	7.5	0.03	10																			
	0.7	0.8	7.2	0.03	10																			
	0.8	0.9	7.2	0.03	10	13	38	10	39	6	2.4	3.2	0.11	0.54			2	0.8	0.44	10	0.15	0.043	0.424	0.013
	0.9	1.0	6.8	0.02	10																			
	1.0	1.1	6.6	0.02	10																			
	1.1	1.2	6.6	0.03	10	14	38	10	37	6	2.2	3.1	0.15	0.31			3	0.7			0.16	0.042	0.389	0.014
	1.2	1.3	5.8	0.03	10																			
	1.3	1.4	5.9	0.04	10																			
	1.4	1.5	6.0	0.04	10																			

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1868	0	0.10B	7.2	1.4	0.1	14	35	22	1.1	12	37	1.2	5.4	5	

Oven dry data @ 105 C

Soil Name: Lancefield (Lf)

Site No: S38 (BAN 2515) **Date Sampled:** 15 June 1995

Location: 245 000 mE 7 337 575 mN ZONE 56

Landscape:

Geology: Interbedded Permian conglomerate and tuff of the Youlambie Conglomerate (Ply) **Substrate Lithology:** Siltstone

Landform Pattern: Steep low hills **Element:** Hillslope

Runoff: Very rapid **Slope:** 45 %

Drainage: Well drained **Permeability:** Moderately permeable

Microrelief: Zero or none **Surface Condition:** Firm

Surface Coarse Fragments: Abundant 50-90%, medium pebbles 6-20mm, angular siltstone

Classifications:

ASC: Haplic, Eutrophic, Brown, DERMOSOL **PPF:** Uf6.31

GSG: No suitable group

Vegetation:

Lower Stratum: Cleared and sown to introduced grasses

Panicum maximum var. trichoglume (green panic); Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.10	Dark brown (10YR3/3) moist; light medium clay; many 20-50%, small pebbles 2-6mm, angular siltstone, and many 20-50%, large pebbles 20-60mm, angular siltstone; strong, <2mm, subangular blocky; non-calcareous. gradual to-
B2	0.10 to 0.35	Brown (7.5YR4/4) moist; light medium clay; abundant 50-90%, small pebbles 2-6mm, angular siltstone, and common 10-20%, large pebbles 20-60mm, angular siltstone; strong, 2-5mm, subangular blocky; non-calcareous. clear to-
B/C	0.35 to 0.50	Dark brown (7.5YR3/4) moist; light medium clay; very abundant >90%, large pebbles 20-60mm, angular siltstone; strong, 2-5mm, subangular blocky; non-calcareous. abrupt to-
C	0.50 to 0.70	Very abundant >90%, weathered siltstone fragments.
R	0.70	Hard, unweathered siltstone.

Effective rooting depth (ERD): 0.7 m (bedrock)

Plant Available Water Capacity PAWC): 40 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.6	0.09	10	27	20	15	37	25	17	3.4	0.09	1.3			0.4	5.0	0.40	16	0.68	0.066	3.14	0.041
B2	0.1	0.2	7.6	0.09	20																			
	0.2	0.3	7.7	0.05	10	23	15	11	49	31	25	6.2	0.24	0.47			0.8	4.0	0.58	19	0.63	0.024	2.99	0.021
B2/B/C	0.3	0.4	7.7	0.05	10																			
B/C	0.4	0.5	7.7	0.04	10																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2515	0	0.10B	7.7	3.6	0.31	12	184	90	2.5	14	53	1.7	6	9	

Oven dry data @ 105 C

Soil Name: Mapala (Mp)

Site No: S39 (BAN 145) **Date Sampled:** 12 October 1990

Location: 231 775 mE 7 300 125 mN ZONE 56

Landscape:

Geology: Deeply weathered undifferentiated Tertiary sandstones and siltstones (Ta)

Substrate Lithology: Sandstone

Landform Pattern: Undulating rises

Element: Hillcrest

Runoff: Very slow

Slope: 0 %

Drainage: Moderately well drained

Permeability: Moderately permeable

Microrelief: Zero or none

Surface Condition: Firm

Surface Coarse Fragments: Few 2-10%, medium pebbles 6-20mm, subrounded ironstones

Classifications:

ASC: Reticulate, Eutrophic, Red, CHROMOSOL **PPF:** Dr4.22

GSG: No suitable group

Vegetation:

Upper Stratum: Predominantly cleared
Eucalyptus cambageana (coowarra box); Acacia fasciulifera (scrub ironbark)

Mid Stratum: Owenia acidula (emu apple); Carissa ovata (currantbush)

Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.10	Dark brown (7.5YR3/2) moist; fine sandy clay loam; massive; moderately moist; moderately weak; non-calcareous. clear to-
A21	0.10 to 0.25	Dark brown (7.5YR3/4) moist; fine sandy clay loam; few 2-10%, medium pebbles 6-20mm, subangular ironstone; massive; dry; moderately weak; non-calcareous. clear to-
A22	0.25 to 0.40	Brown (7.5YR4/4) moist; fine sandy clay loam; very few <2%, small pebbles 2-6mm, subangular quartz; massive; dry; moderately weak; non-calcareous. abrupt to-
B2	0.40 to 0.60	Reddish brown (5YR4/4) moist; fine sandy light medium clay; few 2-10%, medium pebbles 6-20mm, subangular quartz; strong, 10-20mm, angular blocky; dry; moderately strong; non-calcareous. abrupt to-
B3	0.60 to 0.70	Strong brown (7.5YR4/6) moist; fine sandy light medium clay; few 2-10%, medium pebbles 6-20mm, angular sandstone; strong, 5-10mm, angular blocky; dry; very firm; non-calcareous. clear to-
C	0.70 to 0.90	Very abundant >90%, weathered sandstone fragments. sharp to -

Effective rooting depth (ERD): 1.2 m (bedrock)

Plant Available Water Capacity PAWC): 100 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.3	0.10	40	15	52	8	24	13	10	2.0	0.12	1.1			0.9	5.0	0.34	7	0.54	0.120	0.583	0.030
A21	0.1	0.2	7.3	0.07	30																			
A21 / A22	0.2	0.3	7.5	0.04	10	14	52	9	25	10	7.7	1.7	0.16	0.28			2	4.5	0.35	7	0.40	0.065	0.545	0.019
A22	0.3	0.4	7.0	0.04	10																			
B2	0.4	0.5	6.4	0.05	30	12	43	10	35										0.56	11		0.033	0.646	0.033
	0.5	0.6	6.5	0.07	30	14	39	9	38	22	13	6.9	0.59	0.52			3	1.9	0.52	16	0.58	0.025	0.693	0.019
B3	0.6	0.7	8.3	0.16	40																			

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
145	0	0.10B	7.3	1.5	0.13	12		98	1.8	27	61	1.9	5.7	9	

Oven dry data @ 105 C

Soil Name: Melton (Mt)

Site No: S40 (BAN 599) **Date Sampled:** 15 November 1991

Location: 209 480 mE 7 289 250 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa) **Substrate Lithology:** Unconsolidated Quaternary alluvium

Landform Pattern: Alluvial plain **Element:** Plain

Runoff: Very slow **Slope:** 0.5 %

Drainage: Moderately well drained **Permeability:** Moderately permeable

Microrelief: Zero or none **Surface Condition:** Firm

Surface Coarse Fragments: No coarse fragments

Classifications:

ASC: Melanic, Hypocalcic, Black, DERMOSOL **PPF:** Uf6.32

GSG: No suitable group

Vegetation:

Upper Stratum: Tall open forest (12-20 m)
Eucalyptus populnea (poplar box); Eucalyptus melanophloia (silver-leaved ironbark)

Mid Stratum: Lysiphyllum hookeri (white flowered bauhinia); Grevillea striata (beefwood)

Lower Stratum: Themeda triandra (kangaroo grass); Heteropogon contortus (black speargrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.15	Black (10YR2/1) moist; silty light medium clay; strong, 5-10mm, subangular blocky largest peds, parting to strong, 2-5mm, subangular blocky next size peds; moist; very weak; non-calcareous. gradual to-
B21	0.15 to 0.30	Black (10YR2/1) moist; silty medium clay; strong, 10-20mm, angular blocky largest peds, parting to strong, 2-5mm, angular blocky next size peds; moist; moderately weak; non-calcareous. gradual to-
B22k	0.30 to 0.65	Black (10YR2/1) moist; light medium clay; strong, 10-20mm, prismatic largest peds, parting to strong, 2-5mm, angular blocky next size peds; dry; moderately firm; very few <2%, medium 2-6mm, calcareous soft segregations, non-calcareous. gradual to-
B23	0.65 to 1.10	Very dark greyish brown (10YR3/2) moist; light medium clay; strong, 20-50mm, prismatic largest peds, parting to strong, 5-10mm, angular blocky next size peds; dry; moderately firm; non-calcareous. gradual to-
2D	1.10 to 1.55	Dark brown (10YR3/3) moist; clay loam, fine sandy; weak, 10-20mm, subangular blocky; dry; moderately firm; very few <2%, medium 2-6mm, calcareous soft segregations, non-calcareous.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 130 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.9	0.03	10	4	29	32	37	32	17	6.0	0.20	1.1			0.6	2.8	0.62	15	0.86	0.073	1.34	0.034
B21	0.2	0.3	7.2	0.02	10	3	21	29	42	34	19	7.7	0.37	0.40			1	2.5	0.63	17	0.81	0.065	1.35	0.021
B22k	0.5	0.6	7.7	0.03	10	3	27	28	44	37	23	8.9	0.50	0.47			1	2.6	0.62	17	0.84	0.067	1.38	0.022
B23	0.8	0.9	8.1	0.04	10	4	39	20	40	34	22	8.1	0.50	0.58			2	2.7	0.56	16	0.85	0.077	1.43	0.022
2D	1.1	1.2	8.3	0.05	20	22	45	13	25	23	16	5.4	0.40	0.36			2	3.0			0.92	0.073	1.59	0.018
	1.4	1.5	8.2	0.05	20	27	39	8	26	23	14	5.3	0.30	0.36			1	2.6	0.61	9	0.88	0.077	1.49	0.018

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
599	0	0.10B	7.0	2.3	0.13	18		56	1.4	23	40	2.4	10		3

Oven dry data @ 105 C

Soil Name: Mungi (Mg)

Site No: S41 (BAN 541) **Date Sampled:** 17 October 1991

Location: 210 500 mE 7 291 300 mN ZONE 56

Landscape:

Geology: Permian siltstone and mudstone of the Four Mile Mudstone Member (Purm)

Substrate Lithology: Siltstone

Landform Pattern: Gently undulating rises

Element: Hillslope

Runoff: Slow

Slope: 2 %

Drainage: Imperfectly drained

Permeability: Slowly permeable

Microrelief: Linear gilgai

Microrelief Component: Depression

Horizontal Interval: 4 m

Vertical Interval: 0.15 m

Surface Coarse Fragments: No coarse fragments

Surface Condition: Periodic cracking, surface flake

Classifications:

ASC: Endocalcareous-Endohypersodic, Epipedal, Black, VERTOSOL

PPF: Ug5.12

GSG: Black earth

Vegetation:

Upper Stratum: Predominantly cleared with remnant trees
Eucalyptus populnea (poplar box); Eucalyptus melanophloia (silver-leaved ironbark)

Mid Stratum: Acacia farnesiana (mimosa bush); Archidendropsis basaltica (dead finish)

Lower Stratum: Themeda triandra (kangaroo grass); Bothriochloa bladhii (forest bluegrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.04	Very dark greyish brown (10YR3/2) moist; light clay; strong, 2-5mm, polyhedral largest peds, parting to strong, <2mm, polyhedral next size peds; dry; loose; non-calcareous. abrupt to-
B21	0.04 to 0.40	Very dark greyish brown (10YR3/2) moist; medium clay; strong, 10-20mm, lenticular largest peds, parting to strong, 2-5mm, lenticular next size peds; dry; moderately strong; non-calcareous. diffuse to-
B22k	0.40 to 0.80	Very dark greyish brown (10YR3/2) moist; medium clay; very few <2%, small pebbles 2-6mm, angular siltstone; strong, 2-5mm, lenticular; slickensides; dry; moderately strong; few 2-10%, medium 2-6mm, calcareous nodules, slightly calcareous. clear to-
C	0.80 to 0.90	Abundant 50-90%, weathered siltstone fragments.

Effective rooting depth (ERD): 1.2 m (bedrock)

Plant Available Water Capacity PAWC): 130 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C		@105 C	@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	6.8	0.07	20	4	17	29	47	33	15	7.5	0.60	1.1			2	2.0	0.52	17	0.70	0.041	0.917	0.027
B21	0.1	0.2	7.3	0.07	30																			
	0.2	0.3	7.8	0.12	90	3	11	22	63	43	25	10	2.7	0.52			6	2.5	0.53	22	0.68	0.021	0.901	0.019
	0.3	0.4	8.0	0.21	220																			
B22k	0.4	0.5	8.1	0.33	370																			
	0.5	0.6	8.2	0.47	580	3	11	20	62	41	30	11	5.0	0.47			12	2.7	0.63	22	0.66	0.018	0.858	0.018
	0.6	0.7	8.3	0.56	680																			
	0.7	0.8	8.4	0.63	700																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
541	0	0.10B	6.8	1.7	0.12	14		25	0.94	43	95	3	1.3	8	

Oven dry data @ 105 C

Soil Name: Mungi (Mg)

Site No: S41 (BAN 2594) **Date Sampled:** 21 September 1995

Location: 210 505 mE 7 291 300 mN ZONE 56

Landscape:

Geology: Permian siltstone and mudstone of the Four Mile Mudstone Member (Purm)

Substrate Lithology: Siltstone

Landform Pattern: Gently undulating rises

Element: Hillslope

Runoff: Slow

Slope: 2 %

Drainage: Imperfectly drained

Permeability: Slowly permeable

Microrelief: Linear gilgai

Microrelief Component: Mound

Horizontal Interval: 4 m

Vertical Interval: 0.15 m

Surface Coarse Fragments: Few 2-10%, small pebbles 2-6mm, calcareous nodules

Surface Condition: Periodic cracking, self-mulching

Classifications:

ASC: Epicalcareous-Endohypersodic, Self-mulching, Black VERTOSOL

PPF: Ug5.13

GSG: Black earth

Vegetation:

Upper Stratum: Predominantly cleared with remnant trees Eucalyptus populnea (poplar box)

Mid Stratum: Acacia bidwillii (corkwood wattle); Acacia farnesiana (mimosa bush)

Lower Stratum: Themeda triandra (kangaroo grass); Bothriochloa bladhii (forest bluegrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.06	Very dark greyish brown (2.5Y3/2) moist; medium clay; strong, 2-5mm, polyhedral largest peds, parting to strong, <2mm, polyhedral next size peds; dry;; few 2-10%, medium 2-6mm, calcareous nodules. abrupt to-
B2k	0.06 to 0.90	Very dark greyish brown (2.5Y3/2) moist; medium clay; strong, 10-20mm, lenticular largest peds, parting to strong, 2-5mm, lenticular next size peds; slickensides; moderately moist; moderately firm; few 2-10%, medium 2-6mm, calcareous nodules. gradual to-
B3	0.90 to 1.10	Brown (10YR4/3) moist; many 20-50%, medium 5-15mm, prominent dark mottles; medium clay; few 2-10%, medium pebbles 6-20mm, angular siltstone, few 2-10%, small pebbles 2-6mm, angular siltstone; strong, 10-20mm, lenticular largest peds, parting to strong, 2-5mm, lenticular next size peds; slickensides; very few <2%, medium 2-6mm, calcareous nodules. clear to-
BC	1.10 to 1.30	Brown (10YR5/3) moist; common 10-20%, medium 5-15mm, prominent grey mottles, few 2-10%, fine <5mm, prominent brown mottles; light medium clay; abundant 50-90%, large pebbles 20-60mm, angular siltstone.
C	1.30 to 1.55	Very abundant >90%, weathered siltstone fragments.

Effective rooting depth (ERD): 1.3 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 150 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B2k	0	0.1	7.9	0.10	20	4	12	19	61	42	29	8.8	0.85	0.84			2	3.3	0.38	20	0.69	0.028	0.938	0.023
B2k	0.1	0.2	8.1	0.10	20																			
	0.2	0.3	8.5	0.15	30	4	11	19	64	41	28	8.9	1.9	0.41			5	3.1	0.60	21	0.64	0.020	0.944	0.018
	0.3	0.4	8.6	0.20	30																			
	0.4	0.5	8.7	0.28	80																			
	0.5	0.6	8.6	0.39	220	5	10	19	65	41	23	11	5.1	0.34			12	2.1	0.63	22	0.64	0.017	0.917	0.018
	0.6	0.7	8.6	0.53	460																			
	0.7	0.8	8.5	0.69	740																			
	0.8	0.9	8.5	0.74	880	4	11	20	66	43	21	13	7.6	0.48			18	1.6	0.71	23	0.65	0.017	0.935	0.019
B3	0.9	1.0	8.6	0.78	890																			
	1.0	1.1	8.5	0.73	870																			
BC	1.1	1.2	8.3	0.66	750	3	8	24	65	35	17	10	6.5	0.35			19	1.7			0.54	0.015	1.26	0.014
	1.2	1.3	8.3	0.58	720																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2594	0	0.10B	8.2	0.30	0.04	8		3	0.22	11	8.0	0.76	0.69	5	

Oven dry data @ 105 C

Soil Name: Muruguran (Mr)

Site No: S42 (BAN 1271) **Date Sampled:** 18 March 1993

Location: 210 200 mE 7 340 450 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa) **Substrate Lithology:** Unconsolidated Quaternary alluvium

Landform Pattern: Alluvial plain **Element:** Backplain

Runoff: No runoff **Slope:** 0 %

Drainage: Poorly drained **Permeability:** Slowly permeable

Microrelief: Normal gilgai **Microrelief Component:** Depression

Horizontal Interval: 6 m **Vertical Interval:** 0.30 m

Surface Coarse Fragments: No coarse fragments **Surface Condition:** Firm, self-mulching

Classifications:

ASC: Epiacidic-Mottled, Self-mulching, Aquic, VERTOSOL **PPF:** Ug5.1

GSG: No suitable group

Vegetation:

Upper Stratum: Eucalyptus coolabah (coolibah)

Mid Stratum: Callistemon species

Lower Stratum: Cynodon dactylon (couch); Arundinella nepalensis (reed grass)

Profile Morphology:

Horizon	Depth (m)	Description
A11	0.00 to 0.09	Dark brown (10YR3/3) moist; common 10-20%, medium 5-15mm, prominent orange mottles; silty light clay; weak, 2-5mm, granular largest peds, parting to strong, <2mm, granular next size peds; dry; weak; abundant <1mm, roots. abrupt to-
A12	0.09 to 0.23	Dark brown (7.5YR3/4) moist, strong brown (7.5YR5/6) dry; many 20-50%, medium 5-15mm, prominent grey mottles; silty light clay; strong, 5-10mm, subangular blocky; dry; moderately strong; many <1mm, roots. clear to-
B21y	0.23 to 0.90	Very dark grey (10YR3/1) moist; few 2-10%, fine <5mm, faint orange mottles; medium clay; strong lenticular; slickensides; moderately moist; moderately strong; very few <2%, fine <2mm, gypseous crystals; few 1-2mm, roots. diffuse to-
B22k	0.90 to 1.60	Very dark grey (10YR3/1) moist; medium clay; strong, 5-10mm, lenticular largest peds, parting to strong, <2mm, lenticular next size peds; slickensides; moderately moist; moderately firm; very few <2%, medium 2-6mm, calcareous concretions.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 150 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A11 / A12	0	0.1	5.5	0.30	50	13	23	22	41	19	8.8	8.0	0.38	0.60	0.6	1.1	2	1.1	0.42	19	0.46	0.170	0.604	0.167
A12	0.1	0.2	4.9	0.27	30																			
A12 / B21y	0.2	0.3	5.1	0.24	20	3	19	31	47	23	9.7	8.5	0.36	0.47	2.7	3.6	2	1.1	0.61	18	0.49	0.075	0.596	0.086
B21y	0.3	0.4	5.5	0.22	20																			
	0.4	0.5	6.0	0.22	30																			
	0.5	0.6	6.7	0.28	40	2	17	28	51	34	18	15	1.0	0.39			3	1.2	0.69	19	0.67	0.056	0.722	0.039
	0.6	0.7	7.0	0.35	50																			
	0.7	0.8	7.2	0.42	70																			
	0.8	0.9	7.4	0.54	100	1	12	28	56	43	21	19	2.3	0.41			5	1.1	0.73	20	0.77	0.043	0.711	0.048
B22k	0.9	1.0	7.5	0.65	120																			
	1.0	1.1	7.6	0.80	150																			
	1.1	1.2	7.7	0.91	180	1	11	29	58	46	20	21	4.3	0.43			9	1.0			0.79	0.045	0.723	0.071
	1.2	1.3	7.9	0.91	220																			
	1.3	1.4	8.1	0.97	270																			
	1.4	1.5	8.1	0.92	230																			

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1271	0	0.10B	5.4	5.0	0.46	11		146	1.2	158	22	146	22		

Oven dry data @ 105 C

Soil Name: Muruguran (Mr)

Site No: S42 (BAN 1272) **Date Sampled:** 18 March 1993
Location: 210 200 mE 7 340 450 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa)
Substrate Lithology: Unconsolidated Quaternary alluvium
Landform Pattern: Alluvial plain
Element: Backplain
Runoff: Very slow
Slope: 0 %
Drainage: Poorly drained
Permeability: Slowly permeable
Microrelief: Normal gilgai
Microrelief Component: Mound
Horizontal Interval: 6 m
Vertical Interval: 0.30 m
Surface Coarse Fragments: No coarse fragments
Surface Condition: Firm, self-mulching

Classifications:

ASC: Endohypersodic, Self-mulching, Aquic, VERTOSOL **PPF:** Ug5.1
GSG: No suitable group

Vegetation:

Upper Stratum: Eucalyptus coolabah (coolibah)
Mid Stratum: Callistemon species
Lower Stratum: Cynodon dactylon (couch); Arundinella nepalensis (reed grass)

Profile Morphology:

Horizon	Depth (m)	Description
A11	0.00 to 0.08	Dark brown (10YR3/3) moist; common 10-20%, fine <5mm, distinct orange mottles; silty light clay; weak, 2-5mm, granular largest peds, parting to strong, <2mm, granular next size peds; dry; firm; non-calcareous. abrupt to-
A12	0.08 to 0.14	Dark brown (7.5YR3/4) moist, strong brown (7.5YR5/8) dry; many 20-50%, medium 5-15mm, prominent grey mottles; silty light clay; strong, 5-10mm, subangular blocky; dry; very firm; non-calcareous. abrupt to-
B1	0.14 to 0.21	Reddish brown (2.5YR4/3) moist, reddish brown (5YR5/3) dry; many 20-50%, medium 5-15mm, distinct dark mottles; silty light medium clay; strong, 5-10mm, subangular blocky; dry; moderately strong; non-calcareous. clear to-
B21	0.21 to 0.50	Very dark grey (10YR3/1) moist; common 10-20%, medium 5-15mm, distinct orange mottles; medium clay; strong, <2mm, lenticular; dry; moderately strong; non-calcareous. gradual to-
B22ky	0.50 to 1.00	Very dark grey (10YR3/1) moist; very few <2%, fine <5mm, prominent orange mottles; medium clay; strong, 5-10mm, lenticular largest peds, parting to strong, <2mm, lenticular next size peds; slickensides; moderately moist; moderately strong; very few <2%, fine <2mm, gypseous crystals, very few <2%, fine <2mm, calcareous nodules; non-calcareous. diffuse to-
B23ky	1.00 to 1.50	Very dark grey (10YR3/1) moist; medium clay; dry; very firm; few 2-10%, fine <2mm, gypseous crystals, few 2-10%, medium 2-6mm, calcareous concretions, slightly calcareous.

Effective rooting depth (ERD): 1.5 m
Plant Available Water Capacity PAWC): 150 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A11 / A12	0	0.1	5.6	0.41	120	7	23	30	39	22	10	9.8	0.78	0.30	0.4	0.5	4	1.0	0.51	16	0.56	0.109	0.559	0.162
A12/B1	0.1	0.2	5.5	0.30	50																			
B1/B21	0.2	0.3	6.3	0.31	70	1	22	25	52	33	17	15	1.2	0.30			4	1.1	0.59	18	0.63	0.045	0.630	0.051
B21	0.3	0.4	6.6	0.35	130																			
	0.4	0.5	7.0	0.44	100																			
B22ky	0.5	0.6	7.0	0.68	160	2	15	24	58	49	27	19	2.5	0.33			5	1.4	0.58	20	0.84	0.036	0.649	0.164
	0.6	0.7	7.5	1.30	230																			
	0.7	0.8	7.4	1.20	380																			
	0.8	0.9	7.4	2.10	600	2	14	24	60	49	22	22	5.0	0.35			10	1.0	0.59	20	0.82	0.037	0.654	0.264
	0.9	1.0	7.7	1.60	730																			
B23ky	1.0	1.1	7.9	1.70	900																			
	1.1	1.2	7.8	2.40	1280	2	15	27	57	53	22	23	7.6	0.28			14	1.0			0.93	0.039	0.666	0.242
	1.2	1.3	7.9	2.40	1430																			
	1.3	1.4	8.0	2.20	1680																			
	1.4	1.5	8.0	2.50	970																			

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1272	0	0.10B	5.6	5.1	0.42	12		98	0.54	147	45	147	31		

Oven dry data @ 105 C

Soil Name: Neimen (Nm)

Site No: S43 (BAN 688) **Date Sampled:** 27 January 1992

Location: 216 300 mE 7 298 200 mN ZONE 56

Landscape:

Geology: Permian siltstone, mudstone and sandstone of the Back Creek Group (Pb) **Substrate Lithology:** Siltstone

Landform Pattern: Undulating rises **Element:** Footslope

Runoff: Very slow **Slope:** 1.2 %

Drainage: Imperfectly drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Hard setting

Surface Coarse Fragments: Common 10-20%, medium pebbles 6-20mm, subangular siltstone

Classifications:

ASC: Vertic, Hypernatric, Black, SODOSOL **PPF:** Dd1.43

GSG: Solodised solonetz

Vegetation:

Upper Stratum: Tall open forest (12-20 m)
Eucalyptus populnea (poplar box); Eucalyptus crebra (narrow-leaved ironbark)

Mid Stratum: Eromophila mitchellii (false sandalwood); Geijera parviflora (wilga)

Lower Stratum: Bothriochloa decipiens (pitted bluegrass); Aristida ramosa (purple wiregrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.15	Dark brown (10YR3/3) moist; clay loam, sandy; common 10-20%, small pebbles 2-6mm, subangular siltstone, few 2-10%, large pebbles 20-60mm, subangular siltstone; massive; dry; moderately firm; non-calcareous. clear to-
A2e	0.15 to 0.30	Light brownish grey (10YR6/2) moist, white (10YR8/1) dry; clay loam, coarse sandy; many 20-50%, small pebbles 2-6mm, subangular siltstone, few 2-10%, large pebbles 20-60mm, subangular siltstone; massive; dry; moderately weak; non-calcareous. sharp to-
B21	0.30 to 0.45	Very dark greyish brown (2.5Y3/2) moist; few 2-10%, fine <5mm, prominent brown mottles; medium heavy clay; very few <2%, small pebbles 2-6mm, angular quartz, very few <2%, small pebbles 2-6mm, subangular siltstone; strong, 100-200mm, columnar; moderately moist; very firm; very few <2%, fine <2mm, manganiferous nodules, non-calcareous. gradual to-
B22	0.45 to 0.75	Dark greyish brown (2.5Y4/3) moist; medium heavy clay; very few <2%, small pebbles 2-6mm, subangular siltstone, very few <2%, small pebbles 2-6mm, angular quartz; strong, 10-20mm, lenticular; moderately moist; moderately strong; very few <2%, fine <2mm, manganiferous nodules, very highly calcareous. gradual to-
BC	0.75 to 0.80	Dark yellowish brown (10YR4/4) moist; light medium clay; many 20-50%, medium pebbles 6-20mm, subangular siltstone; few 2-10%, medium 2-6mm, calcareous soft segregations, very highly calcareous. clear to-
C	0.80 to 0.90	Very abundant >90%, weathered siltstone fragments.

Effective rooting depth (ERD): 0.3 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 30 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.0	0.03	10	35	15	26	28	23	3.0	3.9	0.39	0.92			2	0.77	0.63	11	0.82	0.092	1.43	0.032
A2e	0.2	0.3	7.2	0.04	20	37	15	19	30	16	1.9	4.6	0.31	0.11			2	0.41	0.75	9	0.53	0.058	1.28	0.018
B21/B22	0.4	0.5	8.7	0.22	250	14	7	12	67	24	4.4	13	7.4	0.16			31	0.34	0.85	19	0.36	0.034	1.95	0.028
B22	0.5	0.6	9.3	0.63	500	10	7	12	72	26	5.5	12	9.0	0.18			35	0.46	0.93	20	0.36	0.033	2.19	0.025

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
688	0	0.10B	6.4	1.7	0.13	13		24	1.1	57	128	1.6	2.7		2

Oven dry data @ 105 C

Soil Name: Nikita (Nk)

Site No: S44 (BAN 2016) **Date Sampled:** 29 September 1994
Location: 226 400 mE 7 323 250 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial sediments (Cza) **Substrate Lithology:** Unconsolidated Cainozoic alluvial-colluvial sediments
Landform Pattern: Undulating rises **Element:** Hillslope
Runoff: Slow **Slope:** 5 %
Drainage: Moderately well drained **Permeability:** Moderately permeable
Microrelief: Zero or none **Surface Condition:** Firm
Surface Coarse Fragments: Few 2-10%, small pebbles 2-6mm, subrounded ironstones

Classifications:

ASC: Sodic, Calcic, Red, CHROMOSOL **PPF:** Dr4.13
GSG: No suitable group

Vegetation:

Upper Stratum: Eucalyptus cambageana (coowarra box); Casuarina cristata (belah)
Mid Stratum: Alectryon diversifolium (holly bush); Carissa ovata (currantbush)
Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.12	Dark reddish brown (5YR3/2) moist; clay loam, fine sandy; few 2-10%, small pebbles 2-6mm, subrounded ironstones and few 2-10%, small pebbles 2-6mm, subrounded quartz; weak, 5-10mm, platy; dry; very firm; non-calcareous. abrupt to-
B21	0.12 to 0.30	Dark reddish brown (5YR3/3) moist; fine sandy light medium clay; few 2-10%, medium pebbles 6-20mm, subrounded ironstones and few 2-10%, small pebbles 2-6mm, subrounded quartz; strong, 10-20mm, prismatic largest peds, parting to strong, 10-20mm, subangular blocky next size peds; dry; moderately strong; non-calcareous. clear to-
B22	0.30 to 0.50	Reddish brown (5YR4/4) moist; fine sandy medium clay; few 2-10%, small pebbles 2-6mm, subrounded ironstones and very few <2%, small pebbles 2-6mm, subangular quartz; strong, 10-20mm, lenticular; dry; very firm; non-calcareous. clear to-
B23k	0.50 to 1.25	Yellowish red (5YR4/6) moist; few 2-10%, fine <5mm, distinct dark mottles; fine sandy light medium clay; very few <2%, small pebbles 2-6mm, subrounded ironstones; strong, 5-10mm, angular blocky; dry; very firm; common 10-20%, coarse 6-20mm, calcareous soft segregations, and few 2-10%, coarse 6-20mm, calcareous nodules, very highly calcareous. gradual to-
B24k	1.25 to 1.60	Strong brown (7.5YR4/6) moist; sandy light medium clay; strong, 5-10mm, subangular blocky; dry; very firm; few 2-10%, coarse 6-20mm, calcareous soft segregations and few 2-10%, medium 2-6mm, calcareous nodules, highly calcareous.

Effective rooting depth (ERD): 1.5 m
Plant Available Water Capacity PAWC): 125 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.8	0.06	30	23	41	9	25	20	10	3.0	0.16	1.1			0.8	3.3	0.36	10	0.80	0.057	0.544	0.054
B21	0.12	0.2	7.0	0.04	20	20	39	9	31										0.40	11		0.037	0.484	
B21	0.2	0.3	7.3	0.04	20	19	37	10	34	23	12	4.6	0.35	0.25			2	2.6	0.35	12	0.68	0.036	0.455	0.041
B22	0.3	0.4	7.6	0.05	20																			
	0.4	0.5	8.3	0.17	30																			
B23k	0.5	0.6	8.8	0.14	20	16	30	10	40	26	15	8.1	0.98	0.17			4	1.9	0.55	14	0.65	0.022	0.404	0.039
	0.6	0.7	8.9	0.16	50																			
	0.7	0.8	9.0	0.21	90																			
	0.8	0.9	9.0	0.25	150	15	31	16	40	22	11	9.5	1.4	0.15			6	1.2	0.59	13	0.55	0.021	0.451	0.054
	0.9	1.0	9.0	0.28	190																			
	1.0	1.1	9.0	0.28	180																			
	1.1	1.2	9.0	0.28	180	19	36	12	34	23	9.9	11	1.6	0.12			7	0.9	0.57	13	0.68	0.021	0.566	0.044
B23k / B24k	1.2	1.3	9.1	0.25	130																			
B24k	1.3	1.4	9.1	0.23	90																			
	1.4	1.5	9.2	0.20	80	28	38	7	26	22	8.3	11	1.9	0.08			9	0.8	0.56	11	0.85	0.020	0.729	0.041

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2016	0	0.10B	7.0	1.9	0.14	14		25	0.75	21	33	1.1	1		

Oven dry data @ 105 C

Soil Name: Olinda (Od)

Site No: S45 (BAN 999) **Date Sampled:** 26 August 1992

Location: 200 140 mE 7 318 310 mN ZONE 56

Landscape:

Geology: Cretaceous intrusive rholite, syenite and quartz and feldspathic porphyry (Ki) **Substrate Lithology:** Syenite

Landform Pattern: Undulating low hills **Element:** Hillslope

Runoff: Very rapid **Slope:** 9.5 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Hard setting

Surface Coarse Fragments: Common 10-20%, medium pebbles 6-20mm, subangular syenite

Classifications:

ASC: Magnesic, Subnatric, Brown, SODOSOL **PPF:** Db1.42

GSG: Solodic

Vegetation:

Upper Stratum: Eucalyptus moluccana (gum-topped box); Eucalyptus crebra (narrow-leaved ironbark)

Mid Stratum: Acacia rhodoxylon (rosewood); Alectryon diversifolium (holly bush)

Lower Stratum: Aristida species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.12	Dark brown (7.5YR3/2) moist; fine sandy clay loam; common 10-20%, small pebbles 2-6mm, subangular syenite; massive; dry; moderately firm. abrupt to-
A2e	0.12 to 0.25	Brown (10YR5/3) moist, light grey (10YR7/2) dry; clay loam, fine sandy; common 10-20%, small pebbles 2-6mm, subangular syenite, few 2-10%, medium pebbles 6-20mm, subangular syenite; massive; dry; moderately firm. abrupt to-
B2	0.25 to 0.45	Brown (7.5YR4/4) moist; medium clay; few 2-10%, medium pebbles 6-20mm, subangular syenite, common 10-20%, small pebbles 2-6mm, subangular syenite; strong, 5-10mm, subangular blocky largest peds, parting to strong, 2-5mm, subangular blocky next size peds; dry; moderately strong. clear to-
C	0.45 to 0.55	Very abundant >90%, weathered syenite fragments. abrupt to-
R	0.55	Hard, unweathered syenite.

Effective rooting depth (ERD): 0.55 m (bedrock)

Plant Available Water Capacity PAWC): 55 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	5.7	0.05	10	24	20	19	33	10	5.6	3.7	0.18	0.68	0.2	0.2	2	1.5	0.80	12	0.30	0.041	1.24	0.044
A2e	0.2	0.25	6.2	0.04	10																			
B2	0.25	03	6.7	0.07	30	8	14	24	55	14	0.69	12	1.4	0.17			10	0.06	0.85	15	0.25	0.021	1.41	0.024
	0.3	0.4	7.1	0.10	60	5	10	18	65	20	0.74	16	2.0	0.20			10	0.05	0.76	18	0.31	0.019	1.61	0.025

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
999	0	0.10B	5.4	3.4	0.21	16		5	0.60	76	86	0.65	2.4		

Oven dry data @ 105 C

Soil Name: Overdeen (Ov)

Site No: S46 (BAN 1323) **Date Sampled:** 12 May 1993

Location: 214 510 mE 7 322 190 mN ZONE 56

Landscape:

Geology: Tertiary olivine basalt (Tb) **Substrate Lithology:** Basalt

Landform Pattern: Undulating rises **Element:** Hillslope

Runoff: Slow **Slope:** 2 %

Drainage: Moderately well drained **Permeability:** Moderately permeable

Microrelief: Zero or none **Surface Condition:** Periodic cracking, self-mulching

Surface Coarse Fragments: Few 2-10%, cobbles
60-200mm, subangular basalt

Classifications:

ASC: Vertic, Supracalcic, Red, DERMOSOL **PPF:** Ug5.37

GSG: Red clay

Vegetation:

Upper Stratum: Predominantly cleared for cattle grazing
Acacia harpophylla (brigalow)

Mid Stratum: Alectryon diversifolium (holly bush); Eremocitrus glauca (limebush)

Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.01	Dark reddish brown (2.5YR2/4) moist; light clay; strong, <2mm, granular; dry; loose; non-calcareous. abrupt to-
B21	0.01 to 0.20	Dark reddish brown (5YR3/3) moist; light clay; strong, 10-20mm, angular blocky largest peds, parting to strong, 2-5mm, angular blocky next size peds; dry; very firm; non-calcareous. gradual to-
B22	0.20 to 0.90	Dark reddish brown (5YR3/4) moist; light clay; strong, 10-20mm, lenticular largest peds, parting to strong, 2-5mm, lenticular next size peds; dry; very firm; non-calcareous. abrupt to-
B23k	0.90 to 1.10	Dark reddish brown (5YR3/4) moist; light clay; strong, 2-5mm, subangular blocky; dry; moderately firm; many 20-50%, medium 2-6mm, calcareous nodules, and many 20-50%, coarse 6-20mm, calcareous soft segregations. clear to-
BCk	1.10 to 1.55	Dark reddish brown (2.5YR3/4) moist; light clay; many 20-50%, large pebbles 20-60mm, subangular basalt; massive; dry; moderately firm; many 20-50%, coarse 6-20mm, calcareous nodules, and common 10-20%, medium 2-6mm, calcareous soft segregations.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 165 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	7.7	0.11	10	11	14	14	58	32	19	2.9	0.16	2.0			0.5	6.6	0.26	20	0.55	0.113	0.375	0.065
B22	0.2	0.3	8.0	0.07	10	9	11	8	70	29	20	2.4	0.19	0.30			0.7	8.3	0.33	19	0.41	0.067	0.233	0.036
	0.5	0.6	7.7	0.05	20	7	10	7	73	29	18	3.7	0.24	0.13			0.8	4.9	0.36	20	0.40	0.055	0.215	0.030
	0.8	0.9	8.2	0.15	10	8	11	7	69	29	20	9.9	0.27	0.14			0.9	2.0	0.32	20	0.42	0.056	0.200	0.031
BCk	1.1	1.2	8.7	0.15	10	31	17	14	37	26	17	7.0	0.24	0.13			0.9	2.4			0.70	0.065	0.228	0.033

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1323	0	0.10B	7.6	2.9	0.25	12		79	2.2	8.6	37	2.2	1.8		

Oven dry data @ 105 C

Soil Name: Overdeen, shallow variant (OvSv)

Site No: S47 (BAN 1328) **Date Sampled:** 12 October 2001

Location: 216 660 mE 7 322 550 mN ZONE 56

Landscape:

Geology: Tertiary olivine basalt (Tb) **Substrate Lithology:** Basalt

Landform Pattern: Plateau **Element:** Summit surface

Runoff: Very slow **Slope:** 2 %

Drainage: Moderately well drained **Permeability:** Moderately permeable

Microrelief: Zero or none **Surface Condition:** Self-mulching, surface flake

Surface Coarse Fragments: Many 20-50%, cobbles 60-200mm, subangular basalt

Classifications:

ASC: Vertic, Eutrophic, Red, DERMOSOL **PPF:** Uf6.31

GSG: No suitable group

Vegetation:

Upper Stratum: Lysiphyllum carronii (red bauhinia); Brachychiton australis (broad-leaved bottletree); Eucalyptus erythrophloia (gum-topped bloodwood)

Mid Stratum: Clerodendrum floribundum (lolly bush); Citrus species

Lower Stratum: Cenchrus ciliaris (buffel grass); Aristida species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.12	Dark reddish brown (5YR3/2) moist; light medium clay; common 10-20%, cobbles 60-200mm, subrounded basalt, and very few <2%, large pebbles 20-60mm, subrounded basalt; strong, <2mm, granular; dry; loose; non-calcareous. abrupt to-
B2	0.12 to 0.40	Reddish brown (5YR4/3) moist; medium clay; many 20-50%, large pebbles 20-60mm, subrounded basalt, and common 10-20%, cobbles 60-200mm, subrounded basalt; strong, 50-100mm, prismatic largest peds, parting to strong, 5-10mm, lenticular next size peds; dry; very firm; non-calcareous. clear to-
BC	0.40 to 0.60	Reddish brown (5YR4/3) moist; light medium clay; common 10-20%, medium pebbles 6-20mm, subangular basalt, and abundant 50-90%, cobbles 60-200mm, subrounded basalt; moderate, 2-5mm, polyhedral; dry; moderately firm; non-calcareous. sharp to
R	0.60	Hard, unweathered basalt.

Effective rooting depth (ERD): 0.60 m

Plant Available Water Capacity PAWC): 60 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.1	0.07	10	7	7	23	56	47	35	11	0.04	0.98			0.1	3.1	0.36	28	0.84	0.240	0.613	0.024
B2	0.1	0.2	7.6	0.07	10																			
	0.2	0.3	7.7	0.05	10	3	6	12	74	47	32	14	0.19	0.35			0.4	2.3	0.37	33	0.64	0.097	0.350	0.009
	0.3	0.4	7.5	0.05	10																			
BC	0.4	0.5	7.5	0.05	10																			
	0.5	0.6	7.0	0.02	10	24	20	16	38	44	30	13	0.51	0.37			1.2	2.2	0.67	23	1.2	0.241	0.499	<.005

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1328	0	0.10B	6.9	3.3	0.29	11	881	294	2.1	43	44	3.3	1.7	11	28

Oven dry data @ 105 C

Soil Name: Pakington (Pk)

Site No: S48 (BAN 1088) **Date Sampled:** 17 November 1992

Location: 195 550 mE 7 323 240 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa) **Substrate Lithology:** Unconsolidated Quaternary alluvium

Landform Pattern: Alluvial plain **Element:** Plain

Runoff: Very slow **Slope:** 0.5 %

Drainage: Imperfectly drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Surface flake, periodic cracking

Surface Coarse Fragments: Very few <2%, medium pebbles 6-20mm, subrounded silcrete

Classifications:

ASC: Endocalcareous-Endohypersodic, Epipedal, Brown, VERTOSOL **PPF:** Uf6.31

GSG: No suitable group

Vegetation:

Lower Stratum: Bothriochloa species; Heterpogon contortus (black speargrass)

Profile Morphology:

Horizon	Depth (m)	Description
AP	0.00 to 0.10	Very dark greyish brown (10YR3/2) moist; light medium clay; moderate, 10-20mm, subangular blocky peds and weak, 2-5mm, platy peds; dry; moderately strong; non-calcareous. abrupt to-
B21	0.10 to 0.40	Dark brown (10YR3/3) moist; medium clay; very few <2%, medium pebbles 6-20mm, subangular quartz; strong, 5-10mm, subangular blocky; dry; moderately strong; very few <2%, medium 2-6mm, manganiferous concretions, non-calcareous. diffuse to-
B22k	0.40 to 1.10	Dark yellowish brown (10YR3/4) moist; light medium clay; very few <2%, medium pebbles 6-20mm, subangular silcrete; moderate, 5-10mm, subangular blocky parting to weak, lenticular; slickensides; dry; very firm; few 2-10%, medium 2-6mm, calcareous nodules and very few <2%, medium 2-6mm, manganiferous concretions, slightly calcareous. diffuse to-
B23k	1.10 to 1.60	Dark yellowish brown (10YR3/4) moist; light medium clay; strong, 10-20mm, lenticular; slickensides; moderately moist; very firm; few 2-10%, medium 2-6mm, manganiferous concretions, very few <2%, medium 2-6mm, calcareous soft segregations and very few <2%, medium 2-6mm, calcareous nodules, moderately calcareous.

Effective rooting depth (ERD): 1.1 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 125 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
AP	0	0.1	7.1	0.17	90	6	16	39	39	19	10	3.2	0.48	1.2			3	3.1	0.63	12	0.49	0.052	1.13	0.026
B21	0.1	0.2	8.0	0.26	130																			
	0.2	0.3	8.4	0.10	40	4	12	32	54	23	13	4.8	1.6	0.23			7	2.7	0.63	14	0.43	0.032	1.18	0.015
	0.3	0.4	8.4	0 .09	30																			
B22k	0.4	0.5	8.5	0.09	30																			
	0.5	0.6	8.6	0.11	50	4	11	29	58	23	12	7.4	2.5	0.19			11	1.6	0.84	16	0.40	0.029	1.21	0.016
	0.6	0.7	8.7	0.07	20																			
	0.7	0.8	8.7	0.09	20																			
	0.8	0.9	8.6	0.14	60	7	12	22	59	25	9.6	9.1	4.3	0.19			17	1.1	0.89	18	0.42	0.028	1.23	0.013
	0.9	1.0	8.7	0.11	20																			
	1.0	1.1	8.9	0.20	20																			
B23k	1.1	1.2	9.3	0.41	60	7	14	23	56	24	7.1	8.5	5.0	0.22			21	0.8			0.43	0.029	1.19	0.017
	1.2	1.3	9.2	0.26	20																			
	1.3	1.4	9.2	0.27	20																			
	1.4	1.5	9.5	0.42	70																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1088	0	0.10B	6.7	2.3	0.20	12	114	90	0.97	32	124	2.1	11	14	

Oven dry data @ 105 C

Soil Name: Police Camp (Pc)

Site No: S49 (BAN 804) **Date Sampled:** 26 March 1992

Location: 196 750 mE 7 307 070 mN ZONE 56

Landscape:

Geology: Permian siltstone, sandstone and mudstone of the Flat Top Formation (Puf) **Substrate Lithology:** Siltstone

Landform Pattern: Gentle undulating rises **Element:** Plain

Runoff: Slow **Slope:** 2 %

Drainage: Imperfectly drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Hard setting

Surface Coarse Fragments: Few 2-10%, large pebbles 20-60mm, subangular siltstone

Classifications:

ASC: Vertic, Subnatric, Black, SODOSOL **PPF:** Dd1.33

GSG: Solodic

Vegetation:

Upper Stratum: Tall closed forest (12-20 m)
Acacia harpophylla (brigalow); Eucalyptus populnea (poplar box)

Mid Stratum: Geijera parviflora (wilga); Eremophila mitchellii (false sandalwood); Carissa ovata (currantbush); Cassia brewsteri (leichhardt bean); Eremocitrus glauca (limebush); Grevillea striata (beefwood)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Dark brown (10YR3/3) moist; clay loam, fine sandy; few 2-10%, small pebbles 2-6mm, subangular siltstone; strong, 2-5mm, subangular blocky; dry; moderately firm; non-calcareous. abrupt to-
A2j	0.05 to 0.15	Very dark greyish brown (10YR3/2) moist, white (10YR8/1) dry; clay loam, fine sandy; many 10-20%, small pebbles 2-6 mm, subangular siltstone; strong, 10-20mm, subangular blocky; dry; moderately firm; non-calcareous. sharp to-
B21	0.15 to 0.50	Very dark greyish brown (10YR3/2) moist; light medium clay; few 2-10%, small pebbles 2-6mm, subangular siltstone; strong, 20-50mm, prismatic largest peds, parting to strong, 2-5mm, lenticular next size peds; dry; very firm; very few <2%, medium 2-6mm, calcareous nodules, slightly calcareous. clear to-
B22k	0.50 to 0.70	Brown (10YR4/3) moist; common 10-20%, medium 5-15mm, distinct dark mottles; medium clay; few 2-10%, medium pebbles 6-20mm, subangular siltstone and very few <2%, small pebbles 2-6mm, subangular quartz; strong, lenticular; moderately moist; moderately strong; few 2-10%, medium 2-6mm, calcareous soft segregations, slightly calcareous. clear to-
BC	0.70 to 0.80	Brown (10YR4/3) moist; common 10-20%, medium 5-15mm, distinct dark mottles; light medium clay; many 20-50%, medium pebbles 6-20mm, subangular siltstone; slightly calcareous. abrupt to-
C	0.80 to 0.90	Very abundant >90%, weathered siltstone fragments.
R	0.90	Hard, unweathered siltstone.

Effective rooting depth (ERD): 0.9 m (bedrock)

Plant Available Water Capacity PAWC): 80 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.05	6.9	0.07	10	15	43	21	28	23	11	4.9	0.15	0.91			0.7	2.2	0.58	12	0.82	0.042	0.594	0.051
A2j/B21	0.1	0.2	7.7	0.16	150																			
B21	0.2	0.3	8.6	0.42	370	7	23	13	57	37	16	15	4.6	0.30			12	1.1	0.77	21	0.65	0.020	0.635	0.035
B22k	0.5	0.6	8.8	0.73	780	9	22	15	56	34	13	16	5.7	0.28			17	0.8	0.82	20	0.61	0.020	0.649	0.039

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
804	0	0.10B	7.1	2.5	0.15	17		9	0.94	39	43	1.1	0.91		

Oven dry data @ 105 C

Soil Name: Powerhouse (Ph)

Site No: S50 (BAN 1625) **Date Sampled:** 07 December 1993

Location: 244 900 mE 7 293 390 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial colluvial sediments (Cza)

Substrate Lithology: Unconsolidated Cainozoic alluvial-sediments

Landform Pattern: Undulating rises

Element: Hillslope

Runoff: Moderately rapid

Slope: 4 %

Drainage: Moderately well drained

Permeability: Very slowly permeable

Microrelief: Zero or none

Surface Condition: Firm

Surface Coarse Fragments: Common 10-20%, medium pebbles 6-20mm, ferruginous siltstones

Classifications:

ASC: Sodic, Calcic, Brown, DERMOSOL **PPF:** Uf6.31

GSG: No suitable group

Vegetation:

Lower Stratum: Cleared and sown to introduced grasses
Cenchrus ciliaris (buffel grass); Panicum maximum var. trichoglume (green panic)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.04	Dark brown (10YR3/3) moist; fine sandy light clay; few 2-10%, medium pebbles 6-20mm, subrounded ferruginous siltstones; moderate, <2mm, subangular blocky; dry; moderately weak; non-calcareous. abrupt to-
B21	0.04 to 0.35	Dark brown (7.5YR3/4) moist; fine sandy light clay; few 2-10%, medium pebbles 6-20mm, subrounded ferruginous siltstones; strong, 20-50mm, angular blocky; dry; very firm; non-calcareous. clear to-
B22k	0.35 to 0.90	Yellowish brown (10YR5/4) moist; few 2-10%, medium 5-15mm, faint brown mottles; fine sandy light medium clay; few 2-10%, medium pebbles 6-20mm, subrounded ferruginous siltstones; strong, 20-50mm, prismatic; moderately moist; moderately firm; common 10-20%, coarse 6-20mm, calcareous soft segregations, very highly calcareous, and very few <2%, fine <2mm, manganiferous soft segregations. diffuse to-
B23	0.90 to 1.50	Light olive brown (2.5Y5/4) moist; many 20-50%, coarse 15-30mm, distinct brown mottles; fine sandy light medium clay; strong, 20-50mm, prismatic largest peds, parting to strong, 10-20mm, subangular blocky next size peds; moderately moist; moderately strong; common 10-20%, medium 2-6mm, manganiferous soft segregations, highly calcareous.

Effective rooting depth (ERD): 0.7 m (EC ≥ 1.0)

Plant Available Water Capacity PAWC): 85 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	6.9	0.04	20	21	26	17	34	20	9.8	2.8	0.14	0.87			0.7	3.5	0.30	12	0.59	0.091	0.441	0.049
B21	0.1	0.2	7.2	0.05	10																			
	0.2	0.3	7.6	0.08	20	21	24	14	41	26	11	8.3	2.0	0.28			8	1.3	0.74	15	0.63	0.038	0.396	0.039
B21 / B22k	0.3	0.4	8.3	0.27	60																			
B22k	0.4	0.5	9.0	0.35	200																			
	0.5	0.6	9.1	0.67	600	21	26	13	42	23	6.5	11	4.2	0.22			18	0.59	0.77	14	0.55	0.023	0.370	0.052
	0.6	0.7	9.0	0.82	850																			
	0.7	0.8	8.9	1.10	1140																			
	0.8	0.9	8.9	1.20	1210	22	25	13	42	22	5.3	12	5.8	0.30			26	0.44	0.83	14	0.52	0.022	0.364	0.065
B23	0.9	1.0	8.9	1.20	1140																			
	1.0	1.1	8.9	1.20	1000																			
	1.1	1.2	8.9	1.20	1200	21	24	13	44	21	5.0	12	5.8	0.28			28	0.42	0.90	14	0.48	0.022	0.360	0.069
	1.2	1.3	9.0	1.10	1060																			
	1.3	1.4	9.0	1.10	1000																			
	1.4	1.5	8.9	1.20	1170	23	25	12	40	19	3.2	12	6.0	0.24			32	0.27	1.0	13	0.48	0.019	0.354	0.063

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1625	0	0.10B	6.9	2.0	0.12	17		85	1.4	35	60	2.7	3.6		

Oven dry data @ 105 C

Soil Name: Precipice (Pp)

Site No: S51 (BAN 2558) **Date Sampled:** 09 August 1995

Location: 245 900 mE 7 323 700 mN ZONE 56

Landscape:

Geology: Flat lying, Jurassic, quartz sandstone, siltstone shale and coal (Jlp)

Substrate Lithology: Sandstone

Landform Pattern: Undulating rises

Element: Hillslope

Runoff: Moderately rapid

Slope: 6 %

Drainage: Well drained

Permeability: Moderately permeable

Microrelief: Zero or none

Surface Condition: Hard setting

Surface Coarse Fragments: Few 2-10%, small pebbles 2-6mm, subangular sandstone

Classifications:

ASC: Reticulate, Magnesic, Red, KUROSOL **PPF:** Dr3.31

GSG: No suitable group

Vegetation:

Upper Stratum: Tall open woodland (12-20 m)
Eucalyptus citriodora (lemon-scented gum); Eucalyptus crebra (narrow-leaved ironbark)

Mid Stratum: Acacia rhodoxylon (rosewood); Owenia acidula (emu apple)

Lower Stratum: Aristida species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.15	Black (10YR2/1) moist; fine sandy clay loam; few 2-10,% medium pebbles, 6-20mm, subangular sandstone; massive; dry; weak consistence. clear to-
A2j	0.15 to 0.30	Dark greyish brown (10YR4/2) moist, light grey (10YR7/1) dry; clay loam; few 2-10%, medium pebbles 6-20mm, subangular sandstone; massive; dry; weak consistence. sharp to-
B21	0.30 to 0.60	Reddish brown (5YR5/4) moist; common 10-20%, fine <5mm, prominent, grey mottles; medium clay; strong, 10-20mm, subangular blocky largest peds, parting to strong, 5-10mm, subangular blocky next size peds; dry; firm consistence. clear to-
B22	0.60 to 0.90	Grey (5YR6/1) moist; few 2-10%, fine <5mm, distinct, brown mottles; medium clay; strong, 5-10mm, subangular blocky; dry; firm consistence. abrupt to-
C	0.90 to 1.00	Very abundant >90%, weathered sandstone fragments.

Effective rooting depth (ERD): 0.3 m (pH < 5.5)

Plant Available Water Capacity PAWC): 35 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.6	0.05	10	36	28	9	24	14	8.2	4.6	0.08	1.1			0.6	1.8	0.37	12	0.58	0.055	1.50	0.041
A1/A2j	0.1	0.2	6.5	0.04	20																			
A2j	0.2	0.3	6.2	0.06	30	36	24	10	28	7	2.0	3.6	0.21	0.99			3	0.56	0.59	11	0.25	0.029	1.53	0.021
B21	0.3	0.4	5.1	0.14	140					7	0.58	3.7	0.63	1.2	0.8	0.9	9	0.16				0.015	1.52	0.019
	0.4	0.5	4.7	0.24	250					8	0.60	3.8	0.99	1.1	1.1	1.4	12	0.16				0.015	1.53	0.019
	0.5	0.6	4.4	0.27	300	16	10	8	65	8	0.35	3.6	1.2	1.0	1.6	1.7	15	0.10	0.54	19	0.12	0.012	1.59	0.020
B22	0.6	0.7	4.3	0.29	310																			
	0.7	0.8	4.4	0.29	320																			
	0.8	0.9	4.2	0.30	320	7	14	16	61	8	0.24	3.2	1.5	0.88	2.1	2.1	19	0.08	0.48	18	0.13	0.012	1.06	0.029

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2558	0	0.10B	6.2	2.8	0.12	23	17	30	0.82	44	45	0.35	3.7	7	

Oven dry data @ 105 C

Soil Name: Rannes (Rn)

Site No: S52 (BAN 215) **Date Sampled:** 22 September 1994
Location: 218 330 mE 7 329 210 mN ZONE 56

Landscape:

Geology: Spilite, tuff, pillow lava and siltstone of the Rockwood Volcanics (Pr) **Substrate Lithology:** Spilite
Landform Pattern: Rolling low hills **Element:** Pediment
Runoff: Moderately rapid **Slope:** 4 %
Drainage: Well drained **Permeability:** Slowly permeable
Microrelief: Zero or none **Surface Condition:** Periodic cracking, self-mulching
Surface Coarse Fragments: Common 10-20%, cobbles 60-200mm, subangular spilite

Classifications:

ASC: Epicalcareous-Endohypersodic, Self-mulching, Brown, VERTOSOL **PPF:** Ug5.3
GSG: Brown clay

Vegetation:

Lower Stratum: Cleared for cropping and introduced pastures
Sorghum halepense

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.07	Dark brown (7.5YR3/4) moist; medium clay; few 2-10%, small pebbles 2-6mm, subangular spilite, and few 2-10%, medium pebbles 6-20mm, subangular spilite; strong, <2mm, granular; dry; loose; highly calcareous. abrupt to-
B21	0.07 to 0.40	Dark brown (7.5YR3/4) moist; medium heavy clay; few 2-10%, small pebbles 2-6mm, subangular spilite, and few 2-10%, medium pebbles 6-20mm, subangular spilite; strong, 2-5mm, lenticular; moderately moist; very firm; very few <2%, medium 2-6mm calcareous soft segregations, highly calcareous. gradual to-
B22k	0.40 to 0.70	Brown (7.5YR4/4) moist; medium heavy clay; few 2-10% small pebbles 2-6mm, subangular spilite; strong, 10-20mm, lenticular largest peds, parting to strong, 2-5mm, lenticular next size peds; slickensides; moderately moist; very firm; few 2-10%, coarse 6-20mm, calcareous soft segregations and few 2-10%, fine <2mm, calcareous soft segregations, very highly calcareous. gradual to-
B23k	0.70 to 1.25	Yellowish red (5YR4/6) moist; medium heavy clay; few 2-10%, small pebbles 2-6mm, subangular spilite; strong, 5-10mm, lenticular largest peds, parting to strong, 2-5mm, lenticular next size peds; slickensides; moderately moist; very firm; few 2-10%, medium 2-6mm, calcareous soft segregations, very highly calcareous. clear to-
BC	1.25 to 1.55	Light yellowish brown (2.5Y6/4) moist; many 20-50%, fine <5mm, prominent red mottles; medium clay; many 20-50%, weathered fragments of spilite; moderate, <2mm, lenticular; moderately moist; moderately firm; common 10-20%, medium 2-6mm, calcareous soft segregations, slightly calcareous.

Effective rooting depth (ERD): 1.0 m (EC ≥ 1.0 dS/m and ESP ≥ 20)
Plant Available Water Capacity PAWC): 125 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	8.5	0.16	20	8	16	15	57	51	37	12	0.55	0.51			1	3.1	0.35	27	0.89	0.058	0.167	0.064
B21	0.1	0.2	8.7	0.18	10																			
	0.2	0.3	9.0	0.21	10	8	18			47	20	21	2.3	0.20			5	0.95	0.46	24		0.027	0.088	0.050
	0.3	0.4	9.1	0.29	20																			
B22k	0.4	0.5	9.2	0.32	30																			
	0.5	0.6	9.3	0.40	70	8	13			45	10	29	5.7	0.11			13	0.34	0.62	23		0.020	0.064	0.047
	0.6	0.7	9.2	0.53	190																			
B23k	0.7	0.8	9.2	0.65	320																			
	0.8	0.9	9.0	0.90	490	10	14			42	6.5	27	8.1	0.09			19	0.24	0.60	23		0.020	0.062	0.063
	0.9	1.0	9.0	1.10	660																			
	1.0	1.1	8.9	1.30	800																			
	1.1	1.2	8.9	1.20	800	14	16	26	47	34	7.0	19	7.6	0.08			22	0.37	0.71	20	0.72	0.019	0.059	0.088
B23k / BC	1.2	1.3	8.9	1.30	800																			
BC	1.3	1.4	8.8	1.30	880																			
	1.4	1.5	8.8	1.30	900	22	19	24	41	26	5.3	15	3.8	0.11			15	0.35	0.86	17	0.63	0.022	0.063	0.085

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
215	0	0.10B	8.4	2.4	0.15	16		24	0.56	9.7	7.0	3.0	0.74		

Oven dry data @ 105 C

Soil Name: Retro (Rt)

Site No: S53 (BAN 289) **Date Sampled:** 18 December 1990

Location: 235 375 mE 7 325 500 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa) **Substrate Lithology:** Unconsolidated Quaternary alluvium

Landform Pattern: Alluvial plain **Element:** Backplain

Runoff: Very slow **Slope:** 0.2 %

Drainage: Imperfectly drained **Permeability:** Moderately permeable

Microrelief: Zero or none **Surface Condition:** Hard setting

Surface Coarse Fragments: No coarse fragments

Classifications:

ASC: Calcic, Subnatric, Black, SODOSOL **PPF:** Dd1.33

GSG: Solodic

Vegetation:

Upper Stratum: Cleared for cropping
Eucalyptus populnea (poplar box)

Mid Stratum: Acacia salicina (sally wattle)

Lower Stratum: Panicum maximum var. trichoglume (green panic)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.18	Very dark grey (10YR3/1) moist; clay loam, fine sandy; weak, 2-5mm, subangular blocky; moderately moist; moderately weak; non-calcareous. abrupt to-
A2j	0.18 to 0.25	Dark brown (10YR3/3) moist, light grey (10YR7/2) dry; clay loam, fine sandy; massive; moderately moist; moderately weak; non-calcareous. abrupt to-
B21	0.25 to 0.35	Dark brown (10YR 3/3) moist; few 2-10%, fine <5 mm, distinct dark mottles; fine sandy light medium clay; strong, 20-50 mm, prismatic largest peds parting to strong, 10-20 mm, angular blocky peds; moderately moist; moderately firm; non-calcareous. gradual to -
B22	0.35 to 1.10	Very dark grey (10YR3/1) moist; light medium clay; strong, 20-50 mm, prismatic parting to 5-10mm, subangular blocky; moderately moist; moderately firm; non-calcareous. diffuse to-
B22k	1.10 to 1.75	Very dark grey (10YR3/1) moist; few 2-10%, fine <5mm, faint, brown mottles; fine sandy light medium clay; strong, 5-10mm, subangular blocky; moderately moist; moderately firm; few 2-10%, medium 2-6mm, calcareous soft segregations, slightly calcareous.

Effective rooting depth (ERD): 0.8 m (ESP ≥ 20)

Plant Available Water Capacity PAWC): 90 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.8	0.08	50	2	45	28	29	29	13	4.8	0.33	1.2			1	2.7	0.47	13	1.0	0.097	1.22	0.038
A2j	0.2	0.25	7.4	0.04	10	1	59	21	24	18	11	4.0	0.65	0.38			4	2.8	0.67	9	0.75	0.065	1.21	0.019
B21/B22	0.3	0.4	6.8	0.16	150	2	43	16	41	22*	12	6.0	2.0	0.36			9	2.0	0.66	13	0.54	0.068	1.06	0.025
B22	0.4	0.5	7.3	0.17	170																			
	0.5	0.6	8.3	0.15	140	1	45	19	42	29	15	9.0	3.5	0.30			12	1.7	0.71	15	0.69	0.051	1.09	0.022
	0.6	0.7	8.2	0.69	830																			
	0.7	0.8	8.7	0.64	790																			
	0.8	0.9	8.7	0.70	880	2	41	17	43	30	16	10	4.0	0.20			13	1.6	0.51	18	0.74	0.045	1.04	0.027
	0.9	1.0	8.7	0.71	1140																			
	1.0	1.1	8.8	0.71	1190																			
B22k	1.1	1.2	8.8	0.67	1020	3	38	17	41	31	16	16	5.5	0.30			18	1.0			0.76	0.049	0.993	0.028
	1.2	1.3	8.9	0.65	780																			
	1.3	1.4	8.9	0.63	750																			
	1.4	1.5	8.9	0.62	740																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)] * Aqueous cations @ pH 7.0, ECEC = sum of cations

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
289	0	0.10B	7.2	2.6	0.14	19		101	1.5	58	34	3.0	4		3

Oven dry data @ 105 C

Soil Name: Rundull (Rd)

Site No: S54 (BAN 1562) **Date Sampled:** 28 September 1993

Location: 242 250 mE 7 288 550 mN ZONE 56

Landscape:

Geology: Permian siltstone, mudstone, chert and sandstone of the Rannes Beds (Pw) **Substrate Lithology:** Slate

Landform Pattern: Undulating low hills **Element:** Hillslope

Runoff: Moderately rapid **Slope:** 4 %

Drainage: Well drained **Permeability:** Moderately permeable

Microrelief: Zero or none **Surface Condition:** Firm

Surface Coarse Fragments: Abundant 50-90%, medium pebbles 6-20mm, angular slate

Classifications:

ASC: Acidic, Eutrophic, Brown, KANDOSOL **PPF:** Um5.51

GSG: No suitable group

Vegetation:

Upper Stratum: Mid-high woodland (6-12 m)
Acacia rhodoxylon (rosewood)

Mid Stratum: Acacia fasciulifera (scrub ironbark); Geijera parviflora (wilga); Dodonaea viscosa (sticky hop bush)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Dark brown (7.5YR3/2) moist; clay loam, sandy; many 20-50%, small pebbles 2-6mm, angular slate, few 2-10%, medium pebbles 6-20mm, angular slate; massive; dry; moderately firm; non-calcareous. abrupt to-
B2	0.05 to 0.40	Dark brown (7.5YR3/4) moist; clay loam, sandy; many 20-50%, small pebbles 2-6mm, angular slate, few 2-10%, medium pebbles 6-20mm, angular slate; massive; dry; moderately weak; non-calcareous. abrupt to-
BC	0.40 to 0.70	Strong brown (7.5YR5/6) moist, pinkish white (7.5YR8/2) dry; clay loam; very abundant >90% weathered slate fragments.
R	0.70	Hard, unweathered slate.

Effective rooting depth (ERD): 0.7 m (bedrock)

Plant Available Water Capacity PAWC): 40 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl^- (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H^+	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.05	5.9	0.18	10	43	13	18	25	15	10	2.7	0.07	2.1	0.1	0.1	0.5	3.7	0.67	12	0.60	0.121	2.38	0.048
B2	0.2	0.3	5.4	0.04	10	37	11	22	31	8	3.6	2.2	0.19	0.29	1.5	1.7	2	1.6	0.58	11	0.26	0.066	2.35	0.033

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1562	0	0.10B	5.1	5.8	0.46	13		123	1.2	77	233	1	5.1		

Oven dry data @ 105 C

Soil Name: Santo (Sn)

Site No: S55 (BAN 657) **Date Sampled:** 08 January 1992

Location: 212 825 mE 7 308 600 mN ZONE 56

Landscape:

Geology: Permian andesite, basaltic and trachytic lava, tuff etc of the Camboon Andesite (Pln)

Substrate Lithology: Andesite

Landform Pattern: Undulating rises

Element: Hillslope

Runoff: Slow

Slope: 4 %

Drainage: Moderately well drained

Permeability: Slowly permeable

Microrelief: Zero or none

Surface Condition: Firm

Surface Coarse Fragments: Few 2-10%, medium pebbles 6-20mm, angular quartz

Classifications:

ASC: Haplic, Eutrophic, Brown, DERMOSOL **PPF:** Uf6.31

GSG: No suitable group

Vegetation:

Upper Stratum: Tall woodland (12-20 m)

Eucalyptus melanophloia (silver-leaved ironbark); Eucalyptus erythrophloia (gum-topped bloodwood)

Mid Stratum: Petalostigma pubescens (quinine tree)

Lower Stratum: Themeda triandra (kangaroo grass); Heterpogon contortus (black speargrass); Dichanthium sericeum (queensland

bluegrass); Indigofera pratensis (narrow-leaved indigo); Rhynchosia minima (rhynchosia);

Glycine tomentella (woolly glycine)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.07	Black (10YR2/1) moist; light clay; strong, 2-5mm, subangular blocky; moderately moist; moderately weak. gradual to-
B21	0.07 to 0.25	Dark brown (7.5YR3/3) moist; medium clay; very few <2%, small pebbles 2-6mm, angular quartz; strong, 5-10mm, subangular blocky; moderately moist; moderately weak. gradual to-
B22	0.25 to 0.40	Reddish brown (5YR4/4) moist; few 2-10%, fine <5mm, distinct dark mottles; medium clay; very few <2%, small pebbles 2-6mm, angular quartz; strong, 10-20mm, subangular blocky; moderately moist; moderately firm. clear to-
B3	0.40 to 0.55	Brown (7.5YR4/3) moist; few 2-10%, fine <5mm, faint yellow mottles; medium clay; common 10-20%, medium pebbles 6-20mm, angular andesite; strong, 10-20mm, lenticular; moderately moist; moderately firm. abrupt to-
C	0.55 to 0.60	Very abundant >90%, weathered andesite fragments.
R	0.60	Hard, unweathered andesite.

Effective rooting depth (ERD): 0.6 m (bedrock)

Plant Available Water Capacity PAWC): 70 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.07	7.5	0.05	10	13	27	21	41	39	20	11	0.24	0.63			0.6	1.8	0.52	17	0.95	0.058	0.186	0.048
B21	0.1	0.2				11	30	20	43											17				
B21/B22	0.2	0.3	7.7	0.04	10	10	25	17	50	34	17	12	0.37	0.19			1	1.4	0.43	18	0.68	0.038	0.092	0.028
B22	0.3	0.4				13	27	17	45											18				
B3	0.4	0.5	8.1	0.05	10	12	30	17	47	26	14	11	0.38	0.10			1	1.3	0.50	18	0.55	0.034	0.106	0.023

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
657	0	0.10B	7.5	2.1	0.11	19		8	0.36	13	39	2.7	2.0		2

Oven dry data @ 105 C

Soil Name: Santo fertile phase (SnFp)

Site No: S57 (BAN 1128) **Date Sampled:** 18 December 1992

Location: 199 800 mE 7 324 350 mN ZONE 56

Landscape:

Geology: Permian andesite, basaltic and trachytic lava, tuff etc of the Camboon Andesite (Pln) **Substrate Lithology:** Andesite

Landform Pattern: Undulating rises **Element:** Hillslope

Runoff: Moderately rapid **Slope:** 4.5 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Firm

Surface Coarse Fragments: Few 2-10%, medium pebbles 6-20mm, angular andesite

Classifications:

ASC: Vertic, Calcic, Red, DERMOSOL **PPF:** Uf6.31

GSG: No suitable group

Vegetation:

Upper Stratum: Predominantly cleared and sown to introduced grasses
Brachychiton rupestris (narrow-leaved bottletree); Eucalyptus cambageana (coowarra box)

Mid Stratum: Lysiphyllum hookeri (white flowered bauhinia)

Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.12	Dark reddish brown (5YR3/2) moist; medium clay; very few <2%, small pebbles 2-6mm, angular andesite; strong, 5-10mm, subangular blocky largest peds, parting to strong, 2-5mm, subangular blocky next size peds; moderately moist; moderately weak; non-calcareous. diffuse to-
B21	0.12 to 0.30	Dark reddish brown (5YR3/3) moist; medium clay; very few <2%, small pebbles 2-6mm, angular andesite; strong, 5-10mm, subangular blocky; dry; moderately strong; non-calcareous. gradual to-
B22	0.30 to 0.55	Dark reddish brown (5YR3/4) moist; few 2-10%, fine <5mm, faint dark mottles; light medium clay; few 2-10%, small pebbles 2-6mm, angular andesite; strong, 10-20mm, lenticular; slickensides; dry; moderately strong; non-calcareous. clear to-
B3k	0.55 to 0.90	Dark brown (7.5YR3/3) moist; few 2-10%, fine <5mm, distinct red mottles; light clay; many 20-50%, medium pebbles 6-20mm, angular andesite; moderate, 2-5mm, subangular blocky; dry; very firm; common 10-20%, coarse 6-20mm, calcareous nodules, slightly calcareous. clear to-
BC	0.90 to 1.20	Abundant 50-90%, weathered andesite fragments; common 10-20%, coarse 6-20mm, calcareous nodules, moderately calcareous. abrupt to-
R	1.20	Hard, unweathered andesite.

Effective rooting depth (ERD): 1.2 m

Plant Available Water Capacity PAWC): 100 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.5	0.18	10	11	23	19	46	36	20	8.6	0.09	0.67			0.3	2.3	0.44	15	0.78	0.073	0.806	0.056
B21	0.2	0.3	7.8	0.24	10	10	20	12	55	45	25	13	0.29	0.19			0.6	1.9		19	0.82	0.038	0.259	0.033
B22/B3k	0.5	0.6	8.3	0.30	30	30	16	12	42	33	17	11	0.01	0.09			0	1.5	0.56	14	0.79	0.060	0.280	0.027
B3k	0.8	0.9	8.5	0.27	10	32	17	17	35	25	13	9.6	0.14	0.09			0.6	1.4	0.46	12	0.71	0.054	0.243	0.024

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1128	0	0.10B	7.4	2.6	0.22	12		42	1.1	18	84	3.6	2.0		

Oven dry data @ 105 C

Soil Name: Santo stoney phase (SnSp)

Site No: S56 (BAN 1332) **Date Sampled:** 19 May 1993

Location: 218 550 mE 7 326 550 mN ZONE 56

Landscape:

Geology: Spilite, tuff, pillow lava and siltstone of the Rockwood Volcanics (Pr)

Substrate Lithology: Spilite

Landform Pattern: Rolling low hills

Element: Hillslope

Runoff: Rapid

Slope: 9 %

Drainage: Well drained

Permeability: Slowly permeable

Microrelief: Zero or none

Surface Condition: Firm

Surface Coarse Fragments: Many 20-50%, large pebbles 20-60mm, subangular spilite

Classifications:

ASC: Haplic, Eutrophic, Red, FERROSOL **PPF:** Uf6.31

GSG: No suitable group

Vegetation:

Upper Stratum: Partially cleared

Eucalyptus melanophloia (silver-leaved ironbark); Eucalyptus erythrophloia (gum-topped bloodwood)

Lower Stratum: Heterpogon contortus (black speargrass); Aristida ramosa (speargrass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.15	Dark reddish brown (5YR3/2) moist; light medium clay; common 10-20%, medium pebbles 6-20mm, angular spilite; strong 2-5mm polyhedral; moderately moist; moderately weak; non-calcareous. gradual to-
B21	0.15 to 0.30	Dark reddish brown (2.5YR3/4) moist; few 2-10%, fine <5mm, distinct dark mottles; light medium clay; common 10-20%, large pebbles 20-60mm, angular spilite, common 10-20%, medium pebbles 6-20mm, angular spilite; strong, 20-50mm, prismatic largest peds, parting to strong, 5-10mm, polyhedral next size peds, parting to strong, 2-5mm, polyhedral next size peds; dry; very firm; non-calcareous. gradual to-
B22	0.30 to 0.45	Dark reddish brown (2.5YR3/4) moist; light medium clay; few 2-10%, small pebbles 2-6mm, subangular spilite; strong, 20-50mm, prismatic largest peds, parting to strong, 10-20mm, angular blocky next size peds, parting to strong, 2-5mm, lenticular next size peds; dry; moderately strong; non-calcareous. abrupt to-
B3	0.45 to 0.60	Dark reddish brown (5YR3/4) moist; light clay; many 20-50%, small pebbles 2-6mm, subangular spilite; massive; dry; very firm.
C	0.60 to 0.75	Very abundant >90%, weathered spilite fragments.
R	0.75	Hard, unweathered spilite.

Effective rooting depth (ERD): 0.75 m (bedrock)

Plant Available Water Capacity PAWC): 70 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.9	0.04	10	14	21	21	46	29	20	8.1	0.10	0.42			0.3	2.5	0.38	17	0.63	0.081	0.205	0.056
B21	0.2	0.3	7.2	0.02	10	10	16	16	60	30	19	11	0.19	0.15			0.6	1.7	0.51	20	0.50	0.042	0.110	0.036
B22	0.3	0.4	7.4	0.02	10	7	12	15	64	34	22	13	0.26	0.14			0.8	1.7	0.50	22	0.53	0.029	0.087	0.031
B3	0.5	0.6	7.6	0.02	10	18	16	22	41	46	28	18	0.40	0.12			0.9	1.6	0.57	20	1.1	0.023	0.107	0.027

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1332	0	0.10B	6.8	3.6	0.23	16		63	1.0	18	80	2.0	5.5		

Oven dry data @ 105 C

Soil Name: Scoria (Sc)

Site No: S58 (BAN 312) **Date Sampled:** 16 January 1991

Location: 242 475 mE 7 294 440 mN ZONE 56

Landscape:

Geology: Tertiary olivine basalt (Tb) **Substrate Lithology:** Basalt

Landform Pattern: Plateau **Element:** Summit surface

Runoff: Slow **Slope:** 0.8 %

Drainage: Imperfectly drained **Permeability:** Slowly permeable

Microrelief: Normal gilgai **Microrelief Component:** Mound

Horizontal Interval: 3 m **Vertical Interval:** 0.10 m

Surface Coarse Fragments: Common 10-20%, cobbles 60-200mm, rounded basalt **Surface Condition:** Periodic cracking, self-mulching

Classifications:

ASC: Epicalcareous, Self-mulching, Black, VERTOSOL **PPF:** Ug5.12

GSG: Black earth

Vegetation:

Upper Stratum: Cleared and sown to introduced grasses
Brachychiton australis (broad-leaved bottletree); Brachychiton rupestris (narrow-leaved bottletree)

Mid Stratum: Acacia harpophylla (brigalow); Alectryon diversifolium (holly bush); Alstonia constricta (bitter bark)

Lower Stratum: Panicum maximum var. trichoglume (green panic)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.08	Very dark grey (10YR3/1) moist; medium heavy clay; weak, 2-5mm, subangular blocky largest peds, parting to strong, <2mm, granular next size peds; moderately moist; moderately weak; common 10-20%, fine <2mm, calcareous soft segregations, very highly calcareous. clear to-
B21	0.08 to 0.20	Very dark grey (7.5YR3/0) moist; medium heavy clay; very few <2%, large pebbles 20-60mm, rounded basalt, very few <2%, cobbles 60-200mm, rounded basalt; strong, 10-20mm, subangular blocky largest peds, parting to strong, 5-10mm, lenticular next size peds, parting to strong, <2mm, lenticular next size peds; moist; moderately weak; few 2-10%, medium 2-6mm, calcareous soft segregations, moderately calcareous. gradual to-
B22	0.20 to 0.70	Very dark grey (7.5YR3/0) moist; medium heavy clay; few 2-10%, cobbles 60-200mm, rounded basalt, few 2-10%, large pebbles 20-60mm, rounded basalt; strong, 5-10mm, lenticular largest peds, parting to strong, <2mm, lenticular next size peds; slickensides; moist; moderately weak; very few, <2% fine, <2mm calcareous nodules, slightly calcareous. sharp to-
R	0.70	Rock.

Effective rooting depth (ERD): 0.7 m (bedrock)

Plant Available Water Capacity PAWC): 130 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	8.1	0.26	30	7	13	18	59	71	46	12	0.54	3.1			0.8	3.8	0.36	38	1.2	0.190	0.575	0.130
B21	0.1	0.2	8.3	0.20	50																			
B22	0.2	0.3	8.4	0.19	40	2	13	17	71	75	45	15	1.3	1.6			2	3.0	0.42	37	1.1	0.050	0.260	0.041
	0.3	0.4	8.5	0.18	40																			
	0.4	0.5	8.4	0.25	110																			
	0.5	0.6	8.3	0.38	220	2	13	14	74	71	43	18	2.5	0.39			4	2.4	0.45	37	0.96	0.024	0.123	0.050
	0.6	0.7	8.2	0.51	320																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
312	0	0.10B	6.7	2.7	0.23	12	82	62	0.92	35	64	1.7	1.5	15	

Oven dry data @ 105 C

Soil Name: Shield (Sd)

Site No: S59 (BAN 1326) **Date Sampled:** 18 May 1993

Location: 217 230 mE 7 319 690 mN ZONE 56

Landscape:

Geology: Deeply weathered undifferentiated Tertiary sandstones and siltstones (Ta) **Substrate Lithology:** Sandstone

Landform Pattern: Plateau **Element:** Summit surface

Runoff: Slow **Slope:** 2 %

Drainage: Well drained **Permeability:** Highly permeable

Microrelief: Zero or none **Surface Condition:** Soft

Surface Coarse Fragments: Common 10-20%, small pebbles 2-6mm, subrounded quartz

Classifications:

ASC: Acidic, Paralithic, Orthic, TENOSOL **PPF:** Uc5.11

GSG: No suitable group

Vegetation:

Upper Stratum: Partially cleared
Eucalyptus citriodora (lemon-scented gum); Eucalyptus crebra (narrow-leaved ironbark); Eucalyptus polycarpa (long fruited bloodwood)

Mid Stratum: Acacia species; Alphitonia excelsa (soap bush)

Lower Stratum: Aristida species; Cymbopogon refractus (barbwire grass)

Profile Morphology:

Horizon	Depth (m)	Description
A11	0.00 to 0.14	Very dark brown (10YR2/2) moist, dark brown (10YR3/3) dry; sandy loam; few 2-10%, medium pebbles 6-20mm, subangular ironstone, common 10-20%, small pebbles 2-6mm, subrounded quartz; massive; dry; very weak; non-calcareous. gradual to-
A12	0.14 to 0.28	Dark brown (7.5YR3/2) moist, brown (10YR4/3) dry; sandy loam; common 10-20%, small pebbles 2-6mm, subrounded quartz, few 2-10%, medium pebbles 6-20mm, subangular ironstone; massive; dry; very weak; non-calcareous. clear to-
B2w	0.28 to 0.60	Brown (7.5YR4/3) moist, brown (7.5YR5/3) dry; sandy loam; abundant 50-90%, large pebbles 20-60mm, subangular ironstone, very few <2%, large pebbles 20-60mm, subrounded quartz; single grain; dry; very weak; non-calcareous. sharp to-
C	0.60 to 0.85	Yellowish brown (10YR5/4) moist, very pale brown (10YR7/4) dry; sandy loam; very abundant >90%, weathered sandstone fragments. sharp to-
R	0.85	Hard, unweathered sandstone.

Effective rooting depth (ERD): 0.85 m (bedrock)

Plant Available Water Capacity PAWC): 40 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A11	0	0.1	6.2	0.02	20	39	49	9	5	4.4	3.1	1.0	0.06	0.26			na	3.1	na	4	0.88	0.036	0.127	0.04
A12 / B2w	0.2	0.3	5.9	0.01	20	38	49	8	7	2.5	2.0	0.26	0.05	0.07	0.1	0.1	na	7.7	na	3	0.36	0.03	0.11	0.031
B2w	0.5	0.6	5.2	0.01	10	33	53	8	6	1.3	0.17	0.18	0.06	0.04	0.8	0.8	na	0.9	na	4	0.22	0.025	0.112	0.028

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)] na – not applicable

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1326	0	0.10B	5.5	1.2	0.07	17		4	0.20	81	3.6	0.19	0.4		

Oven dry data @ 105 C

Soil Name: Spier (Sp)

Site No: S60 (BAN 150) **Date Sampled:** 20 September 1994

Location: 217 930 mE 7 341 240 mN ZONE 56

Landscape:

Geology: Deeply weathered undifferentiated Tertiary sandstone sandstones and siltstones (Ta) **Substrate Lithology:** Deeply weathered Tertiary

Landform Pattern: Plateau **Element:** Plain

Runoff: Very slow **Slope:** 1.5 %

Drainage: Well drained **Permeability:** Moderately permeable

Microrelief: Zero or none **Surface Condition:** Hard setting

Surface Coarse Fragments: No coarse fragments

Classifications:

ASC: Reticulate, Mesotrophic, Red, KANDOSOL **PPF:** Gn2.11

GSG: Red earth

Vegetation:

Upper Stratum: Tall open forest (12-20 m)
Eucalyptus polycarpa (long fruited bloodwood); Eucalyptus crebra (narrow-leaved ironbark); Eucalyptus melanophloia (silver-leaved ironbark)

Mid Stratum: Acacia leiocalyx (black wattle); Alphitonia excelsa (soap bush)

Lower Stratum: Aristida species; Enneapogon species

Profile Morphology:

Horizon	Depth (m)	Description
A11	0.00 to 0.07	Dark brown (7.5YR3/2) moist; fine sandy clay loam; massive; dry; moderately weak; moderately calcareous. gradual to-
A12	0.07 to 0.20	Dark reddish brown (5YR3/3) moist; clay loam, fine sandy; massive; dry; moderately weak; non-calcareous. diffuse to-
B1	0.20 to 0.40	Dark reddish brown (2.5YR3/4) moist; fine sandy light clay; massive; dry; moderately firm; non-calcareous. diffuse to-
B21	0.40 to 0.70	Dark red (2.5YR3/6) moist; fine sandy light medium clay; massive; dry; moderately firm; non-calcareous. diffuse to-
B22	0.70 to 1.50	Red (2.5YR4/6) moist; fine sandy light medium clay; massive; dry; very firm; non-calcareous.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 105 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water pH	EC (dS/m) @40 C	Cl⁻ (mg/kg) @105 C	Particle Size (%) Coarse Sand	Fine Sand	Silt	Clay	Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1}) ECEC @ 105 C	Ca	Mg	Na	K	Exchange Acidity (meq/100g) Al @ 105 C	H^+	Cation Dominance ESP (%)	Ca/Mg Ratio	Dispersion R1 Ratio	Moisture (%) 15 Bar @ 105 C	Clay Mineralogy CEC/Clay Ratio	Total Elements (%) P @ 80 C	K	S
A11 / A12	0	0.1	5.7	0.04	10	25	36	16	23	5.4	3.7	1.2	0.06	0.29	0.1	0.1	1	3.1	0.49	7	0.23	0.038	0.124	0.046
B1	0.2	0.3	5.6	0.02	10																			
B21	0.5	0.6	5.9	0.02	10	16	24	7	56	5.0	2.8	1.9	0.11	0.06	0.1	0.1	2	1.5	0.26	13	0.09	0.036	0.158	0.032
B22	0.8	0.9	5.7	0.02	10	13	24	9	57	3.9	1.6	1.9	0.14	0.08	0.2	0.2	4	0.84	0.09	14	0.07	0.035	0.164	0.034
	1.1	1.2	5.1	0.02	20	12	24	8	55	2.8	0.53	1.1	0.12	0.07	0.9	1.0	4	0.48	0.10	13	0.05	0.032	0.156	0.039
	1.4	1.5	4.6	0.04	40	12	28	15	49	2.7	0.23	0.70	0.10	0.05	1.5	1.6	4	0.33	0.10	12	0.06	0.030	0.155	0.035

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg) Acid P	Bicarb. P	Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg) Fe	Mn	Cu	Zn	Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
150	0	0.10B	5.9	2.6	0.07	37		3	0.35	51	29	0.85	0.70		

Oven dry data @ 105 C

Soil Name: Tarramba (Tr)

Site No: S61 (BAN 2128) **Date Sampled:** 31 February 1994

Location: 237 285 mE 7 312 040 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa) **Substrate Lithology:** Quaternary alluvium

Landform Pattern: Level plain **Element:** Plain

Runoff: Very slow **Slope:** 0 %

Drainage: Imperfectly drained **Permeability:** Very slowly permeable

Microrelief: Normal gilgai **Microrelief Component:** Mound

Horizontal Interval: 6 m **Vertical Interval:** 0.10 m

Surface Coarse Fragments: No coarse fragments **Surface Condition:** Periodic cracking, surface flake

Classifications:

ASC: Endocalcareous- Endohypersodic, Epipedal, Black, VERTOSOL **PPF:** Ug5.1

GSG: Black earth

Vegetation:

Upper Stratum: Isolated tall trees (12-20 m)
Eucalyptus tereticornis (queensland blue gum)

Lower Stratum: Bothriochloa species; Sclerolaena species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Very dark brown (10YR2/2) moist; light medium clay; strong, 2-5mm, subangular blocky; dry; very firm; non-calcareous. abrupt to-
B21	0.05 to 0.40	Black (10YR2/1) moist; medium clay; very few <2%, medium pebbles 6-20mm, rounded siltstone; strong, 5-10mm, subangular blocky largest peds, parting to strong, <2mm, lenticular next size peds; moderately moist; very firm; non-calcareous. clear to-
B22	0.40 to 0.90	Black (10YR2/1) moist; medium clay; strong, <2mm, lenticular; moderately moist; moderately firm; non-calcareous. clear to-
B23k	0.90 to 1.50	Very dark grey (10YR3/1) moist; few 2-10%, medium 5-15mm, prominent grey mottles; light medium clay; strong, 10-20mm, prismatic largest peds, parting to strong, <2mm, lenticular next size peds; moderately moist; moderately weak; very few <2%, medium 2-6mm, calcareous nodules, non-calcareous.

Effective rooting depth (ERD): 0.8 m (EC ≥ 1.0 dS/m)

Plant Available Water Capacity PAWC): 130 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	8.1	0.19	20	4	14	20	63	47	23	17	1.4	0.62			3	1.4	0.48	22	0.75	0.050	0.753	0.026
B21	0.1	0.2	8.3	0.17	130																			
	0.2	0.3	8.7	0.32	200	4	14	18	65	49	19	22	3.9	0.28			8	0.9	0.53	23	0.75	0.042	0.720	0.018
	0.3	0.4	8.5	0.61	700																			
B22	0.4	0.5	8.5	0.73	900																			
	0.5	0.6	8.6	0.82	950	3	14	21	65	49	16	25	7.1	0.30			15	0.6	0.65	24	0.75	0.041	0.731	0.017
	0.6	0.7	8.5	0.88	1170																			
	0.7	0.8	8.5	1.00	1380																			
	0.8	0.9	8.6	1.00	1290	3	10	18	70	52	15	28	9.2	0.28			18	0.5	0.71	26	0.74	0.037	0.672	0.016
B23k	0.9	1.0	8.4	1.10	1490																			
	1.0	1.1	8.4	1.10	1440																			
	1.1	1.2	8.6	1.10	1400	4	12	22	64	48	14	26	8.0	0.25			17	0.5			0.75	0.039	0.702	0.013
	1.2	1.3	8.6	1.00	1330																			
	1.3	1.4	8.6	1.00	1360																			
	1.4	1.5	8.6	1.10	1490																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2128	0	0.10B	7.4	1.9	0.14	14	134	91	0.94	63	33	4.1	1	14	

Oven dry data @ 105 C

Soil Name: Tequila (Tq)

Site No: S62 (BAN 1895) **Date Sampled:** 17 May 1993

Location: 225 200 mE 7 323 310 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial gravel sediments (Qa) **Substrate Lithology:** Quaternary alluvial clay, sand and

Landform Pattern: Level plain **Element:** Valley-flat

Runoff: Very slow **Slope:** 0 %

Drainage: Moderately well drained **Permeability:** Moderately permeable

Microrelief: Zero or none **Surface Condition:** Hard setting

Surface Coarse Fragments: Very few <2%, small pebbles 2-6mm, subrounded quartz

Classifications:

ASC: Haplic, Calcic, Brown, CHROMOSOL **PPF:** Db1.33

GSG: No suitable group

Vegetation:

Lower Stratum: Cleared and sown to introduced grasses

Capparis lasiantha (nipan); Panicum maximim var. trichoglume (green panic); Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.30	Brown (10YR4/3) moist; fine sandy loam; massive; dry; very weak; non-calcareous. clear to-
A2j	0.30 to 0.55	Strong brown (7.5YR4/6) moist, very pale brown (10YR8/3) dry; fine sandy loam; massive; dry; very weak; non-calcareous. clear to-
B21	0.55 to 0.80	Brown (7.5YR4/4) moist; few 2-10%, medium 5-15mm, faint brown mottles; fine sandy light clay; strong, 5-10mm, prismatic largest peds, parting to strong, 2-5mm, subangular blocky next size peds; dry; very firm; common 10-20%, fine <2mm, calcareous soft segregations, slightly calcareous. sharp to-
2D1	0.80 to 1.20	Brown (7.5YR4/4) moist; clayey sand; massive; dry; weak; very few <2%, fine <2mm, calcareous soft segregations, non-calcareous. sharp to-
2D2	1.20 to 1.50	Strong brown (7.5YR4/6) moist; sand; massive; dry; weak; very few <2%, fine <2mm, calcareous soft segregations, non-calcareous.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 100 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.8	0.06	10	11	62	19	13	10	6.9	1.1	0.04	0.63			0.4	6.3	0.57	4	0.77	0.045	0.258	0.031
	0.2	0.3	8.5	0.08	10	8	65	19	13	5	4.8	0.47	0.01	0.52			0.2	10	0.57	3	0.38	0.031	0.252	0.020
A2j	0.5	0.55	8.6	0.09	10	6	61	20	13	4	3.4	0.47	0.05	0.09			1	7.2	0.74	6	0.31	0.018	0.251	0.021
B21	0.6	0.7	8.8	0.09	10	4	48	14	34	13	8.0	3.8	0.23	0.08			2	2.1	0.56	11	0.38	0.025	0.438	0.017
2D1	0.8	0.9	8.8	0.09	10	4	62	24	12	10	5.8	3.7	0.17	0.08			2	1.6	0.63	8	0.83	0.022	0.361	0.017
	1.1	1.2	8.9	0.09	30	18	61	5	17	8	3.5	2.3	0.19	0.11			2	1.5			0.47	0.024	0.285	0.018
2D2	1.4	1.5	8.8	0.23	220																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1895	0	0.10B	7.6	1.5	0.1	15	40	17	0.7	10	22	0.60	2.4	2	

Oven dry data @ 105 C

Soil Name: Thalberg (Tb)

Site No: S63 (BAN 1971) **Date Sampled:** 26 August 1994

Location: 216 710 mE 7 336 650 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial sediments (Cza) **Substrate Lithology:** Unconsolidated Cainozoic alluvial-colluvial sediments

Landform Pattern: Gently undulating plains **Element:** Plain

Runoff: Slow **Slope:** 1 %

Drainage: Moderately well drained **Permeability:** Moderately permeable

Microrelief: Zero or none **Surface Condition:** Hard setting

Surface Coarse Fragments: Very few <2%, cobbles 60-200mm, subrounded conglomerate

Classifications:

ASC: Sodic, Eutrophic, Red, CHROMOSOL **PPF:** Dr2.12

GSG: Red brown earth

Vegetation:

Upper Stratum: Cleared for pasture with remnant trees and shrubs Flindersia australis (crows ash)

Mid Stratum: Capparis lasiantha (nipan); Carissa ovata (currantbush)

Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.20	Dark brown (7.5YR3/4) moist; clay loam, fine sandy; very few <2%, small pebbles 2-6mm, rounded ironstones; massive; dry; very firm; non-calcareous. abrupt to-
B21t	0.20 to 0.30	Dark reddish brown (5YR3/4) moist; fine sandy light medium clay; very few <2%, small pebbles 2-6mm, rounded quartz; strong, 5-10mm, subangular blocky; dry; moderately firm; non-calcareous. clear to-
B22t	0.30 to 0.70	Dark reddish brown (2.5YR3/4) moist; very few <2%, fine <5mm, distinct grey mottles; light medium clay; very few <2%, small pebbles 2-6mm, rounded ironstones; strong, 5-10mm, angular blocky largest peds, parting to strong, 2-5mm, angular blocky next size peds; dry; very firm; non-calcareous. diffuse to-
B23t	0.70 to 1.50	Reddish brown (5YR4/4) moist; few 2-10%, fine <5mm, distinct grey mottles; light clay; very few <2%, medium pebbles 6-20mm, rounded ironstones; strong, 5-10mm, angular blocky largest peds, parting to strong, 2-5mm, angular blocky next size peds; dry; very firm; few 2-10%, fine <2mm, manganiferous soft segregations, non-calcareous.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 130 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	7.0	0.06	30	21	31	22	28	8.9	6.8	1.1	0.04	1.0			0.4	6.2	0.45	11	0.32	0.062	0.289	0.050
	0.1	0.2	7.2	0.04	20																			
B21t	0.2	0.3	7.5	0.03	20					6.9	5.3	1.3	0.09	0.20			1	4.1	0.58	10	0.13	0.034	0.267	0.032
B22t	0.3	0.4	7.6	0.04	20	15	23	11	50	9.0	5.9	2.5	0.28	0.32			3	2.4	0.52	14	0.18	0.031	0.304	0.030
	0.4	0.5	7.7	0.04	20																			
	0.5	0.6	7.5	0.05	30	11	20	12	56	9.3	5.0	3.5	0.49	0.27			5	1.4	0.54	15	0.17	0.029	0.329	0.028
	0.6	0.7	7.0	0.07	40																			
B23t	0.7	0.8	6.6	0.09	70																			
	0.8	0.9	6.7	0.14	140	11	20	10	57	9.8	4.4	4.3	1.0	0.13			10	1.0	0.50	15	0.17	0.031	0.336	0.034
	0.9	1.0	7.0	0.20	200																			
	1.0	1.1	7.3	0.28	290																			
	1.1	1.2	7.5	0.34	370	11	20	11	59	11	4.3	4.8	2.0	0.19			18	0.9	0.47	16	0.19	0.033	0.343	0.036
	1.2	1.3	7.6	0.36	390																			
	1.3	1.4	7.7	0.38	400																			
	1.4	1.5	7.8	0.37	400	13	22	11	54	10	3.4	4.3	2.5	0.18			25	0.8	0.50	15	0.19	0.031	0.324	0.033

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1971	0	0.10B	7.4	1.8	0.13	14		16	1.1	17	57	2.5	4		

Oven dry data @ 105 C

Soil Name: Tiamby (Tm)

Site No: S64 (BAN 1501) **Date Sampled:** 26 August 1993

Location: 230 320 mE 7 295 690 mN ZONE 56

Landscape:

Geology: Carboniferous acid and intermediate lava (Ct) (unidentified) **Substrate Lithology:** Intermediate igneous rock

Landform Pattern: Undulating rises **Element:** Hillslope

Runoff: Moderately rapid **Slope:** 3 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Surface flake, self-mulching

Surface Coarse Fragments: Few 2-10%, medium pebbles 6-20mm, subangular igneous rocks (unidentified)

Classifications:

ASC: Epicalcareous-Endohypersodic, Self-mulching, Black, VERTOSOL **PPF:** Ug5.14

GSG: Black earth

Vegetation:

Upper Stratum: Cleared with remnant trees and shrubs
Brachychiton rupestris (narrow-leaved bottletree); Brachychiton australis (broad-leaved bottletree)

Mid Stratum: Acacia harpophylla (brigalow); Capparis lasiantha (nipan)

Lower Stratum: Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.05	Black (10YR2/1) moist; silty light clay; weak, 2-5mm, subangular blocky largest peds, parting to strong, <2mm, granular next size peds; dry; loose. abrupt to-
B21t	0.05 to 0.15	Black (10YR2/1) moist; medium clay; strong, 5-10mm, subangular blocky; dry; very firm. gradual to-
B22t	0.15 to 1.05	Very dark greyish brown (10YR3/2) moist; light medium clay; very few <2%, medium pebbles 6-20mm, subrounded igneous rock (unidentified); strong, 5-10mm, lenticular; moderately moist; very firm; few 2-10%, medium 2-6mm, calcareous nodules, few 2-10% medium 2-6mm, calcareous soft segregations. gradual to-
B3k	1.05 to 1.30	Light olive brown (2.5Y5/4) moist; fine sandy light clay; very few <2%, medium pebbles 6-20mm, subrounded igneous rock (unidentified), common 10-20%, small pebbles 2-6mm, angular igneous rock (unidentified); strong, 5-10mm, subangular blocky; moderately moist; very firm; common 10-20%, medium 2-6mm, calcareous soft segregations, and few 2-10%, coarse 6-20mm, calcareous nodules. clear to-
B/Ck	1.30 to 1.40	Light yellowish brown (2.5Y6/4) moist; few 2-10%, fine <5mm, faint brown mottles; light clay; many 20-50%, medium pebbles 6-20mm, angular igneous rock (unidentified); strong, lenticular; moderately moist; moderately firm; common 10-20%, medium 2-6mm, calcareous soft segregations, and few 2-10%, medium 2-6mm, calcareous nodules. abrupt to-
C	1.40 to 1.60	Very abundant >90%, weathered igneous rock (unidentified) fragments.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 150 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21t	0	0.1	7.6	0.10	20	12	21	20	44	45	26	7.2	0.33	1.9			0.7	3.6	0.48	19	1.0	0.068	0.636	0.066
B21t / B22t	0.1	0.2	8.4	0.15	30																			
B22t	0.2	0.3	8.7	0.17	40	7	17	17	56	46	35	12	1.7	0.30			4	2.9	0.67	22	0.82	0.021	0.447	0.035
	0.3	0.4	8.9	0.25	100																			
	0.4	0.5	8.8	0.30	160																			
	0.5	0.6	8.8	0.36	260	9	18	16	53	42	22	15	4.5	0.25			11	1.5	0.82	21	0.79	0.018	0.434	0.038
	0.6	0.7	8.8	0.52	460																			
	0.7	0.8	8.8	0.65	670																			
	0.8	0.9	8.7	0.74	1090	8	15	17	57	45	20	16	6.6	0.26			15	1.3	0.85	22	0.79	0.018	0.450	0.036
	0.9	1.0	8.7	0.80	1200																			
B22t / B3k	1.0	1.1	8.6	0.85	1190																			
B3k	1.1	1.2	8.7	0.89	1240	9	15	16	57	46	20	17	6.8	0.29			15	1.2			0.81	0.017	0.602	0.028
	1.2	1.3	8.7	0.79	1030																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1501	0	0.10B	7.8	4.1	0.34	12		64	1.7	23	20	1.6	1.6		

Oven dry data @ 105 C

Soil Name: Tognolini (Tn)

Site No: S65 (BAN 2164) **Date Sampled:** 11 January 1995

Location: 235 710 mE 7 318 760 mN ZONE 56

Landscape:

Geology: Unconsolidated Quaternary alluvial sediments (Qa)

Substrate Lithology: Unconsolidated Quaternary alluvium

Landform Pattern: Level plain

Element: Backplain

Runoff: Very slow

Slope: 0 %

Drainage: Imperfectly drained

Permeability: Slowly permeable

Microrelief: Zero or none

Surface Condition: Recently cultivated, periodic cracking otherwise fine self-mulching

Surface Coarse Fragments: Very few <2%, medium pebbles 6-20mm, subangular

Classifications:

ASC: Endocalcareous-Endohypersodic, Self-mulching, Black, VERTOSOL

PPF: Ug5.16P

GSG: Black earth

Vegetation:

Fallow cultivation

Profile Morphology:

Horizon	Depth (m)	Description
AP	0.00 to 0.12	Very dark grey (10YR3/1) moist; medium clay; fragments and weak, <2mm, subangular blocky; dry; moderately firm. abrupt to-
B21t	0.12 to 0.50	Black (10YR2/1) moist; medium clay; strong, 2-5mm, lenticular; dry; very firm. diffuse to-
B22t	0.50 to 0.90	Very dark grey (10YR3/1) moist; medium clay; strong, 2-5mm, lenticular; slickensides; moderately moist; moderately firm. gradual to-
B23t	0.90 to 1.20	Very dark grey (10YR3/1) moist; medium clay; strong, 2-5mm, lenticular; slickensides; moderately moist; moderately weak; very few <2%, fine <2mm, calcareous concretions, slightly calcareous. diffuse to-
B24tk	1.20 to 1.60	Dark grey (10YR4/1) moist; few 2-10%, fine <5mm, faint dark mottles; medium clay; strong, 2-5mm, lenticular; slickensides; moderately moist; moderately weak; common 10-20%, medium 2-6mm, calcareous concretions, and few 2-10%, fine <2mm, calcareous concretions, slightly calcareous.

Effective rooting depth (ERD): 1.5 m

Plant Available Water Capacity PAWC): 195 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
AP	0	0.1	7.3	0.09	20	1	10	29	60	45	22	14	1.2	0.76			3	1.6	0.53	21	0.75	0.055	0.749	0.021
AP/B21t	0.1	0.2	7.1	0.10	20																			
B21t	0.2	0.3	7.6	0.13	40	1	6	28	63	47	23	15	2.4	0.33			5	1.5	0.62	23	0.75	0.053	0.745	0.020
	0.3	0.4	7.8	0.11	50																			
	0.4	0.5	7.9	0.18	90																			
B22t	0.5	0.6	8.1	0.21	200	1	6	25	65	48	23	16	4.1	0.27			9	1.4	0.77	24	0.74	0.042	0.710	0.016
	0.6	0.7	8.1	0.28	250																			
	0.7	0.8	8.1	0.36	370																			
	0.8	0.9	8.3	0.48	500	1	4	25	71	50	22	18	6.3	0.24			13	1.2	0.82	25	0.70	0.033	0.680	0.018
B23t	0.9	1.0	8.2	0.58	630																			
	1.0	1.1	8.3	0.70	880																			
	1.1	1.2	8.4	0.81	1000	2	5	19	73	50	21	19	8.1	0.24			16	1.1			0.69	0.031	0.587	0.025
B24tk	1.2	1.3	8.3	0.76	800																			
	1.3	1.4	8.3	0.85	1080																			
	1.4	1.5	8.3	0.83	1090																			

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2164	0	0.10B	7.2	1.4	0.08	18	76	49	0.85	32	22	3.6	0.68	8	

Oven dry data @ 105 C

Soil Name: Ulogie (Ug)

Site No: S66 (BAN 1805) **Date Sampled:** 12 May 1994

Location: 223 470 mE 7 314 510 mN ZONE 56

Landscape:

Geology: Unconsolidated alluvial-colluvial sediments (Cza)

Substrate Lithology: Unconsolidated Cainozoic alluvial-sediments

Landform Pattern: Gently undulating plains

Element: Plain

Runoff: Slow

Slope: 2 %

Drainage: Imperfectly drained

Permeability: Very slowly permeable

Microrelief: Zero or none

Surface Condition: Hard setting

Surface Coarse Fragments: Very few <2%, small pebbles 2-6mm, subangular quartz

Classifications:

ASC: Eutrophic, Mesonatric, Brown, SODOSOL **PPF:** Dy2.32

GSG: Solodized solonetz

Vegetation:

Upper Stratum: Very tall woodland (20-35 m)
Eucalyptus moluccana (gum-topped box); Eucalyptus crebra (narrow-leaved ironbark)

Mid Stratum: Eremophila mitchellii (false sandalwood); Geijera parviflora (wilga)

Lower Stratum: Aristida species; Eragrostis species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.25	Dark brown (10YR3/3) moist; fine sandy clay loam; massive; dry; moderately weak; non-calcareous. abrupt to-
A2j	0.25 to 0.30	Dark greyish brown (10YR4/2) moist, white (10YR8/2) dry; fine sandy clay loam; massive; dry; moderately weak; few 2-10%, medium 2-6mm, ferruginous nodules, non-calcareous, very few <2%, medium 2-6mm, manganiferous nodules. sharp to-
B21	0.30 to 0.75	Yellowish brown (10YR5/4) moist; fine sandy medium clay; strong, 100-200mm, columnar largest peds, parting to weak, 20-50mm, subangular blocky next size peds; dry; very strong; non-calcareous. diffuse to-
B22	0.75 to 1.70	Strong brown (7.5YR4/6) moist; fine sandy light medium clay; moderate 5-10mm subangular blocky; moderately moist; very strong; few 2-10%, fine <2mm, manganiferous soft segregations, non-calcareous.

Effective rooting depth (ERD): 0.3 m

Plant Available Water Capacity PAWC): 35 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1	0	0.1	6.4	0.02	10	12	61	15	16	4.7	3.1	1.2	0.10	0.31			2	2.6	0.69	5	0.31	0.039	0.296	0.033
	0.1	0.2	6.5	0.03	10																			
A1/A2j	0.2	0.3	6.7	0.04	10	13	61	15	17	3.7	1.1	2.0	0.41	0.16			10	0.55	0.81	5	0.24	0.030	0.287	0.032
B21	0.3	0.4	6.4	0.11	90	10	49	14	30	8.2	1.3	5.0	1.8	0.12			23	0.26	1.00	11	0.27	0.025	0.425	0.032
	0.4	0.5	6.5	0.18	170					9.8	1.5	5.7	2.5	0.11			25	0.26	0.97	12		0.026	0.454	0.034
	0.5	0.6	6.9	0.28	300	8	47	12	38	12	1.6	6.5	3.6	0.12			30	0.25	0.97	13	0.32	0.026	0.490	0.036
	0.6	0.7	7.6	0.39	450																			
B21/B22	0.7	0.8	7.8	0.48	580																			
B22	0.8	0.9	7.7	0.58	700	6	47	12	36	14	1.6	6.9	5.7	0.10			41	0.23	1.00	13	0.39	0.025	0.525	0.036
	0.9	1.0	7.9	0.59	730																			
	1.0	1.1	7.9	0.63	820																			
	1.1	1.2	7.8	0.64	830	5	49	17	40	13	1.4	6.0	5.5	0.09			42	0.23	0.99	12	0.33	0.025	0.497	0.034
	1.2	1.3	7.6	0.60	800																			
	1.3	1.4	7.5	0.63	860																			
	1.4	1.5	6.8	0.72	950	6	36	20	41	14	1.2	6.2	6.3	0.11			45	0.19	0.99	14	0.34	0.034	0.535	0.035

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
1805	0	0.10B	6.3	1.7	0.04	43		14	0.53	28	41	0.68	3		

Oven dry data @ 105 C

Soil Name: Wandoo (Wd)

Site No: S67 (BAN 814) **Date Sampled:** 02 April 1992

Location: 197 800 mE 7 309 550 mN ZONE 56

Landscape:

Geology: Permian siltstone, sandstone and mudstone of the Flat Top Formation (Puf)

Substrate Lithology: Mudstone

Landform Pattern: Gentle undulating rises

Element: Hillslope

Runoff: Slow

Slope: 1.8 %

Drainage: Moderately well drained

Permeability: Slowly permeable

Microrelief: Zero or none

Surface Condition: Hard setting

Surface Coarse Fragments: Few 2-10%, small pebbles 2-6mm, subangular mudstone

Classifications:

ASC: Vertic, Supracalcic, Red, CHROMOSOL **PPF:** Dr2.13

GSG: Affinities with Red-brown earth

Vegetation:

Upper Stratum: Eucalyptus melanophloia (silver-leaved ironbark); Eucalyptus erythrophloia (gum-topped bloodwood)

Mid Stratum: Maytenus cunninghamii

Lower Stratum: Bothriochloa bladhii (forest bluegrass); Heterpogon contortus (black speargrass); Aristida species

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.17	Dark reddish brown (5YR3/2) moist; clay loam, fine sandy; very few <2%, medium pebbles 6-20mm, subrounded chert; moderate, 2-5mm, subangular blocky; dry; very firm; non-calcareous. clear to-
B1	0.17 to 0.25	Dark reddish brown (5YR3/3) moist; light clay; very few <2%, small pebbles 2-6mm, subangular mudstone, very few <2%, medium pebbles 6-20mm, subrounded quartz; strong, 5-10mm, subangular blocky; dry; very firm; non-calcareous. gradual to-
B21	0.25 to 0.60	Dark reddish brown (2.5YR3/4) moist; medium clay; no coarse fragments; strong, 20-50mm, prismatic largest peds, parting to strong, 5-10mm, next size peds; dry; very firm; non-calcareous. diffuse to-
B22	0.60 to 0.90	Dark red (2.5YR3/6) moist; medium clay; no coarse fragments; strong, 20-50mm, prismatic largest peds, parting to strong, 10-20mm, lenticular next size peds; dry; very firm; non-calcareous. abrupt to-
B23k	0.90 to 1.00	Dark red (2.5YR3/6) moist; light medium clay; common (10-20%), large pebbles (20-60mm), subangular mudstone; strong, 5-10mm, lenticular; many 20-50%, coarse 6-20mm, calcareous concretions, and few 2-10%, medium 2-6mm, calcareous soft segregations. sharp to-
C	1.00 to 1.20	Very abundant >90% weathered mudstone fragments.
R	1.20	Hard, unweathered mudstone.

Effective rooting depth (ERD): 1.2 m (bedrock)

Plant Available Water Capacity PAWC): 150 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water pH	1:5 Soil/Water EC (dS/m) @40 C	1:5 Soil/Water Cl⁻ (mg/kg) @105 C	Particle Size (%) Coarse Sand	Fine Sand	Silt	Clay	Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg⁻¹) ECEC @ 105 C	Ca	Mg	Na	K	Exchange Acidity (meq/100g) Al @ 105 C	H⁺	Cation Dominance ESP (%)	Ca/Mg Ratio	Dispersion R1 Ratio	Moisture (%) 15 Bar @ 105 C	Clay Mineralogy CEC/Clay Ratio	Total Elements (%) P @ 80 C	K	S
A1	0	0.1	6.8	0.05	10	14	36	15	34	14	10	2.5	0.15	1.0			1	4.0	0.42	12	0.41	0.037	1.050	0.037
B1/B21	0.2	0.3	7.0	0.06	10	5	14	5	76	19	15	3.3	0.15	0.81			0.8	4.5	0.26	23	0.25	0.024	0.749	0.023
B21	0.3	0.4	7.2	0.04	10																			
	0.5	0.6	7.2	0.03	10	5	15	6	75	19	15	3.2	0.34	0.53			2	4.7	0.24	22	0.25	0.019	0.816	0.020
B22	0.8	0.9	7.5	0.03	10	4	18	7	70	19	15	3.3	0.55	0.47			3	4.5	0.27	21	0.27	0.018	1.010	0.018

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg) Acid P	Bicarb. P	Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg) Fe	Mn	Cu	Zn	Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
814	0	0.10B	6.8	1.5	0.08	19		6	0.88	22	67	1.1	0.97		

Oven dry data @ 105 C

Soil Name: Woolein (Wn)

Site No: S68 (BAN 726) **Date Sampled:** 19 February 1992

Location: 213 650 mE 7 304 600 mN ZONE 56

Landscape:

Geology: Permian andesite, basaltic and trachytic lava, tuff etc of the Camboon Andesite (Pln) **Substrate Lithology:** Andesite

Landform Pattern: Undulating rises **Element:** Footslope

Runoff: Slow **Slope:** 2 %

Drainage: Moderately well drained **Permeability:** Slowly permeable

Microrelief: Zero or none **Surface Condition:** Periodic cracking, self-mulching

Surface Coarse Fragments: Few 2-10%, medium pebbles 6-20mm, angular quartz

Classifications:

ASC: Haplic, Self-mulching, Red, VERTOSOL **PPF:** Ug5.37

GSG: Red clay

Vegetation: Cleared

Upper Stratum: Brachychiton populneus (kurrajong)

Lower Stratum: Panicum maximum var. trichoglume (green panic); Brachiaria gilesii; Indigofera pratensis; Cenchrus ciliaris (buffel grass)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.02	Dark reddish brown (5YR3/3) moist; light clay; very few <2%, medium pebbles 6-20mm, angular andesite; weak, 5-10mm, subangular blocky largest peds, parting to strong, 2-5mm, subangular blocky next size peds; dry; loose; non-calcareous. abrupt to-
B21	0.02 to 0.25	Dark reddish brown (5YR3/3) moist; light clay; very few <2%, medium pebbles 6-20mm, subangular andesite, very few <2%, small pebbles 2-6mm, subangular andesite; strong, 20-50mm, angular blocky largest peds, parting to strong, 5-10mm, subangular blocky next size peds; moderately moist; moderately weak; non-calcareous. gradual to-
B22	0.25 to 0.65	Dark reddish brown (2.5YR3/4) moist; medium heavy clay; very few <2%, small pebbles 2-6mm, subangular andesite; strong, <2mm, lenticular; moderately moist; moderately firm; non-calcareous. diffuse to-
B23	0.65 to 1.00	Dark reddish brown (2.5YR3/4) moist; medium clay; very few <2%, small pebbles 2-6mm, subangular andesite, very few <2%, large pebbles 20-60mm, subangular andesite; strong, lenticular; moderately moist; moderately firm; very few <2%, fine <2mm, manganiferous soft segregations, non-calcareous. gradual to-
B3	1.00 to 1.10	Dark reddish brown (2.5YR3/4) moist; medium clay; many 20-50%, medium pebbles 6-20mm, subangular andesite; strong, lenticular; very few <2%, fine <2mm, manganiferous nodules, non-calcareous. clear to-
C	1.10 to 1.30	Very abundant >90%, weathered andesite fragments.
R	1.30	Hard, unweathered andesite.

Effective rooting depth (ERD): 1.3 m (bedrock)

Plant Available Water Capacity PAWC): 140 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	CEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A1/B21	0	0.1	7.3	0.04	10	11	21	15	51	35	17	9.1	0.18	0.50			0.5	1.9	0.41	17	0.69	0.042	0.268	0.040
B21	0.1	0.2	7.5	0.04	10																			
B21/B22	0.2	0.3	7.5	0.03	10	8	18	16	57	38	18	10	0.37	0.16			1	1.8	0.43	20	0.67	0.027	0.306	0.031
B22	0.3	0.4	7.6	0.03	10																			
	0.4	0.5	7.8	0.04	10																			
	0.5	0.6	8.1	0.05	10	8	19	14	57	36	17	13	0.56	0.16			2	1.3	0.54	21	0.63	0.021	0.266	0.028
B22/B23	0.6	0.7	8.2	0.06	10																			
B23	0.7	0.8	8.4	0.09	10																			
	0.8	0.9	8.7	0.16	10	10	16	16	58	38	19	15	0.68	0.12			2	1.3	0.49	21	0.66	0.019	0.626	0.027
	0.9	1.0	8.8	0.16	30																			
B3	1.0	1.1	9.0	0.15	20	13	16	13	57	32	17	15	0.69	0.12			2	1.1	0.47	17	0.56	0.017	2.790	0.024

CEC/Alcoholic Cations @ pH 8.5 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
726	0	0.10B	7.4	1.6	0.1	16		6	0.59	10	33	3.2	0.48		

Oven dry data @ 105 C

Soil Name: Youlambie (Ym)

Site No: S69 (BAN 2543) **Date Sampled:** 28 July 1995

Location: 243 060 mE 7 333 710 mN ZONE 56

Landscape:

Geology: Interbedded Permian conglomerate and tuff of the Youlambie Conglomerate (Ply) **Substrate Lithology:** Conglomerate

Landform Pattern: Rolling low hills **Element:** Hillslope

Runoff: Very rapid **Slope:** 18 %

Drainage: Rapidly drained **Permeability:** Highly permeable

Microrelief: Zero or none **Surface Condition:** Hard setting

Surface Coarse Fragments: Abundant 50-90%, large pebbles to cobbles 20-200mm, angular siltstone and conglomerate

Classifications:

ASC: Basic, Paralithic, Leptic, RUDOSOL **PPF:** Um1.44

GSG: No suitable group

Vegetation:

Upper Stratum: Eucalyptus crebra (narrow-leaved ironbark)

Mid Stratum: Acacia bidwillii (corkwood wattle); Erythrina vespertilio (bat's wing coral tree)

Lower Stratum: Heterpogon contortus (black speargrass); Stylosanthes scabra cv. Seca (seca stylo)

Profile Morphology:

Horizon	Depth (m)	Description
A1	0.00 to 0.15	Black (10YR2/1) moist; fine sandy clay loam; many 20-50%, large pebbles 20-60mm, angular siltstone; weak, 2-5mm, polyhedral; clear to-
A12	0.15 to 0.30	Very dark greyish brown (10YR3/2) moist; fine sandy clay loam; abundant 50-90%, cobbles 60-200mm, subangular conglomerate, common 10-20%, large pebbles 20-60mm, angular siltstone; weak, 2-5mm, polyhedral; abrupt to-
C	0.30 to 0.40	Very abundant >90%, weathered conglomerate fragments.
R	0.40	Hard, unweathered conglomerate.

Effective rooting depth (ERD): 0.4 m (bedrock)

Plant Available Water Capacity PAWC): 22 mm

Analytical Data:

Horizon	Upper Depth (m)	Lower Depth (m)	1:5 Soil/Water			Particle Size (%)				Cation Exchange Capacity/Exchangeable Cations # (cmol[+] kg^{-1})					Exchange Acidity (meq/100g)		Cation Dominance		Dispersion	Moisture (%)	Clay Mineralogy	Total Elements (%)		
			pH	EC (dS/m)	Cl$^-$ (mg/kg)	Coarse Sand	Fine Sand	Silt	Clay	ECEC	Ca	Mg	Na	K	Al	H$^+$	ESP (%)	Ca/Mg Ratio	R1 Ratio	15 Bar	CEC/Clay Ratio	P	K	S
			@40 C	@105 C		@ 105 C				@ 105 C					@ 105 C					@ 105 C		@ 80 C		
A11	0	0.1	6.5	0.02	10	41	28	9	20	11	6.4	4.1	0.07	0.54			0.6	1.6	0.55	10	0.55	0.045	2.510	0.023
A11 /A12	0.1	0.2	6.5	0.02	10																			
A12	0.2	0.3	6.7	0.02	10	40	29	11	20	9	4.6	4.1	0.13	0.19			1	1.1	0.52	8	0.45	0.034	2.200	0.015

Aqueous Cations @ pH 7.0 [Methods 15I3,15C1 - Rayment and Higginson (1992)]

Site #	Upper Depth (m)	Lower Depth (m)	pH (1:5)	Org. C (%)	Tot N (%)	C/N Ratio	Extr. P (mg/kg)		Acid Extr. K (meq/100g)	DTPA Extr. Micronutrientients (mg/kg)				Phos. Extr. S (mg/kg)	Water Sol. NO3-N (mg/kg)
							Acid P	Bicarb. P		Fe	Mn	Cu	Zn		
2543	0	0.10B	6.7	1.5	0.09	17		26	0.72	33	29	0.68	1.7	3	

Oven dry data @ 105 C