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Soils of Technical College Reserve R1624 Parish of Tinaroo, County of Nares, Mareeba, North Queensland

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SOILS OF TECHNICAL COLLEGE RESERVE R1624 PARISH OF TINAROO, COUNTY OF NARES, MAREEBA, NORTH QUEENSLAND

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Abstract

A detailed soil survey of a 51 ha area, that is now Technical College Reserve R1624 at Mareeba, North Queensland, recognized fourteen soil types and two land units. These are described, classified according to four systems, and features limiting their agricultural use are tabulated. Also, laboratory data for nine profiles are presented.

Red earths and gleyed podzolic soils make up most of the arable land and there are small areas of red and yellow podzolic soils, earthy sands and solodic soils. About one quarter of the property consists of either strongly dissected slopes or small alluvial flats subject to flooding and is therefore non-arable.

All of the soils have very low nutrient status and need fertilizer for productive crops. The red earths and red podzolic soils are freely-drained and therefore suitable for a wide range of irrigated crops but the yellow and gleyed podzolic soils have impeded internal drainage; markedly reducing their potential usefulness.

INTRODUCTION

This 51 ha property is situated in the northern part of the Atherton Tableland, some 40 km inland from Cairns and 5 km south-east of Mareeba (Fig.1). It was formerly occupied by CSIRO Tobacco Research Institute (1957 to 1975) and is now the site of the Mareeba College of Technical and Further Education. The property consists mainly of old alluvium forming a plain that is sharply incised by the present drainage to depths of up to 18 m. Elevations range from 400 to 420 m ASL. The property has a short frontage on the eastern bank of Tinaroo Creek from which water has been available for irrigation.

The soils were examined and mapped in 1957 to provide a basis for the selection of experimental sites, and to aid interpretation of the effects of soil factors on the performance of field experiments. A detailed map of soil distribution, a description of the units mapped, and an assessment of factors likely to influence soil suitability for irrigated tobacco were made available to the Tobacco Research Institute in 1957. This showed that the important differences between these soils for irrigated crops were in field texture, internal drainage and depth to hardpan.

The purpose of the present report is to formally record the soil descriptions, soil map, and laboratory information arising from the survey; the data will then be generally available and may serve as a sample of the larger area of similar land along the eastern side of Tinaroo Creek.

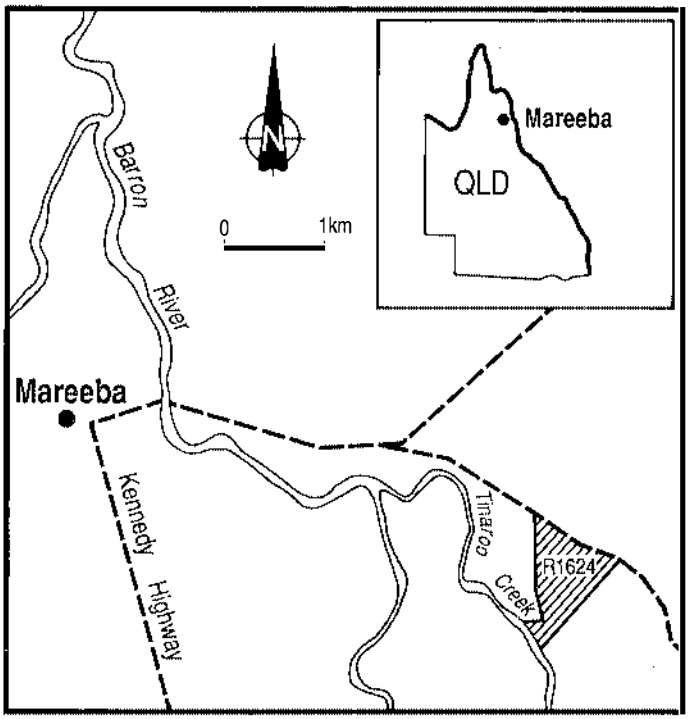


Figure 1. Locality plan

ENVIRONMENT

Climate

Located in the drier, northern end of the Atherton Tableland, the area has a sub-humid tropical climate contrasting strongly with that of the high-rainfall, humid portion of the Tableland south of Tolga and the wet coastal lands to the east.

The mean annual rainfall for Mareeba, as recorded at the Queensland Water Resources Commission (Lat. 17°'S: Long. 145°25'E; 335 m elevation), is 915 mm (standard period normal), the median 863 mm, and the 10 and 90 percentiles 564 and 1274 mm, respectively (calculated from Anon. 1968). The mean annual maximum and minimum temperatures are 25.6°C and 15.7°C, and mean annual evaporation 1327 mm (Hounan 1961). The area lies at the northern limit of Australia's frost zone and light frosts can occur between mid-June and mid-August, with an average of 4 per annum (Foley 1945).

Monthly means for rainfall, measured evaporation and temperature at Mareeba are shown in Figure 2. The rainfall is strongly summer dominant, 90 per cent of the annual mean being recorded in the November - April period. The winters are mild and dry. Also shown are mean monthly values for a climatic index $P/E^{0.75}$ (Prescott and Thomas 1949), used as a measure of both the growing season for crops (as determined by the availability of water for growth) and the leaching factor significant in soil formation. Using monthly values of 0.4 for break of season and

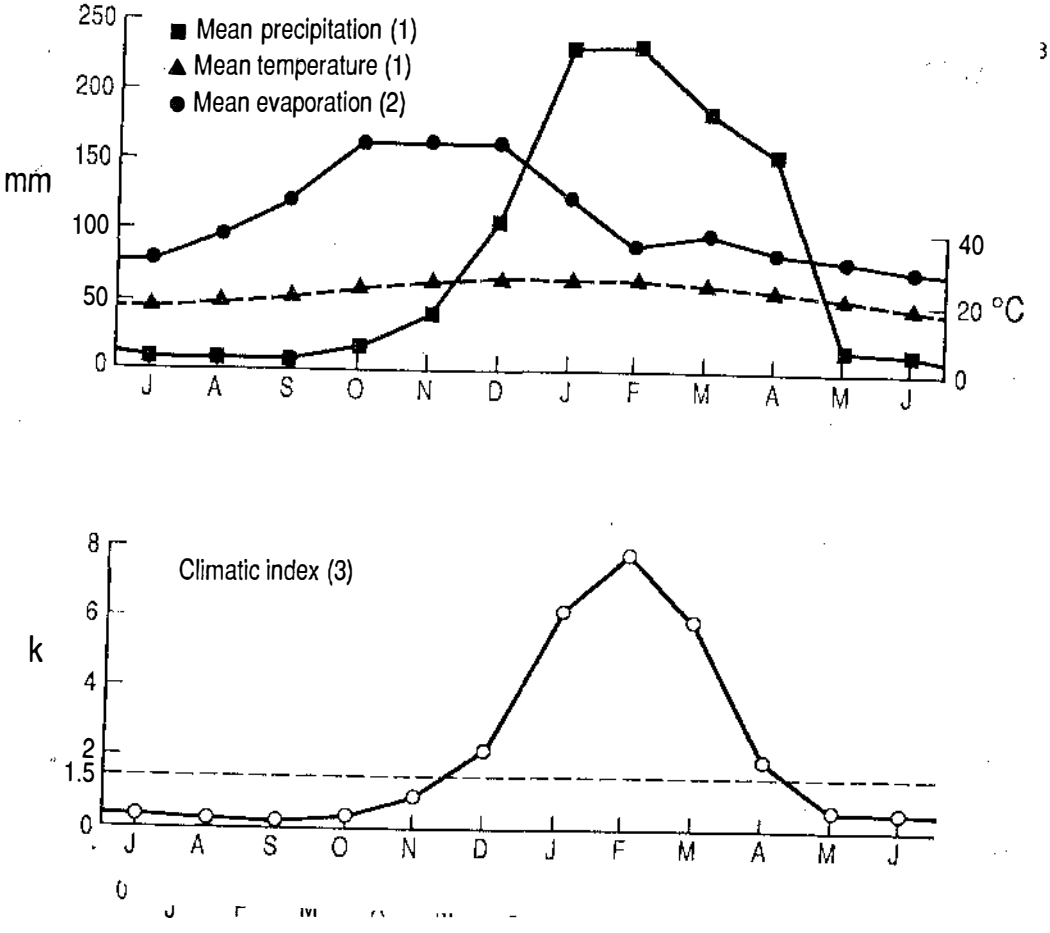


Figure 2. (above) Selected climatic data and (below) climatic index for Mareeba [(1) Anon 1966, 1975; (2) Hounan 1961; (3) Prescott and Thomas 1949)].

1.2 for vegetation of average transpiration, there is a well-defined 5 months growing season.

Prescott (1948) also found that the monthly value of the index, corresponding to the point where rainfall balances transpiration from vegetation and evaporation from the soil, varied from 1.3 to 1.5 for freely transpiring vegetation. Accepting the higher value for this area, there is a considerable excess of rainfall for leaching or run-off during a period of about seven months in which the combination of available soil water and high temperature promote weathering and soil development. The freely-drained soils of the area are, in fact, strongly weathered to depths in excess of 2 m and mildly acid throughout.

Geomorphology and geology

Most of the property is part of a gently undulating plain which is the surface of an old valley fill of sandy and gravelly Quaternary alluvium, 10 to 20 m thick. This deposit has been deeply incised to depths of up to 12 m by the present drainage through Tinaroo and Tri Creeks and associated gullies. The incision has partially isolated small portions of the property and, in places, exposed underlying hard rocks. These are dominantly greywacke, silt stone, shale and slate of the Lower Carboniferous Hodgkinson Formation and the closely similar Barron River Metamor-

phics (Arnold and Fawckner 1980). They provide the parent materials for the soils of a minor area of the property on the toe slope of a bordering hill. Together with Permian granitic rocks, the metamorphics also make up the provenance of the Quaternary sediments. There are also minor areas of low-level Recent alluvium along Tinaroo and Tri Creeks. The maximum relief across the property is just over 20 m.

Broad low banks and gently sloping flats crossed by ill-defined drainage depressions form the surface of the plain giving it a variation in local relief of 3-4 m. Some sorting of the alluvium is evident locally; it is dominantly coarse sandy but includes some areas of fine sandy materials and some clayey patches. The low banks are freely-drained to depths of 3 m or more but surface drainage of the flats is sluggish and temporary flooding of depressions occurs during the wet season. Internal drainage of both the flats and depressions is poor to strongly impeded. Even in the dry season, the subsoil layers at these sites may be partially saturated at less than 1 m depth and water tables were also recorded below 3 m under the soils of the banks which have free drainage in the upper part. On the steep slopes where the modern drainage is incised into the plain, seepage areas are common at the junction of the alluvium and country rock, and also above cemented bands in the old alluvium.

The small area of hill slope in the eastern corner of the property rises 6 to 7 m above the plain and has less than 2° slope, generally. The underlying rock is weathered micaceous schist with numerous fine to coarser quartz veins. In places, quartz reefs are evident at or near the surface and cross-section outcrops impede downslope subsurface drainage causing intermittent saturation of the adjacent deep subsoil.

Minor areas of young alluvium occur along the creeks as low banks and shallow depressions, differing in level by 1 to 2 m. The alluvium is fine sandy to silty and highly micaceous, apparently being largely derived from micaceous schist and slate. Surface drainage varies from free to slow: internal drainage is free, except along parts of Tri Creek where some soils are saturated by seepage from the higher plain. Apart from the surface layer, the young alluvial deposits show little evidence of pedological differentiation.

Vegetation

The dominant native vegetation was apparently grassy open forest with minor occurrences of grassy woodland and grassland. Most of the property had been cleared before the soil survey. Observations of the remnants indicate some correlation between plant species and the distribution of soils and imply that several distinct plant communities occurred within the grassy open forest.

The modified remnants imply that the grassy forest consisted of moderately spaced eucalypts 9 to 15 m tall, a lower storey of rather scattered small trees and shrubs (2 to 6 m) and a grassy floor of varying density. Grey bloodwood (*Eucalyptus* sp. aff. *polycarpa*) appears to have been the dominant tree, with poplar gum (*Eucalyptus alba*) and/or grey box (*Eucalyptus leptophleba*) sometimes co-dominant. Both the density and species of the middle layer varied greatly and included quinine (*Petalostigma pubescens*), ironwood (*Erythrophleum chlorostachys*), black wattle (*Grevillea glauca*), beefwoods (*Grevillea striafa, G.pteridifolia*), tea trees (*Melaleuca viridiflora, M.nervosa, M.minutifolia*) and cocky apple (*Planchonia careya*). Black spear (*Hetereopogon contortus*), giant spear (*Hetereopogon triticeus*) and kangaroo (*Themeda australis*) were the dominant grasses, with some red natal (*Rhynchelytrum repens*),

Chloris sp., *Panicum* sp., *Eragrostis* sp., northern cane grass (*Coelorhachis roetboelioides*), and *Pseudopogonatherum irritans*.

The grassy woodland was associated with minor flats and depressions. Scattered eucalypts 6 to 12 m tall formed the upper layer, poplar gum usually being dominant with some ghost-gum and grey bloodwood. A few beefwood (*Grevillea pteridifolia*) and tea trees (*Meleleuca nervosa* and *M.viridiflora*), 2 to 4 m high, formed a lower tree/shrub level. The grassy ground cover was patchy and generally thin consisting mainly of *Chloris* sp. and *Pseudopogonatherum irritans*, with occasional clumps of black spear and kangaroo grasses. Nardoo (*Marsilea* sp.) and cyperaceous plants occurred in small depressions.

The grassland was restricted to the small area of young alluvium bordering the creeks and comprised a dense cover of black spear grass with some blady (*Imperata cylindrica*) and kangaroo grasses. Cyperaceous plants were dominant in slow-draining depressions.

SOILS

Introduction and classification

The soils were examined and described from shallow pits extended by auger examinations to depths of 1 to 2 m, at 20 to 80 m intervals along traverses 60 m apart. The average density of profile descriptions was 4 per ha. Soil boundaries were drawn in the field on a contoured (ca 30 cm interval) base map at 1:1200 scale, prepared by the then Commonwealth Department of Interior.

About half of the property had been farmed for irrigated tobacco before it was purchased for research experiments. Rough levelling for this purpose had considerably modified the surface soil in places, particularly areas bordering the slightly depressed flats. Soil boundary delineation in these parts necessitated closely spaced spade examinations of the upper profile.

Fourteen soil units (Mareeba 1- 14) and two miscellaneous land types were identified and mapped. The soil units were differentiated at approximately soil type level but have not been named because of the small areas involved. However, they are expected to have a wider distribution and to be fairly representative of the soils of the old alluvial plain to the east of Tinaroo Creek but are unlikely to occur west of the Barron River.

Each of the 14 soil units can be related to an Australian great soil group (Stace *et al,* 1968) or to intergrades, with degrees of fit varying from good to marginal. The relationships and the main characteristics of the Mareeba soil units are given in Table 1. The approximate placings of the soils at equivalent level in three other classification systems (Northcote 1979, Soil Survey Staff 1975, FAO-UNESCO 1974) are given in Table 2. These should be viewed as "best estimates" because of the absence of definitive laboratory data, such as thin section identification of clay skins or cation data by a specified method required by Soil Taxonomy and World Soil Map Legend, and also some field data, such as field textures over a defined interval or measurements of the hardsetting surface feature required by A Factual Key. In Tables 1 and 2, the soil units are arranged in approximate order of increasing drainage impedence and wetness, except for M14 which, owing to its much finer texture and heavy clay subsoil, has a different water regime to the other soils.

The distinguishing characteristics of the great soil groups are outlined in A Handbook of Australian Soils (Stace *et al.* 1968). Also, a general description of soils classified according to A Factual Key terminology is given in A Description of Australian Soils (Northcote *et al.* 1975).

Profile descriptions and some related data for the Mareeba soil units are given below and detailed descriptions and laboratory data for those soils sampled are presented in Appendix 1.

Table 1 Main morphological features of soil units

	Great Group and Mareeba unit	Morphological features
1.	Earthy sand M12	Grey-brown sand, grading into pale yellowish brown sandy loam below 40 cm and gravelly sand below 1.3 m; perched water table on clay D horizon at about 1.7 m.
2.	Red earths M1	Dark reddish brown loamy sand, grading into red massive sandy clay to sandy massive clay at 30 cm and to sandy clay below 1 m; overlies clayey grits and gravels below 1.7 m and may have water table at about 3.3 m.
	M2	Light brown loamy sand, grading through light reddish brown A2 to massive or weakly-structured red light to medium clay below 40 cm and to gritty clay below 1.5 m; overlies weathered metamorphic rock below about 2.4 m.
	M3	Light reddish brown loamy fine sand, grading through a paler A2 to massive or weakly structured red fine sandy clay loam to fine sandy clay with a few nodules below 40 cm and to red-brown fine sandy loams below 1.6 m; overlies weathered metamorphic rock below about 2.4 m.
	Red earth - red podzolic soil intergrade	
	M4	Light brown loamy fine sand, grading through a pale A2 to reddish brown fine sandy loam below 35 cm and or mottled red-brown fine sandy clay loam below 70 cm; mottling increases and there are large amounts of black nodules below 1.2 m.
3.	Red podzolic soil M13	Grey or brown loamy coarse sand, grading through a bleached A2 to brown or reddish brown gravelly sandy clay loam below 50 cm, and overlying gravelly clayey coarse sands below 90 cm.
4.	Yellow podzolic soils (mottled subsoils)	
	M5	Brownish grey loamy sand, grading into bleached A2 overlying mottled brownish yellow and red sandy clay loam to sandy clay below 40-50 cm; many nodules below 90 cm; gritty hardpan below 1.5 m with perched water table above it.
	M6	Brownish grey loamy fine sand grading into thick bleached A2 overlying mottled light grey, yellow-brown, and red fine sandy clay or light clay; many nodules below 1.2 m; gritty hardpan below 1.5 m.

5. Gleyed podzolic soils

M7	Brownish grey loamy sand, grading into a bleached A2 with few faint rusty tracings, over grey mottled with yellow-brown and red sandy to medium clay below 45 cm; there are large amounts of nodules below 50 cm and a gritty hardpan below about 1 m.
M11	Brownish grey loam to clay loam grading to bleached A2 with rusty flecks with a clear boundary to grey medium to heavy clay below 15 cm; texture decreases to silty clay below 90 cm and grades to gritty clay loam below 2.5 m. A few fine black nodules occur through the profile.
M10	Light brownish grey sandy loam grading to bleached A2 with rusty flecks with an abrupt boundary to mottled grey or grey-brown light to medium clay below 30 cm; many black nodules below 35 cm becoming cemented with depth; overlies gritty hardpan below about 1.1 m.
M8	Brownish grey loamy sand grading to bleached A2 with rusty flecks; mottled light yellow-grey, yellow-brown and red sandy clay loam to sandy clay below 45 cm with many black nodules; gritty hardpan below 1 m.
M9	Brownish grey loamy sands grading to bleached A2 with rusty flecks; mottled white, black and yellow brown sandy clay loam below 35 cm with many black nodules, these become cemented with depth and form cavernous pans below 80 cm.

6. Solodic soils

M14	Dark brownish grey sandy loam grading to bleached A2 abruptly overlying reddish brown heavy clay at about 15 cm; these grade into olive light to medium clay below 50 cm and to clayey grit and gravels below 1.5 m.

Table 2 Classification of the soils

Mareeba Unit	Factual Key(1)	Great Soil Group (2)	Soil Taxonomy (3)*	World Soil Map Legend (4)*
M12	Uc5.23	Earthy sand	Haplustalf	Ferric Luvisol
M1	Dr2.62	Red earth	Paleustalf (ultic)	Ferric Luvisol
M2	Dr2.62	Red earth	Paleustalf (ultic)	Ferric Luvisol
M3	Dr2.61	Red earth	Paleustalf (ultic)	Ferric Luvisol
M4	Dr2.62	Red earth - Red podzolic soil intergrade	Paleustalf (ultic)	Ferric Luvisol
M13	Dy4.81	Red podzolic soil	Haplustalf (arenic)	Ferric Luvisol
M5	Dy3.81	Yellow podzolic soil (mottled)	Paleustalf (ultic)	Ferric Luvisol

Mareeba Unit	Factual Key(1)	Great Soil Group (2)	Soil Taxonomy (3)*	World Soil Map Legend (4)*
M6	Dy3.81	Yellow podzolic soil (mottled)	Haplustalf	Eutric Podzoluvisol
M7	Dy3.81	Gleyed podzolic soil	Haplustalf	Albic Luvisol
M11	Dy2.42	Gleyed podzolic soil	Paleustalf	Eutric Planosol
M10	Dy3.42	Gleyed podzolic soil	Haplustalf	Eutric Planosol
M8	Dy3.81	Gleyed podzolic soil	Haplustalf	Gleyic Podzoluvisol or Gleyic Acrisol
M9	Dg2.82	Gleyed podzolic soil	Haplustalf	Gleyic Acrisol
M14	Dr2.43	Solodic soil	Paleustalf (udic)	Albic Luvisol

1. Northcote (1979)
2. Stace *et al.* (1968)
3. Soil Survey Staff, USDA (1975)
4. FAO-UNESCO (1974)

* Placement of the soils is a "best estimate" in the absence of definite laboratory data e.g. (1)

Profile descriptions of soil units

Mareeba 1 loamy sand (Dr2.62) occupies gently sloping low banks of coarse sandy to gritty alluvium (probably mainly from granitic and metamorphic rocks) on an old flood plain. Twenty auger examinations of this soil show that it is very uniform to a depth of 1.5 m. A light profile phase with slightly thinner surface and coarse sandy clay loam textures below 80 cm occurs in one area.

Horizon	Depth (cm)	Soil Morphology
Al/Ap	0	Dark reddish brown (5YR 4/3, *d** 5/4) loamy sand; massive breaking to 20 mm fragments; very friable, dry hard, numerous 0.5 - 1 mm pores; few pieces of 6 mm quartz gravel. Clear to -
AB1	18 (15+ (25	Patchy red (10R 4/4-4/6) and dark red-brown (2.5YR 4/4) sandy clay loam increasing to sandy clay; weak blocky 50 mm size, moist very friable, numerous 1 mm pores; may contain a few manganiferous segregations or nodules; trace to low amounts of 3 mm quartz gravel. Gradual to -

* Colour descriptions are for moist soil unless marked "d" = dry

+ Range of depths recorded and common depth to each horizon are given

B21	30	(23 (33	Red (10R 3/6-3/8) with some dark red (10R 3/3-3/5) cutans, sandy clay to sandy medium clay; weak blocky 50 mm size breaking 12 mm units, very friable, numerous 1 mm pores; trace to low amounts of black segregations, few soft black nodules; trace to low amount 3-6 mm quartz gravel. Gradual to -
B22	107	(58 (130	Red (10R 3/6-3/8) coarse sandy clay to light clay sandy; very weak blocky 50 mm size, very friable, numerous 0.5 - 1 mm pores; few soft black nodules and segregations; low amounts of fine quartz gravel. Gradual to -
B31	178	(165 (203	Light brownish red (2.5YR 5/8) to red (10R 3/8) gritty or fine gravelly clay loam to coarse sandy clay; massive, friable, mostly quartz and granite gravel, some mica flakes. Diffuse to -
B32	250	(236 (270	Mottled red-brown, very light grey-brown and yellowish brown clayey grit and gravel; water-worn quartz gravel to 75 mm size, continuing below 3.8 m. Water table at 3.3 m at profile sample site.

Mareeba 2 loamy sand (Dr2.62) occurs on crests of low banks of coarse sandy to gritty alluvium (probably mainly from granitic and metamorphic rocks). The nearest related soil is Mareeba 1 which is distinguished by its thinner and darker surface horizon; the boundary between the two is diffuse and therefore somewhat arbitary.

Horizon	Depth (cm)		Soil Morphology
Al/Ap	0		Light brown (7.5YR 4/4, d 5/4) loamy sand; massive breaking to 50 mm fragments, dry hard, many fine pores; few 3 mm black nodules and trace of quartz gravel. Gradual to
A2	20	(15 (25	Light reddish brown (5YR 4/4) loamy sand; massive, friable, very porous; few pieces of fine quartz gravel. Clear to -
B1	33	(30 (38	Light brownish red (2.5YR 3/6-3/8, d 5/8) sandy clay loam; with few fine black markings and yellow-red patches; massive, friable and porous; few pieces of fine quartz gravel. Gradual to -
B2	43	(38 (50	Red (10R 3/8) with dark red (10R 3/6) cutans light to medium clay sandy; weak blocky 50 mm size, moist friable; few fine black segregations, few 6 mm soft black nodules in some profiles, few pieces of quartz gravel. Gradual to -
B3	158	(140 (175	Brownish red (2.5YR 4/8, d 5/8) gritty clay with few light yellow-brown patches; massive, highly porous; few to low amounts of soft 6 mm black nodules. Light to moderate amounts of fine quartz gravel. Diffuse to -
C	340		Light brown, yellow-brown and reddish brown clayey coarse sand and gravel; water table below 3.4 m.

Mareeba 3 loamy fine sand (Dr2.61) has formed in fine sandy slope deposits derived from fine-grained metamorphic rocks (principally micaceous schist with some coarse quartz veins); it occupies 2 to 3° lower hill slopes, 3 to 6 m above the plain. Lighter subsoil textures, fine sandy loam or lighter above 85 cm, were recorded in one area.

Horizon	Depth (cm)	Soil Morphology
A1	0	Reddish brown (5YR 5/4) with some paler patches loamy fine sand; massive breaking to 50 mm fragments, moist friable, numerous 0.5-1.5 mm pores; few soft black segregations. Gradual to -
A2	15 (13 (20	Light reddish brown (3.5YR 5/6), with small lighter and darker coloured patches, loamy fine sand; massive breaking to 50 mm fragments, moist friable, many 0.5-1 mm pores, few black segregations and few 10-50 mm irregular lumps with black coatings. Gradual to -
B1	28 (20 (36	Red-brown (2.5YR 4/6-4/8) fine sandy clay loam; massive breaking to 50 mm fragments, friable, many pores; few 6-10 mm soft black nodules. Gradual to -
B21	43 (38 (53	Red (10R 4/8) and dark red (10R 3/6) fine sandy clay loam to fine sandy clay; massive to very weak blocky 50 mm size, friable, many pores; low amounts 3 mm black nodules. Gradual to -
B22	61 (53 (102	Red (10R 4/8), with some dark red aggregate faces, fine sandy clay; weak blocky, friable, very porous; low amounts 5-10 mm soft black nodules; few pieces fine quartz gravel; changing to fine sandy clay loam with depth. Gradual to -
B31	160 (130 (190	Red-brown (2.5YR 4/6-4/8) with light grey-brown and brownish white patches, fine sandy loam; massive, very porous; few soft black nodules and hardened red lumps. Gradual to -
B32	245 (230 (245	Brownish yellow, very light grey-brown; reddish brown; white, etc. fine sandy loam; with weathered fine metamorphic rock increasing with depth and continuing below 3.8 m.

Mareeba 4 loamy fine sand (Dr2.62) has formed in fine sandy slope deposits derived from fine-grained metamorphic rocks; it occupies a narrow zone on the lower hillslope (2°); subsoil colour below 60 cm varies from red-brown to reddish yellow.

Horizon	Depth (cm)	Soil Morphology
A1	0	Light brown (10YR 6/4) to light reddish brown (5YR 5/4) loamy fine sand; massive breaking to 25 mm fragments, moist friable and highly porous. Gradual to -
A2	18 (15 (23	Yellow-brown (10YR 6/8) to light reddish brown (5YR 6/8) loamy fine sand; massive, friable, very porous. Gradual to-
B1	36 (30 (48	Reddish yellow-brown (5YR 7/8) or reddish brown (5YR 4/8) fine sandy loam; massive, friable, very porous; few irregular nodules and black segregations. Gradual to -

B2	69	(58 (76	Red-brown (2.5YR 4/8) or reddish brown mottled with reddish yellow-brown (5YR 4/8), fine sandy clay loam; massive, friable, highly porous; low amounts of irregular black nodules and black segregations generally increasing with depth; colour usually becoming more patchy with depth. Gradual to -
B3	125	(125 (130	Mottled brownish white, yellow-brown, black and some reddish brown, sandy clay loam; large accumulations of irregular black nodules and some quartz gravel, continuing to below 2.1 m. This horizon has a seasonal water table.

Mareeba 5 loamy sand (Dy3.81) occurs on broad low banks of coarse sandy to gritty alluvium derived largely from granitic and metamorphic rocks. It overlies a gritty gravelly hardpan, at about 1.5 m depth, which has low permeability and seasonally perches water. Pronounced bleaching of the A2 horizon and duller B horizon are features of the wetter margins of this unit.

Horizon	Depth (cm)		Soil Morphology
A1	0		Brownish grey (10YR 4/2-5/2, d 6/1-6/2) loamy sand; massive and weakly coherent in place, very friable, numerous 0.5-1 mm pores; small amounts of fine quartz gravel. Gradual to -
A2	18	(13 (20	Very light yellow-grey (2.5Y 6/4-7/4, d 2.5Y 8/4) sand; massive and weakly coherent in place, very friable, numerous 0.5-1 mm pores; few 3-10 mm yellowish brown nodules with black kernels. Gradual to-
A3/B1	28	(23 (43	Light brownish yellow (2.5Y 5/6-5/8, d 7/5) sandy loam to sandy clay loam; with few slightly hardened red-brown and yellowish brown mottles; massive, very friable, numerous 0.5-1 mm pores; few 5-25 mm nodules, mostly hardened mottles. Clear to -
B21	43	(36 (56	Light brownish yellow (1Y 7/6-7/8) mottled with red (2.5YR 3/8) and yellowish brown (7.5YR 5/6) sandy clay; massive, friable, many 0.5-1 mm pores; mottles are hardened to form low amounts of soft nodules 10-50 mm size, with black centres. Gradual to -
B22	89	(70 (100	Mottled yellow-brown (1Y 5/5); reddish brown (5YR 5/4) or red (2.5YR 6/8) sandy clay loam to sandy clay; massive, friable, many 0.5-1 mm pores; mottles hardened to form large amounts of irregular nodules 20-50 mm size, often with black centres. With increasing depth texture decreases, nodules become fewer and there is an increase in quartz gravel. Clear to gradual to -
B3	150	(127 (150	Coarsely mottled light grey, yellow-brown and red, gritty gravelly sandy clay loam or gritty medium clay becoming less clayey with depth; massive compacted gritty hardpan with very low permeability, leading to seasonally perched water tables.

Mareeba 6 loamy fine sand (Dy3.81) occupies 1-2° slopes of fine sandy alluvium/colluvium fringing the low hill of fine-grained metamorphic rocks (principally phyllitic slates with some coarse quartz reefs). It overlies the gritty hardpan of the old valley fill at depths of 1.2-2.1 m. It has free surface drainage but internal drainage is impeded firstly by the fine sandy clay B horizon and then by the underlying hardpan.

Horizon	Depth (cm)		Soil Morphology
A1	0		Brownish grey (10YR 6/1) with some white (10YR 9/2) patches, loamy fine sand massive breaking to 25 mm fragments, moist friable, very porous. Clear to -
A2	10	(8 (13	White (10YR 9/2) fine sand; massive, extremely friable, very porous; few soft 1-2 mm black nodules. Clear to -
A3	48	(40 (53	White (10YR 9/2) with dark red, black and light grey mottling, clayey fine sand; massive, very friable, porous; low amounts of 10-25 mm nodules with clayey coatings. Abrupt, very irregular with tongues of A2 penetrating to -
B21	60	(50 (76	Coarsely mottled light grey (2.5Y 7/2) with yellowish brown (10YR 5/4) and red (1YR 3/6), fine sandy clay to light clay; massive to weak blocky 20-50 mm size, firm, many very fine pores; low amounts of 10-25 mm nodules, mostly red and yellowish brown with black centres, few black throughout. Gradual to -
B22	125	(95 (140	Coarsely mottled light grey (2.5Y 8/1) and light yellow-grey (2.5Y 7/4) with some red, yellow-brown and black, fine sandy clay loam; massive, very porous; moderate increasing to large amounts of 25 mm nodules, mostly black and red; nodules decrease with depth. Gradual to -
D	150	(140 (210	Mottled light grey (2.5Y 7/1), yellow-brown (10YR 6/8) and some red-brown (2.5YR 4/8), fine sandy clay loam with grit, or fine gravelly clay loam - gritty hard pan with very low permeability; continuing to below 2.8 m.

Mareeba 7 loamy medium sand (Dy3.81) has developed in coarse sandy to gritty alluvium of the old floodplains, it occupies gently (1°) slopes between Mareeba Units 3 and 4. Texture of the B2 varies from sandy clay to sandy medium clay; also, some profiles have 5 cm of puggy medium heavy clay immediately above the gritty hardpan.

Horizon	Depth (cm)		Soil Morphology
A1	0		Brownish grey (10YR 4/1-5/1, d 6/1) loamy sand (medium grained), with few lighter patches; massive, weakly coherent, very porous. Gradual to -
A2	13	(10 (23	Very light grey-brown (10YR 6/3-7/3, d 8/3) sand; massive, weakly coherent, very porous, few faint rusty brown root lines. Gradual to -
B1	43	(41 (56	Mottled light brownish grey (10YR 6/1-7/1) and yellowish brown (10YR 5/4) with some red and black, sandy clay loam

			to sandy clay; massive, very porous; variable amounts of 12-25 mm red-brown, yellowish brown and black nodules. Gradual to -
B2	76	(56 (91	Mottled light brownish grey (10YR 6/1-7/1), light yellow-brown (2.5Y 7/6-7/8) and red-brown (2.5YR 4/6) sandy clay to sandy medium clay; moderate to large amounts of 10-50 mm nodules, mostly yellowish brown and reddish brown, few black. Grading into a thin band of puggy medium heavy clay or to -
C	96	(76 (117	Light grey mottled with reddish brown and light yellowish brown, gritty hardpan of compacted clayey grit and fine gravel with very low permeability, continuing to below 1.5m.

Mareeba 8 loamy sand (Dy3.81) occupies flat to gently sloping areas of gravelly sandy alluvium derived mainly from granitic and metamorphic rocks. The sandy clay subsoil contains moderate to abundant amounts of irregular black nodules and overlies a gritty, gravelly hardpan at 80-120 cm. Surface drainage is slow and internal drainage is impeded by the hardpan.

Horizon	Depth (cm)		Soil Morphology
A1	0		Brownish grey (10YR 4/1-5/1, d 6/1) loamy sand; massive breaking to 50 mm fragments, very friable, many 1 mm pores; may have a few fine quartz fragments, few faint rusty flecks and root lines. Gradual to -
A21	13	(8 (20	Very light grey-brown (10YR 6/3 or 7/3, d 8/2) sand; massive, very friable, very porous; may have a few fine quartz fragments, few faint rusty root lines, decreasing with depth. Gradual to -
A22	23	(20 (36	Very light yellow-grey (2.5Y 6/4-7/4, d 8/4) sandy loam; massive, friable and porous; few small black nodules in the lower part, may have a few fine quartz fragments. Clear to
B21	43	(38 (48	Mottled very light yellow-grey (2.5Y 6/4-7/4), brownish yellow (10YR 7/8) and light red (2.5YR 6/8) sandy clay loam increasing to sandy clay; firm, massive and porous; few to moderate black nodules; red and yellow mottles are slightly hardened, may have a few fine quartz fragments. Gradual to -
B22	60	(48 (70	Very light yellow-grey (2.5Y 6/4-7/4) and light grey (2.5Y 7/1) sandy clay with prominent black, yellow-brown and red mottles; massive and porous; large accumulations of 10-50 mm irregular nodules. Clear to -
B3 pan	100	(84 (120	Coarsely mottled grey (5Y 7/1) with red-brown and yellow brown hardpan of clayey grit and gravel. Eroded gully exposures show the gravelly hardpan continuing to depths of more than 9 m.

Mareeba 9 loamy sand (Dy2.82) occupies low-lying flats and shallow depressions in the old floodplain of gritty alluvium derived largely from granitic and metamorphic rocks. In the north-east section of the property, fine sandy wash from the metamorphic hill has accumulated in some of the shallow depressions forming a fine sandy surface variant of Mareeba 9. Surface drainage is slow and internal drainage impeded on hardpan.

Horizon	Depth (cm)		Soil Morphology
A1	0		Brownish grey (10YR 5/1-6/1, d 7/1) loamy sand or loamy fine sand, with distinct rusty brown rootlines and flecks; massive, dry very hard, numerous 1 mm pores. Gradual to
A2	5	(2 (8	Brownish white (10YR 8/1-8/2, d 9/1) sandy or loamy sand, with rusty brown rootlines and flecks; massive, dry hard, numerous 1mm pores; few 0.5-3mm black nodules. Gradual to-
B2	33	(25 (46	Mottled brownish white (10YR 9/2), black (10R 2/0 and yellowish brown (10YR 5/6) sandy loam to sandy clay loam; massive, dry hard; moderate to large amounts of black nodules 20-50mm size becoming cemented with depth. Gradual to-
B22	80	(68 (100	Mottled black (10YR 2/0) very light grey (10YR 7/1-8/1) and yellowish or reddish brown cemented hardpan, with light grey and yellowish sandy clay loam fill in cavities within the nodular mass. In some profiles this pan continues to below 1.5m depth while in others it is underlain by mottled light yellow-brown and grey gritty clay below depths of about 1.2m.

Mareeba 10 sandy loam (Dy3.82) occurs on near-level floors of some shallow drainage depressions in the old floodplain of gritty alluvium; few profiles were described, data are too limited to establish common horizon depth values.

Horizon	Depth (cm)		Soil Morphology
A1	0		Light brownish grey (10YR 6/1-6/2) sandy loam or lighter, massive, dry hard, some rusty flecks and rootlines. Gradual to -
A2	8		Brownish white (10YR 8/2, d 9/2) loamy sand; massive, dry hard, few faint rusty rootlines and flecks. Abrupt to -
B21		(25 (35	Brownish grey (10YR 5/2-6/2) light clay, massive to very weak blocky, dry very hard; few black nodules; some with dark brown (7.5YR 4/4) patches and rusty rootlines and flecks. Gradual to -
B22		(38 (53	Light grey-brown (10YR 5/2.5) mottled with brownish yellow (10YR 6/8) and black, medium clay often sandy; moderate blocky 50-75 mm size, dry very hard, moderate to large amounts of 10-50mm black nodules, sometimes becoming weakly cemented with depth. Gradual to -

B3 pan	(105 (135	Mottled light grey (2.5 YR 6/1), yellow-brown (10YR 6/8) and reddish brown (2.5YR 3/5) cemented gritty clay, grading to clayey grit and gravel with depth and continuing below 2m.

Mareeba 11 clay loam (Dy2.42) formed in fine textured alluvium overlying gritty alluvium; it occurs in shallow depressions which may be remnants of effluent channels through the old floodplain. The unit has slight development of swamp hummock micro-relief and the profile description is from level areas between hummocks.

Horizon	Depth (cm)		Soil Morphology
A1	0		Brownish grey (d 10YR 4/1-5/1) loam to clay loam; weak platy, dry hard. Gradual to -
A2	3	(1 (3	Brownish white (d 10YR 8/2-9/2) silty loam to clay loam; massive, dry very hard; few 3-5 mm black nodules; rusty yellow rootlines and flecks and few brownish grey patches. Clear to -
B21	15	(8 (20	Brownish grey (10YR 5/1) medium to heavy clay, with brownish white patches; blocky, dry hard; low amounts 3-5 mm black nodules. Gradual to -
B22	40	(30 (53	Brownish grey (10YR 5/1) heavy clay; moderate, blocky, highly plastic, dry hard and brittle; few black nodules. Gradual to -
B31	90	(90 (100	Light brownish grey (2.5Y 5/1-7/1) silty light clay; weak blocky, firm, dry hard; fine black segregations on aggregate faces. Gradual to -
B32		(175 (190	Light yellow-grey (2.5Y 6/2-6/4) silty light clay, with brownish and yellowish patches; very weak pedality, dry hard; becoming mottled and gritty with depth; field pH 7.0. Gradual to -
D		(250 (270	Light yellow-grey (2.5Y 6/2) gritty clay loam to light clay with yellow-brown patches; much fine quartz gravel, granitic grit and mica flakes; continuing below 3m; field pH 7.0-7.5.

Mareeba 12 sand (Uc5.23) has formed in coarse-textured alluvium in a very shallow depression, probably the sandy bed of an ancient effluent channel, on the old alluvial plain. One profile only was described.

Horizon	Depth (cm)	Soil Morphology
A1	0	Grey-brown (10YR 5/2) sand; weakly coherent and highly porous. Gradual to
A12	23	Light grey-brown (10YR 5/3) sand; weakly coherent and highly porous. Gradual to -
B1	38	Pale yellowish brown (1Y 6/4) sandy loam; weakly coherent; low amounts 12-25mm black nodules becoming fewer with depth. Diffuse to -

Cg	137	Brownish white and light brown sand; low amounts of fine water-worn quartz gravel; perched water table at this depth. Abrupt to -
D	168	Very light grey with coarse red and yellow-brown mottles medium clay; stiff plastic; few fine black nodules and some fine water-worn gravel. Continuing below 2.1 m.

Mareeba 13 loamy coarse sand (Dy4.81) has formed in coarse sandy and fine gravelly alluvium, representing bed load deposits associated with distributary channels on the old floodplain. The sands range from medium to coarse grain as the dominant size fraction and gravels vary from few to abundant.

Horizon	Depth (cm)		Soil Morphology
A1	0		Brownish grey (10YR 4/1) to brown (10YR 4/3, d 6/3) coarse sand to loamy coarse sand; and very porous; few to moderate amounts of fine quartz gravel 3-5 mm. Gradual to -
A2	8	(5 (10	Very light-brown (10YR 6/3) to light yellowish brown (10YR 7/4) medium to coarse grained sand; single grain loose and very porous; few to moderate amounts of fine quartz gravel 3-5 mm. Gradual to -
B1	28	(25 (41	Light yellow-brown (7.5YR 8/6) clayey medium to coarse weakly coherent and very porous sand; single grain to moderate to large amounts of fine quartz gravel, 3-5 mm. Diffuse to -
B2	53	(48 (71	Brown or reddish brown (5YR 5/6) gravelly sandy clay loam; massive, weakly coherent and very porous; large amounts of fine quartz gravel. Gradual to -
B3	90	(84 (100	Brown or yellow-brown grading to light brown gravelly clayey coarse sand, passing to gravelly sand with depth; moderate to large amounts of 10-50 mm gravel mostly quartz, some micaceous metamorphic pieces; continuing below 2.6 m

Mareeba 14 sandy loam (Dr2.42) has developed in mixed fine and coarse alluvium derived mainly from granitic and metamorphic rocks; it occurs on remnants of the old floodplain, some 12 m above present stream level. Small patches of the surface, about 1 m across, are cracked, and under these the bleached A2 is thin or discontinuous and the top of the B2 horizon occurs within 5 cms; these appear to represent potential sites of mounds in weak gilgai development. Profile description is from areas between such patches.

Horizon	Depth (cm)	Soil Morphology
A1	0	Dark brownish grey (10YR 4/1, d 6/1-7/1) loamy sand to fine sandy loam; massive breaking to 20 mm fragments, dry hard and hardsetting, few fine pores; few rusty brown flecks and few 3-5 mm rusty brown nodules. Clear to -

A2	5	(3 (5	Very light brown (10YR 6/3) or very light brownish grey (10YR 7/2, d 8/2) loamy sand to sandy loam; massive, dry hard, many very fine pores; low amounts 3-5 mm rusty brown and black nodules; few pieces of fine quartz gravel. Abrupt to -
A2/B1	13	(10 (25	Very light brown or light brownish grey (10YR 6/3-7/2, d 8/2) with reddish brown (7.5YR 5/4) patches, sandy clay loam to sandy clay; A2 horizon with pockets and patches of reddish brown clay; massive, dry hard, very porous; few rusty brown and black nodules; few pieces fine quartz gravel. Clear to -
B21	18	(13 (25	Reddish brown (5YR 4/4-3/5) medium to heavy clay, with grey-brown aggregate faces and some grey flecks; strongly blocky to polyhedral 50 mm, dry hard, few pieces of fine quartz gravel. Aggregate faces becoming more strongly yellow-grey-brown with depth. Gradual to -
B22	53	(46 (58	Olive-grey (2.5YR 4/3-5/3) with dark brown (10YR 3/4-4/4) mottles, light to medium clay; some yellowish brown patches with depth; strong polyhedral 50 mm breaking to 10 mm units, dry hard; few pieces of quartz gravel. Gradual to -
B3	96	(90 (114	Olive-grey (2.5Y 3/3-5/3) with brown and yellowish patches of much white flecking, gritty light clay or clay loam; large amounts of 5 mm quartz gravel and pieces of micaceous slate. Gradual to -
C	145	(130 (160	Grey, light yellow-brown, white fleckings, etc. clayey grit and gravel; mostly water-worn quartz 5 mm size; continuing below 2.5 m.

Miscellaneous land types

Two units have been mapped.

1. Recent alluvial lands. These comprise minor areas of low-level alluvium bordering Tinaroo and Tri Creeks. The surface is uneven and consists of gently sloping banks and flats with some shallow depressions. The materials are dominated by highly micaceous fine sands, probably derived from schists and micaceous slates. Silty and clayey materials are associated with ponded areas. Because the areas involved are small and fragmented, and access for implements generally impracticable, few profiles were examined.

Along Tinaroo Creek, three distinct soil forms were found associated with the levee, gently sloping flat and shallow closed depressions. The soils of that levee and flats have features of very weakly developed prairie soils; that of the depression is a gleyed clay that cracks when dry.

On the levee, 2 to 3m above the stream bed, the surface soil is dark brownish grey fine sandy loam 20-25 cm thick, with moderate medium (10-25 mm) subangular and angular blocky structure grading below into more than a metre of dominantly yellow-brown sandy loam.

On the flat, the A1 horizon is dark brownish grey loam to clay loam, 40 to 60 cm thick, with high organic content and strong fine (5-10 mm) subangular blocky structure. With depth, it grades into brown and yellow brown fine sandy loam which continues to 120 cm or more.

SOIL MAP OF

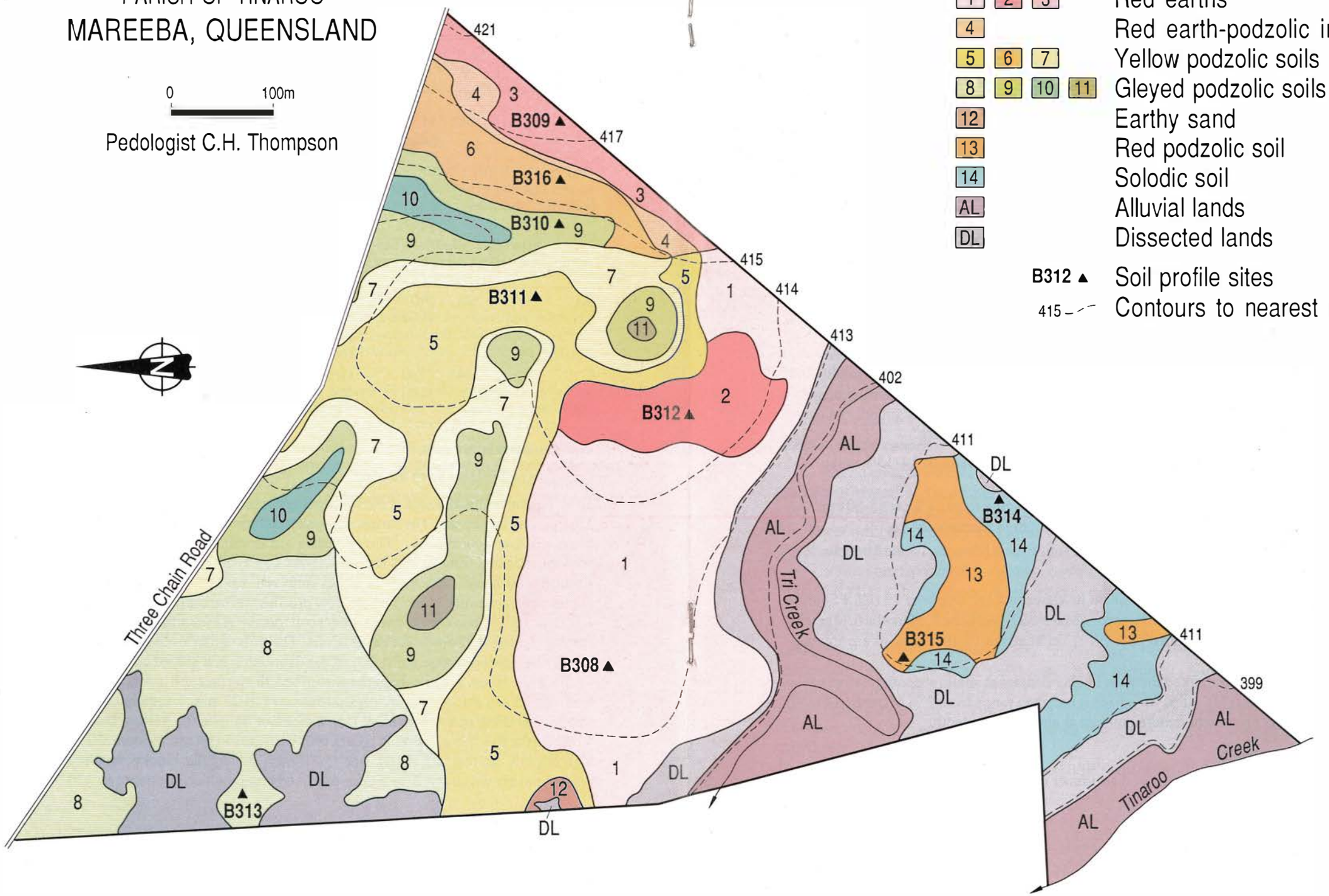
TECHNICAL COLLEGE RESERVE 1624

PARISH OF TINAROO

MAREEBA, QUEENSLAND

0 100m

Pedologist C.H. Thompson



The gleyed soil of the depressions consists of about 25 cm of light grey silty medium clay grading into dark brownish grey silty loam which becomes light yellowish grey below 45 cm, continuing to 120 cm depth. Rusty and ochrous root tracings and flecks are prominent in the clay horizon which has weak blocky structure.

Along Tri Creek, the sandy alluvium is either fine or medium grained, the former being more common; soil profile development is minimal but tends towards prairie soil form. The minor banks and flats of the fine sands have about 10 cm of grey-brown loamy fine sand or fine sandy loam surface which grades into yellowish brown loamy fine sands; below 50-60 cm there is a gradual change to mottled clayey sand containing a few black soft nodules. The areas of medium-grained sand have about 15 cm of darker loamy sand surface grading into about 35 cm of yellow-brown loamy sand which overlies coarse sand and gravel.

2. Dissected land. These comprise the non-arable, steep eroded slopes bordering the creeks, below the old alluvial plain. Differences in level of 6 to 15 m over short distances are common. There are minor areas of shallow gritty and gravelly soils, mostly truncated remnants of soils of the plain. In places, all traces of developed soils have been removed, exposing underlying sediments, cemented hardpan or country rock.

LABORATORY DATA

Limited laboratory data for the fine earth fractions of samples from 9 soil profiles, representing the more important soils, are tabulated in Appendix 1. The analytical methods and abbreviations of terms used for both the profile descriptions and the data are also listed.

In the following comments and interpretation of the laboratory data, the general classes 'low', 'medium' etc. have the value limits used by Queensland Department of Primary Industries (Bruce and Rayment 1982) or by Consolidated Fertilizers (Anon 1977).

Particle size

The data are generally in line with field textures. Notable features are

- Very low surface soil clay contents (3 to 8%) of all but Mareeba 14 (13% in the A1 horizon),
- Increasing clay content with depth to maxima ranging from 18% (at 45-80 cm depth in Mareeba 13) to 63% (at 15-35 cm depth in Mareeba 14).
- Low to very low silt contents (1-7%) in all soils except Mareeba 14 and Mareeba 9 (24 an 14%, respectively).

In the surface soils, coarse sand is dominant in Mareeba 8 and Mareeba 13 (CS:FS ratios 1.3 and 2.2 respectively) and fine sand in Mareeba 2, Mareeba 3, Mareeba 5, Mareeba 6, Mareeba 9 and Mareeba 14 (CS:FS ranging from 0.18 to 0.73). In Mareeba 13, the fractions are approximately equal - CS:FS 0.9.

Most of the soils show a marked increase in clay content at shallow depth relative to the surface horizons; maximum clay ratios for adjacent horizons range from 2 in Mareeba 14 to 10 in Mareeba 6 which has prominent texture contrast at about 45 cm depth.

Soil reaction and salt contents

Despite the high leaching potential of the summer rains, most of the soils are slightly acid

to neutral throughout their profiles; the exceptions are Mareeba 8 which is moderately to strongly acid to the depth sampled, and Mareeba 9 and Mareeba 14 which are mildly to moderately alkaline (maximum pH 8.5) below 46 and 69 cm, respectively. Also, these two soils are the only ones with more than negligible soluble salt in the subsoil. Mareeba 9 has low total soluble salt and chloride contents below 75 cm depth, increasing to medium amounts below 1 m: Mareeba 14 has low contents below 50 cm depth, increasing to 0.038% chloride, and 0.1% total soluble salt between 80-100 cm.

Organic carbon and nitrogen

For a 15 cm 'cultivation depth', all of the soils have very low contents, less than 0.6% organic carbon (Walkley and Black 1934) and less than 0.05% nitrogen (Kjeldahl). The organic carbon and nitrogen contents are barely above these levels in the thinner virgin A1 horizons of Mareeba 6 and Mareeba 9, although the extremely thin A1 of Mareeba 14 has 1.57% organic carbon. Such levels reflects the inherent nutrient poverty of these soils, generally.

After conversion of the Walkley and Black values to equivalent dry combustion organic carbon contents, the carbon:nitrogen ratios for the surface soils range 12 and 21, i.e. they lie within the range common to most Australian soils.

Phosphorus

The available phosphorus status of the surface soils, as determined by 0.1 N sulphuric acid extraction, is very low (less than 10 ppm) except for soils Mareeba 2 and Mareeba 1 which are medium to high (26-44 ppm, respectively). The higher values are undoubtedly the result of fertilizer additions during the past 10 to 15 years when the area was farmed.

The total phosphorus contents for all depths examined range between an extremely low 30 ppm and a low 330 ppm; the latter for the deep subsoil of the loamy solodic soil (Mareeba 14) which has the highest profile content for the soils analysed.

Exchangeable cations

Exchangeable potassium contents range between an extremely low 0.04 m.eq/100 g in the surface of Mareeba 13 and a high 0.69 m.eq/100 g in the clay subsoil of the solodic soils (Mareeba 14). Only two of the surface soils have values at or above the 0.2 m.e% commonly regarded as the lower limit of adequacy for crops (von Stieglitz 1953), and one of these soils has probably received fertilizer.

Values tend to increase with clay content, four soils having medium to high values (0.28-0.69 m.eq/100 g) in the upper part of the clay subsoils, but lower values again at greater depths; only Mareeba 14 has adequate levels throughout.

Exchangeable calcium and magnesium values are also generally low. Only Mareeba14 and subsoil samples of Mareeba 1 (for calcium) and Mareeba 6 and Mareeba 9 (for magnesium) have values equal to or above the thresholds for adequacy - 2 m.e% for calcium and 1.7 m.e% for magnesium/100 g soil (Anon, 1977). In the subsoils, higher magnesium values are associated with higher clay contents. The calcium contents are typically low except for the Mareeba 14 samples; the 2.5 m.eq calcium/100g in the subsoil of Mareeba 1 is possibly due to applied fertilizers.

Exchangeable sodium percentages (ESP's) reach levels considered significant in relation

to soil physical properties in the subsoils of Mareeba 9 (15% ESP with 20% clay content) and Mareeba 14 (5% ESP with 63% clay increasing to 14% ESP in the deeper subsoil).

SUITABILITY OF THE SOILS FOR CROPPING

Although some of the soils defined have fair to moderate subsoil potassium, they are generally poor in major plant nutrients. All would require substantial fertilizer applications to ensure adequate nutrient supply for most agricultural crops where water is not limiting plant growth. The important differences between the soils are those of texture, depth and internal drainage; the latter, along with available water capacity, being determined by the texture and/or structure profile and depth of solum.

The factors affecting the suitability of the soils for agricultural use and a general rating of their potential for cropping based on the survey data are presented in Table 3. The soils may also be placed in four of the five groups of suitability for tobacco described by McDonald (1967) as follows:

Group 1 Soil physical properties are not restrictive for tobacco growing: Mareeba units 1, 2, 3 and 13.

Group 2 soils ith relatively impermeable layers of clay or concentrations in the lower profile which may cause some temporary waterlogging after heavy rain: Mareeba units 4, 5, 6 and 7.

Group 4 shallow soils which are liable to severe waterlogging after heavy rain. An early beginning of the wet season causes severe problems associated with waterlogging: Mareeba units 8 and 9.

Group 5 (a) very shallow, mostly fine-grained soils which are severely waterlogged after heavy rain: Mareeba units 10, 11 and 14.
(b) very deep sand, over a base of impermeable clay or concretions at 150 cm depth or more: Mareeba unit 12.

Thus the red earths with deep sola and free drainage and the red podzolic soil (Mareeba 13) are seen as the most suitable for tobacco. The incidence and severity of impedence to drainage is seen as the main constraint in the other units. The red earths and the red podzolic soil also have fewer constraints (Table 3) for a wide range of agricultural and horticultural crops; the other soils are much less suitable because of their restricted internal drainage or poor available water capacities.

Table 3 Factors affecting the agricultural potential of the soils

Great Soil Group	Soil Unit	Topography and Drainage	Limiting Factors	Agricultural Potential	Suitability for Tobacco*
Earthy sand	M12	gently undulating to level; very slow surface drainage, extremely permeable soil, rapid internal drainage to 150-180 cm depth where clay layer impedes permeability.	.very low nutrient status .very low AWC* droughty soil	Fair to good; suited to spray irrigation; frequent wetting necessary to maintain water availability for plant growth.	Group 5b

Great Soil Group	Soil Unit	Topography and Drainage	Limiting Factors	Agricultural Potential	Suitability for Tobacco*
Red earths	M1 M2	broad gently convex banks of the undulating plain; slow surface drainage, free internal drainage to water table in gravelly sediments at 3 to 5 m.	.low nutrient status .cultivated layer sets hard on drying	Fair to good; suited to spray and fast furrow wetting necessary to maintain available soil water.	Group 1
	M3	lower hill slopes (2-3°) free surface drainage, free internal drainage to metamorphic rocks at 2-3 m.			
Red earth - red podzolic soil intergrade	M4	gently (2-3°) toe slopes of adjacent hills; slow surface drainage; free internal drainage to deep subsoil where lateral drainage may be impeded by quartz reefs.	.very low nutrient .low AWC .cultivated surface soil may form a hard crust on drying	Generally good; suited to spray and fast furrow irrigation; frequent wetting necessary to maintain available soil water.	Group 2
Red podzolic soil	M13	gentle undulating to level extremely permeable soil, very slow surface drainage, rapid internal drainage.	.very low nutrient status .very low AWC-rather droughty soil	Fair to good; suited to spray irrigation, frequent wetting necessary to maintain available soil water.	Group 1
Yellow podzolic soils	M5	broad, gently sloping low banks; slow surface drainage, free internal drainage to 180 cm where drainage impeded by gritty hardpan.	.very low nutrient status .low AWC in very permeable upper horizons but moderate in clay subsoils	suitable for spray irrigation	Group 2
	M6 M7	very gentle slopes and flats, slow surface drainage, moderately to slow internal drainage slightly impeded by gritty hardpan.	.temporary water accumulation on clay subsoils and above gritty hardpan during prolonged wetting.	Fair; spray irrigation only, temporary subsoil waterlogging in wet years or with over-irrigation of adjacent soils.	
Gleyed podzolic	M8	gently sloping flats and shallow depressions; surface drainage slow,	.very low nutrient status .low AWC	poor	Group 4
Gleyed podzolic	M9	internal drainage poor, impeded by clay subsoil, nodular pans, gritty hardpan.	.water perched above hardpan during wet periods		
	M10	shallow depressions;	.very low nutrient status	poor	Group 5a

Great Soil Group	Soil Unit	Topography and Drainage	Limiting Factors	Agricultural Potential	Suitability for Tobacco*
Gleyed podzolic	M11	surface drainage very slow internal drainage poor, impeded on clay subsoils and gritty hardpan.	.low to moderate AWC .partial saturation or perched water tables in subsoil during wet periods		
Solodic soil	M14	gently sloping flats to slightly depressed areas; slow surface and internal drainage	.low nutrient status (except for potassium) .low to moderate AWC. shallow depth to clay .impeded internal drainage	poor	Group 5a
	Alluvial land	gently undulating low banks, flats and depressions	.small area - access difficult. .poorly-drained depressions .subject to flooding	Nil	
	Dissected land	steep eroded slopes and banks; very rapid surface drainage, some areas	.steep slopes .non-arable .strongly eroded	Nil	

* McDonald (1967) see text for detail. * AWC available water capacity

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APPENDIX 1

PROFILE DESCRIPTION AND LABORATORY DATA FOR SOIL SAMPLES

Profile descriptions in the tables below essentially follow the terminology proposed by McDonald *et al.* (1984).

Abbreviations used in Tables

d	dry colour	Org. M	Organic matter
m	moist colour	N	Total nitrogen
w	wet colour	P	Phosphorus (AS = acid soluble "available phosphorus")
T.S.S.	Total soluble salts by conductivity of 1:5 suspension	CS	Coarse sand
NaCl	Chloride calculated as sodium chloride	FS	Fine sand
$CaCO_3$	Carbonate calculated as calcium carbonate	Si	Silt
Org. C	Organic carbon	C	Clay
		H_2O	Air-dry moisture

Exchangeable Cations

CEC	Cation exchange capacity	K	Potassium
Ca	Calcium	Na	Sodium
Mg	Magnesium	H	Hydrogen

Laboratory Methods

pH was determined on a 1:5 soil-water suspension using a glass electrode with a silver-silver chloride electrode in 0.1N potassium chloride as reference half cell. Sodium chloride and total soluble salts were determined on the same suspension, the latter conductimetrically .

Carbonate was determined by a modified Passon method described by Martin and Reeve (1955).

The wet oxidation method of Walkley and Black (1934) was used to determine organic carbon.

Organic matter was calculated using a conversion factor of organic carbon x 2.27 (i.e. organic carbon (Walkley and Black 1934) x 1.32 to convert to the approximate dry combustion values, x 1.72 to convert dry combustion organic carbon to organic matter).

Acid soluble "available phosphorus" was that extracted by 16 hr shaking with 0.01N sulphuric acid as described by Kerr and von Stieglitz (1938), while "total" phosphorus was determined on a boiling hydrochloric acid extraction of pre-ignited soil using the vanadate method described by Beckwith and Little (1963).

Nitrogen was determined by Kjeldahl digestion.

Normal ammonium chloride, adjusted to pH8.4 with ammonium hydroxide, was used as

Normal ammonium chloride, adjusted to pH8.4 with ammonium hydroxide, was used as leachate for exchangeable cations. Sodium and potassium were determined with an E.E.L. flame photometer while calcium and magnesium were determined by EDTA titration. The value for sodium was corrected by subtracting an amount equivalent to the soluble chloride, and the calcium by deducting an amount equivalent to the soluble sulphate present. Sulphate was determined turbidimetrically for this purpose. Soils with pH in excess of 7.8 Total exchange capacity was determined directly by estimating the ammonium and chloride subsequently removed by normal sodium nitrate, and taking the differences as being equivalent to the exchange capacity at pH8.4, allowance being made for the higher than equivalent NH_4:Cl ratio in the normal ammonium chloride.

The Plummet method of Hutton (1955) was used for particle size analysis.

With one exception (a 3 cm depth sample) "available" phosphorus was determined only for the surface soils but is supported by total phosphorus determinations on one or more subsoil horizons in addition to the surface soil. Exchangeable cations were determined on the surface or, where this was thin, the immediate subsurface horizon of each profile sampled.

SOIL UNIT: MAREEBA 1

Great Soil Group: Red earth
Principal Profile Form: Dr2.62
Soil Taxonomy: Paleustalf (ultic)
World Soil Map: Ferric Luvisol

Parent Material: Sandy Alluvium

Land Use: Cultivation

Location: Lat. 17°01'05"
Long. 145°27'58"
Site: Broad low bank on gently undulating plain
Elevation: 411 m

Sample No.	Horizon	Boundary	Depth (cm)	Morphological description		
B308.1	A	Sharp	0-18	Dark reddish brown (5YR 4/3)	loamy sand	massive, dry moderately firm; hardsetting dry
.2	B1	Gradual	18-28	Red (10YR 4/5) with patches of dark reddish brown	sandy clay loam	massive, dry moderately firm; few medium to coarse manganiferous soft segregations and nodules.
.3	B21	Gradual	28-58	Red (10R 3/8) with dark red (10R 3/5) cutans	sandy clay	weak 50-60 mm blocky, moist moderately weak; few medium soft manganiferous segregations; few fine quartz fragments.
.4	B22	Gradual	58-99	Red (10R 3/6-3/8) with dark red (10R 3/4) cutans	coarse sandy clay	very weak 75 mm blocky, moist moderately weak; few medium soft manganiferous segregations; few fine quartz fragments.
.5	B23	Gradual	99-168	Red (10R 3/8)	coarse sandy clay	massive, moist moderately weak; very few medium soft manganiferous segregations; few to common fine quartz fragments.
.6	B31		168-229	Red (10R 3/8)	coarse sandy clay	massive, moist moderately weak; common medium quartz fragments.

No.	pH	TSS %	NaCl %	Air dry Moist. %	Org.C %	Org.M %	N %	P AS	P Total ppm	Particle size CS %	FS %	Si %	C %	Exchangeable cations Total	Ca	Mg me/100g	K	Na	Base Sat. %
.1	6.2	<0.02	<0.01	0.4	0.37	1.03	0.03	44	150	41	47	2	8	2.5	1.5	0.21	0.14	0.07	76
.2	6.6			0.8						33	40	5	22						
.3	6.9			1.2					140	27	31	3	39	6.1	2.5	0.69	0.49	0.05	38
.4	7.0			1.7															
.5	6.8			1.4						28	31	3	39						
.6	6.4			1.6						29	28	6	38						

SOIL UNIT: MAREEBA 2

Great Soil Group: Red earth
Principal Profile Form: Dr2.62
Soil Taxonomy: Paleustalf (ultic)
World Soil Map: Ferric Luvisol

Parent Material: Alluvium
Land Use: Cultivation

Location: Lat. 17°01'13"
Long.145°28'03"
Site: Broad low bank on undulating plain
Elevation: 415 m

Sample No.	Horizon	Boundary	Depth (cm)	Morphological description		
B312.1	A1p	Clear	0-30	Light brown (7.5YR 6/4, d5/4)	loamy sand	massive, dry very weak; very few medium manganiferous nodules; few fine subrounded quartz fragments.
.2	B1	Gradual	33-41	Red (2.5YR 3/8) with few fine black and yellow-red patches	sandy clay loam	massive, moist moderately weak, common fine subrounded quartz fragments.
.3	B21	Diffuse	41-86	Red (10R 3/8) with few dark red (10R 3/6) fracture faces	light clay	massive, moist moderately firm; few fine manganiferous segregations; few fine subrounded quartz fragments.
.4	B22	Diffuse	86-124	Red (10R 3/8) with few dark red (10R 3/6) fracture faces	light clay	massive, moist moderately firm; few soft medium manganiferous nodules; few fine subrounded quartz fragments.
.5	B23	Diffuse	124-173	Red (10R 4/8) with few dark red (10R 3/6) fracture faces	light clay	massive, moist moderately firm; few soft medium manganiferous nodules; few fine subrounded quartz fragments.
.6	B3		173-234	Brownish red (2.5YR 4/8, d 5/8)	gritty clay loam	massive, moist moderately weak; few very coarse manganiferous nodules; many fine subrounded and angular quartz fragments.

No.	pH	TSS %	Air dry NaCl %	Air dry Moist. %	Org.C %	Org.M %	N %	P AS ppm	P Total ppm	Particle size CS %	Particle size FS %	Particle size Si %	Particle size C %	Exchangeable cations Total me/100 g	Ca me/100 g	Mg me/100 g	K me/100 g	Na me/100 g	Base Sat. %
.1	6.4	<0.02	<0.01	0.2	0.23	0.52	0.02	26	110	38	52	3	6	2.2	1.1	0.23	0.20	0.0	71
.2	6.5	<0.02	<0.01	0.8						32	42	4	22						
.3	6.3	<0.02	<0.01	1.7						24	26	2	48						
.4	6.5	<0.02	<0.01	1.7															
.5	6.7	<0.02	<0.01	1.4															
.6	6.0	<0.02	<0.01	1.3															

SOIL UNIT: MAREEBA 3

Great Soil Group: Red earth
Principal Profile Form: Dr2.61
Soil Taxonomy: Paleustalf (ultic)
World Soil Map: Ferric Luvisol

Parent Material: Fine sandy slope deposits
Land Use: Native open forest

Location: Lat. 17°01'13" Long. 145°28'03"
Site: Footslope of low hill
Elevation: 418 m

Sample No.	Horizon	Boundary	Depth (cm)	Morphological description		
B309.1	A1	Gradual	0-18	Reddish brown (d5YR 5/4) with some light reddish brown patches	loamy fine sand	massive, dry moderately weak; very few medium soft manganiferous segregations.
.2	A2	Diffuse	18-36	Light reddish brown (3.5YR 5/6)	loamy fine sand	massive, dry moderately weak; few medium soft manganiferous segregations.
.3	B1	Diffuse	36-51	Brownish red (2.5YR 4/8) with dark red (2.5YR 3/5) patches	fine sandy loam	massive, moderately moist weak; very few coarse manganiferous nodules.
.4	B21	Diffuse	51-81	Red (10R 4/8) with dark red (10R 3/6) patches	fine sandy clay	massive, moderately moist moderately weak; few coarse manganiferous nodules; very few fine quartz fragments.
.5	B22	Diffuse	81-117	Red (10R 4/6) with few dark red (2.5YR 3/6) cutans	fine sandy clay	massive, moderately moist moderately firm; few coarse manganiferous nodules; few fine quartz fragments.
.6	B23	Diffuse	117-183	Red (2.5YR 4/8) with few dark red (2.5YR 3/6) cutans	fine sandy clay	massive, moderately moist moderately weak; common coarse soft manganiferous nodules.
.7	B31		188-229	Red (2.5YR 4/8) with pale patches	fine sandy clay loam	massive, moderately moist moderately weak; very few coarse soft manganiferous nodules.

No.	pH	TSS %	NaCl %	Air dry Moist. %	Org.C %	Org.M %	N %	P AS	P Total ppm	Particle size CS %	FS %	Si %	C %	Exchangeable cations Total	Ca me/100 g	Mg	K	Na	Base Sat. %
.1	6.1	<0.02	-	0.4	0.38	0.89	0.03	6	80	17	74	4	5	2.6	1.2	0.22	0.06	0.03	57
.2	6.3	<0.02	-	0.3	0.12					14	74	3	8						
.3	6.2	<0.02	-	0.6	0.12		0.02			14	68	3	16	2.3	0.77	0.52	0.10	0.06	64
.4	6.5	<0.02	<0.01	1.2	0.07					12	52	2	36						
.5	5.8	<0.02	-	1.4	0.04		0.02		140	11	50	2	37	5.0	1.2	1.4	0.28	0.07	60
.6	5.9	<0.02	-	1.2															
.7	5.9	<0.02	-	1.0						12	58	4	28	3.6	0.62	1.4	0.08	0.05	61

SOIL UNIT: MAREEBA 5

Great Soil Group: Yellow podzolic soil
Prncipal Profile Form: Dy3.81
Soil Taxonomy: Paleustalf (ultic)
World Soil Map: Ferric Luvisol

Parent Material: Alluvium

Land Use: Native open forest

Location: Lat. 17°01'08"
Long. 145°28'10"
Site: Broad low bank on gently undulating plain
Elevation: 415 m

Sample No.	Horizon	Boundary	Depth (cm)	Morphological description		
B311.1	A1	Gradual	0-18	Light brownish grey (10YR 4/2 d 6/2)	loamy sand	single grain, dry loose to moderately weak; very few fine quartz fragments
.2	A2	Gradual	18-36	Very light yellowish grey (2.5Y 6/4, d8/4)	sand	massive, dry very weak; very few medium manganiferous nodules
.3	B1	Gradual	36-51	Very light brownish yellow (2.5Y 6/5, d7/5) with prominent red brown mottles	sandy loam	massive, moist moderately weak; common coarse ferromanganiferous nodules.
.4	B21	Gradual	51-99	Brownish yellow (10YR 6/8) with prominent red (2.5YR 4/6-3/8) mottles	sandy clay	massive, moist moderately weak; few very coarse ferromanganiferous nodules.
.5	B22	Gradual	99-145	Brownish yellow (10YR 5/5) with prominent reddish brown (5YR 5/6) and black (10R 2/1) mottles	sandy clay	massive, moist moderately weak; common very coarse ferromanganiferous nodules.
.6	B3		145-185	Mottled yellowish brown (7.5YR 5/6) dark red (10R 3/6) and pale brownish yellow (2.5Y 6/3)	sandy clay loam	massive, wet slightly sticky; few coarse ferromanganiferous nodules; few fine quartz fragments.

No.	pH	TSS %	NaCl %	Air dry Moist. %	Org.C %	Org.M %	N %	P AS	P Total ppm	Particle size CS %	FS %	Si %	C %	Total	Exchangeable cations Ca me/100 g	Mg	K	Na	Base Sat. %
.1	6.4	<0.02	<0.01	0.4	0.53	1.3	0.04	6	80	38	53	4	4	2.8	1.0	0.58	0.16	0.08	67
.2	6.7	<0.02	<0.01	0.3	0.14	0.32													
.3	6.6	<0.02	<0.01	0.4	0.10	0.23				34	49	4	14						
.4	6.5	<0.02	<0.01	1.2	0.06	0.14			140	28	32	6	36	4.8	0.05	2.3	0.51	0.16	63
.5	6.4	<0.02	<0.01	1.5															
.6	6.2	<0.02	0.01	1.2					60	34	29	6	31	4.5	0.10	2.2	0.32	0.23	64

SOIL UNIT: MAREEBA 6

Great Soil Group: Yellow podzolic soil
Prncipal Profile Form: Dy3.81
Soil Taxonomy: Haplustalf
World Soil Map: Eutric Podzoluvisol

Parent Material: Fine sandy Alluvium/ colluvium
Land Use: Native open forest

Location: Lat. 17°01'14" Long. 145°28'18"
Site: Footslope of low hill
Elevation: 415 m

Sample No.	Horizon	Boundary	Depth (cm)	Morphological description		
B316.1	A1	Clear	0-10	Brownish grey (10YR 6/1) with some white (10YR 9/2) patches	loamy fine sand	massive, dry very weak; some rusty rootlines.
.2	A21	Gradual	10-46	White (d 10YR 9/2)	fine sand	massive, moist very weak; very few fine to medium manganiferous nodules.
.3	A22	Abrupt tonguing	46-61	White (d 10YR 9/2)	fine sand	massive, moist very weak; few fine to coarse ferruginous and manganiferous nodules.
.4	B21	Gradual	61-97	Light grey (2.5Y 7/2) with prominent yellowish brown (10YR 5/4) and red (2.5YR 3/6) mottles	fine sandy clay	massive to weak 10-20 mm blocky, moist moderately firm; common coarse ferromanganiferous nodules.
.5	B22	Gradual	97-127	Light yellowish brown (2.5Y 6/8) with distinct light grey (2.5Y 8/1) mottles	fine sandy clay loam	massive, moist moderately firm; common medium to coarse ferromanganiferous nodules.
.6	B31	Gradual	127-142	Light grey (2.5Y 8/1) with distinct greyish yellow (2.5Y 7/4) and red (10R 3/8) mottles	fine sandy clay loam	massive, moist moderately weak; many medium ferruginous nodules; very few coarse manganiferous nodules.
.7	B32		142-165	Very pale yellow (2.5Y 7/5) with faint white (10YR 9/2) mottles	fine sandy clay loam	massive, moist moderately weak; abundant very coarse manganiferous and ferruginous nodules.

No.	pH	TSS	Air dry NaCl	Moist.	Org.C	Org.M	N	P AS	Total	Particle size CS	FS	Si	C	Exchangeable cations Total	Ca	Mg	K	Na	Base Sat.
		%	%	%	%	%	%		ppm	%	%	%	%			me/100 g			%
.1	5.7	<0.02	<0.01	0.3	0.64	1.5	0.04	8	70	19	73	1	5	3.1	0.56	0.39	0.10	0.06	36
.2	6.0	<0.02	<0.01	0.1	0.07	0.16	0.006			19	77	3	1						
.3	6.1	<0.02	<0.01	0.1	0.03	0.07	0.004			21	74	3	3						
.4	6.1	<0.02	<0.01	1.2	0.07	0.16	0.019		60	14	52	5	30	4.3	0.10	2.0	0.20	0.12	57
.5	6.1	<0.02	<0.01	1.1						15	56	4	25						
.6	6.1	<0.02	<0.01	0.9															
.7	6.4	<0.02	<0.01	0.8					150	24	56	5	16	3.0	0.15	1.2	0.10	0.08	49

SOIL UNIT: MAREEBA 8

Great Soil Group: Gleyed podzolic soil
Prncipal Profile Form: Dy3.81
Soil Taxonomy: Haplustalf
World Soil Map: ?Gleyic Podzoluvisol

Parent Material: Sandy alluvium
Land Use: Native open forest
Elevation: 412 m

Location: Lat. 17°00'58"
Long. 145°27'59"
Site: Flat to gently sloping areas on gently undulating plain

Sample No.	Horizon	Boundary	Depth (cm)	Morphological description		
B313.1	A1	Clear	0-9	Brownish grey (10YR 3/1, d 6/1)	loamy sand	massive, dry moderately weak; few fine quartz fragments; few rusty root tracings and flecks.
.2	A21	Gradual	9-20	Very light brown (10YR 6/3, d 8/2)	loamy sand	massive, dry moderately weak; few fine quartz fragments; very few fine manganiferous nodules.
.3	A22	Clear	20-38	Very light yellowish grey (2.5Y 6/4, d 8/4)	sandy loam	massive, dry moderately weak; few fine quartz fragments.
.4	B21	Gradual	38-58	Very light yellowish grey (2.5Y 6/4) with distinct brownish yellow (10YR 7/8) and light red (2.5YR 4/8) mottles	sandy clay loam - sandy clay	massive, dry moderately firm; very few fine ferromanganiferous nodules; few fine quartz fragments
.5	B22	Gradual	61-97	Very light yellowish grey (2.5Y 6/4) with distinct light grey (2.5Y 7/1) mottles	sandy clay	massive, dry moderately firm; many medium ferromanganiferous nodules; few fine quartz fragments.
.6	B3 pan		97-114	Grey (5Y 7/1) with prominent brownish red (2.5YR 5/3) mottles	cemented hardpan	massive, dry rigid; abundant fine subangular quartz fragments; gravelly grit with clay matrix.

No.	pH	TSS	NaCl	Air dry Moist.	Org.C	Org.M	N	P AS	P Total	Particle size CS	FS	Si	C	Total	Exchangeable cations Ca	Mg	K	Na	Base Sat.
%	%	%	%	%	%	%	%	ppm		%	%	%	%		me/100 g				%
.1	5.3	<0.02	<0.01	0.3	0.42	0.95	0.03	2	60	52	40	4	5	2.7	0.20	0.10	0.06	0.0	13
.2	5.2	<0.02	-	0.3	0.19	0.43				41	48	4	6						
.3	5.1	<0.02	<0.01	0.6					110	39	41	4	16	3.5	0.31	0.34	0.08	0.01	21
.4	5.3	<0.02	<0.01	1.2	0.16	0.36			190	40	29	3	28	3.9	0.10	1.1	0.08	0.01	33
.5	5.8	<0.02	<0.01	1.2	0.08	0.18		2	50	45	26	4	26	3.3	0.05	1.5	0.08	0.13	54
.6	5.8	<0.02	<0.01	2.0						38	17	4	42						

SOIL UNIT: MAREEBA 9

Great Soil Group: Gleyed podzolic soil
Principal Profile Form: Dg2.82
Soil Taxonomy: Haplustalf
World Soil Map: Gleyic Acrisol

Parent Material: Sandy alluvium

Land Use: Native woodland

Location: Lat. 17°01'09"
Long.145°28'10"
Site: shallow depression in gently undulating plain
Elevation: 414 m

Sample No.	Horizon	Boundary	Depth (cm)	Morphological description		
B310.1	A1	Clear	0-5	Brownish grey (10YR 5/1, d 7/1)	loamy fine sand	masive, dry moderately firm; few rusty root tracings and flecks.
.2	A21	Gradual	5-33	Brownish white (10YR 8/2, d 9/1)	fine sand	massive, dry moderately weak; very few fine manganiferous nodules; few rusty root tracings and flecks.
.3	A22	Clear	33-46	Brownish white (10YR 8/2, d 9/1) with distinct yellowish brown (d 10YR 5/6-6/8) mottles	fine sandy loam	massive, dry moderately firm; many coarse manganiferous nodules
.4	B21	Gradual	46-81	Very light grey (10YR 8/1) with yellowish brown (7.5YR 6/8) and few red-brown mottles	fine sandy clay loam	massive, moist moderately weak; many coarse manganiferous nodules.
.5	B22	Gradual	81-107	Very light grey (10YR 8/1) with prominent yellowish brown (7.5YR 6/8) mottles	sandy clay loam	massive, dry moderately firm; very many very coarse manganiferous nodules in part cemented as a cavernous pan.
.6	B23 pan		107-163	Black (10YR 2/1) with prominent light grey (10YR 5/1) and brownish yellow (10YR 7/8) mottles	cemented	massive, dry moderately firm; pan of cemented manganiferous nodules with pockets of soil

No.	pH	TSS	NaCl	Air dry Moist.	Org.C	Org.M	N	AS	P Total	CS	Particle size FS	Si	C	Total	Exchangeable cations Ca	Mg	K	Na	Base Sat.
		%	%	%	%	%	%		ppm	%	%	%	%			me/100 g			%
.1	5.3	<0.02	-	0.5	0.61	1.4	0.05	4	50	13	70	11	4						
.2	5.8	<0.02	-	0.2					30	14	70	13	4	1.2	0.10	0.15	0.06	0.04	28
.3	6.6	0.02	<0.01	0.3	0.06	0.14				16	64	14	6						
.4	7.4	0.03	0.011	0.1						18	50	13	20	4.4	0.15	2.1	0.20	0.64	70
.5	7.9	0.09	0.042	1.4						23	47	6	22						
.6	7.4	0.20	0.110	1.7															

SOIL UNIT: MAREEBA 13

Great Soil Group: Red podzolic soil
Principal Profile Form: Dy4.81
Soil Taxonomy: Haplustalf (Arenic)
World Soil Map: Ferric Luvisol

Parent Material: Sandy alluvium
Land Use: Native open forest

Location: Lat. 17°01'15"
Long. 145°27'53"
Site: Old distributory channel on gently undulating plain
Elevation: 412 m

Sample No.	Horizon	Boundary	Depth (cm)	Morphological description		
B315.1	A1	Clear	0-8	Brown (10YR 7/5, d 6/3)	coarse sand	single grain, dry loose; common fine subangular quartz fragments.
.2	A21	Gradual	8-28	Light yellowish brown (d 10YR 7/4)	coarse sand	single grain, dry loose; common fine subangular quartz fragments.
.3	A22	Clear	28-48	Light yellowish brown (7.5YR 8/6) with some light reddish brown (7.5YR 7/6) patches	clayey coarse sand	single grain, dry loose to weakly coherent; many quartz fragments.
.4	B2	Gradual	48-84	Reddish brown (5YR 5/6)	gravelly light sandy clay loam	massive, moist moderately weak; many fine subrounded quartz fragments.
.5	B3		84-188	Brown (7.5YR 5/4) and light brown (10YR 6/4)	gravelly light sandy clay loam	massive, moist moderately weak; many fine to medium subrounded quartz fragments.

No.	pH	TSS %	NaCl %	Air dry Moist. %	Org.C %	Org.M %	N %	P AS ppm	P Total ppm	Particle size CS %	FS %	Si %	C %	Total	Exchangeable cations Ca me/100 g	Mg me/100 g	K me/100 g	Na me/100 g	Base Sat. %
.1	6.4	<0.02	<0.01	0.4	0.39	0.88	0.03	9	150	63	28	6	3	1.7	1.4	0.24	0.04	0.0	99
.2	6.5	<0.02	<0.01	0.3						58	32	6	4						
.3	6.3	<0.02	<0.01	0.4						56	28	7	8						
.4	6.0	<0.02	<0.01	1.0						61	14	6	18						

SOIL UNIT: MAREEBA 14

Great Soil Group: Solodic soil
Prncipal Profile Form: Dr2.42
Soil Taxonomy: Paleustalf (udic)
World Soil Map: ?Albic Luvisol

Parent Material: Mixed fine and coarse alluvium

Land Use: Native open forest

Location: Lat. 17°01'15" Long.145°27'53"
Site: Isolated remnant of old gently undulating plain
Elevation: 413 m

Sample No.	Horizon	Boundary	Depth (cm)	Morphological description		
B314.1	A1	Abrupt	0-3	Dark brownish grey (10YR 4/1, d 6/1)	loam, fine sandy	massive, dry moderately firm,hardsetting; very few fine ferromanganiferous nodules.
.2	A2	Abrupt	3-13	Very light brown (10YR 6/3,d 8/2)	loam, fine sandy	massive, dry moderately firm; few fine ferromanganiferous nodules; few fine quartz fragments.
.3	A2/B1	Abrupt	13-16	Very light brown (10YR 6/3, d/82) with reddish brown (d 7.5YR 5/4) patches	light clay	massive to weak 50 mm angular blocky, dry very firm; very few fine ferromanganiferous nodules; very few fine quartz fragments.
.4	B21	Gradual	16-36	Dark reddish brown (5YR 3/5)	medium heavy clay	strong 20-50 mm angular blocky, moderately moist very firm; few fine quartz fragments.
.5	B22	Gradual	38-53	Reddish brown (5YR 4/4) with dark brown (10YR 3/4) cutans	medium heavy clay	moderate 50-100 mm angular blocky, moderately moist very firm; very few fine quartz fragments.
.6	B3	Gradual	53-69	Olive grey (2.5Y 4/3) with faint brown (10YR 4/3) mottles	light clay	moderate 50 mm angular blocky, moderately moist moderately firm; very few fine carbonate segregations and nodules.
.7	2B2b		69-84	Olive grey (2.5Y 3/3-5/3) with distinct yellowish brown (10YR 5/8) and reddish brown (5YR 5/8) mottles	light medium clay	strong 12-25 mm polyhedral, moderately moist moderately firm; very few fine carbonate segregations and nodules*.
.8			84-102			

No.	pH	TSS	NaCl	Air dry Moist.	Org.C	Org.M	N	P AS	P Total	Particle size CS	FS	Si	C	Exchangeable cations Total	Ca	Mg	K	Na	Base Sat.
		%	%	%	%	%	%		ppm	%	%	%	%			me/100 g			%
.1	6.1	0.02	<0.01	1.5	1.57	3.6			220	13	48	22	13						
.2	6.0	<0.02	<0.01	1.0	0.37	0.84	0.04	5	280	16	48	23	14	4.9	2.0	0.84	0.24	0.05	64
.3	6.1	<0.02	<0.01	2.1						12	37	23	29						
.4	6.6	<0.02	<0.01	4.8	0.24	0.32			150	5	18	14	63	19.2	9.8	3.9	0.69	0.91	80
.5	6.5	0.02	0.013	4.3															
.6	6.8	0.05	0.027	3.8						11	34	20	35						
.7	7.7	0.08	0.037	4.5															
.8	8.5	0.10	0.038	3.9					330	14	30	24	33	14.2	10.7	1.3	0.27	1.9	100

* Laboratory analysis records 0.28% $CaCO_3$ in B314.8