The Soils and Vegetation of Part of The Mayvale Land System in the Gulf of Carpentaria Region

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SUMMARY

Major soils identified in this survey of part of the Mayvale Land System between Normanton and Croydon were mottled grey earths (Gn 2.94, Gn 2.95), mottled podzolics, gleyed podzolics and soloths (Dy 3.41, Dy 3.42, Dg 2.42), sandy grey and yellow earths (Gn 2.94, Gn 2.95, Gn 2.34, Gn 2.21), and sandy surfaced duplex soils with a thick A horizon (Dy 3.81, Dy 3.82, Dg 2.81, Dg 2.82). All soils are extremely low in available phosphorus, total nitrogen, organic carbon, soluble salts, and exchangeable cations. The four groups of soils were not significantly different in any chemical attribute.

Major plant communities were low open forests and low woodlands of *Melaleuca viridiflora* and *Petalostigma banksii*, low open forests and low woodlands of *Melaleuca acacioides*, *Terminalia* spp. and *Bauhinia carronii* and low open woodlands of *Melaleuca* spp. and *Eucalyptus* spp. Presently, the area is wholly committed to beef raising based on native pastures. The soils are very infertile and multiple nutrient deficiencies are likely. Major soils differ in moisture characteristics, and seedling regrowth of *Melaleuca* spp. and *Acacia* spp. will be a major problem associated with development.

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1. INTRODUCTION

The Mayvale land system (Perry *et al.*, 1964) occupies over 1 550 000 hectares (ha) in an area committed wholly to beef production based on native pastures. Perry *et al.* (1964) gave a general description of the soils and vegetation, and Isbell, Webb and Murtha (1968) included the area in a broad reconnaissance soil survey. Bishop (1973) referred to the area between Normanton and Croydon as the 'sandy forest country'.

In 1972 a soil survey was carried out in the area bounded by the Carron River, Belmore Creek, the Norman River and approximately 142°E longitude. A botanical survey was conducted over a selected area within these boundaries.

The aims of the survey were:

(a) to obtain data on the nature and distribution of major soils and vegetation communities on a large undeveloped area with a moderate rainfall (760 mm), and

(b) to obtain soil samples for chemical analysis and glasshouse nutrient screening. Results of these processes could act as an aid to the application of current knowledge of land development, and as a basis for the choice of future pasture species testing.

2. CLIMATE

The climate is dry tropical with strongly seasonal rainfall, 85% of rain falling in the four summer months of December to March inclusive (Slatyer, 1964). Mean maximum temperature is above 32°C for eight months of the year at both Normanton and Croydon (Table 1). The occurrence of periods of several consecutive days with maxima in excess of 37°C is highly probable in the months of November and December over most of the Leichhardt - Gilbert area (Slatyer, 1964), but incidence of these periods decreases sharply in the areas of higher rainfall once the wet season commences, usually in January.

Evaporation data from the area are limited and estimated annual tank evaporation is 2 362 mm (Slatyer, 1964). A very high evaporation rate, 228 to 254 mm/mth is recorded from September to December inclusive.

The limited distribution of rainfall restricts the period when sufficient soil moisture is available for plant growth. Slayter (1964) employing water - use models, calculated the time of commencement of the period of initial pasture growth and the total duration of pasture growth. Data relevant to Normanton and Croydon are shown in Table 2.

TABLE 1

Mean monthly rainfall and temperature data for Normanton and Croydon

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Normanton													
Rain (mm)	295	250	170	35	7	16	3	1	2	6	46	123	954
Max. temp. (^{o}C)	34.7	33.9	34.1	33.8	31.6	29.3	29	31	34	36.1	36.9	36	33.4
Min. temp. (^{o}C)	25	24.8	24	21.9	18.6	16	14.8	15.9	19.5	22	24.4	25	21
Croydon													
Rain (mm)	213	177	125	22	8	13	3	3	3	12	47	108	734
Max. temp. (^{o}C)	35.6	35	34.4	34.4	31.6	29.3	29.3	31.4	34.2	37	38.2	37.4	34
Min. temp. (^{o}C)	23.9	23.9	23.2	21.1	17.6	14.9	14	15.9	19.3	22.3	24.4	24.5	20.4

TABLE 2

Characteristics of the period of useful pasture growth at Normanton and Croydon*

Station	Normanton	Croydon
Years of record	29	31
Commencement of pasture growth period		
Mean date	Dec. 14	Jan. 4
Standard deviation (days)	2.7	2.2
Total duration of useful pasture growth (wk)		
Mean	20.2	17.3
Standard deviation	3.1	3.8
% of years with total duration		
of pasture growth 8 wk	100	100
12	97	87
16	86	68
20	48	19
24	0	0

* Extracted from The General Report on Lands of the Leichhardt - Gilbert Area, Queensland, 1953 - 54, by Perry et al., 1964.

3. GEOLOGY AND GEOMORPHOLOGY

Twidale (1964, 1966) described the area surveyed as a depositional plain formed on fluviatile sands and named it the Claraville Plain. He considered that the plain was developed by the end of the Pliocene and has remained essentially the same since.

The Claraville Plain has an overall regional fall to the WNW and is developed on the Cainozoic Wyaaba beds. The surface consists of poorly consolidated clayey quartzose sand (Doutch et al., 1972).

This plain is drained by the Carron River and Walker Creek.

4. SOILS AND ASSOCIATED VEGETATION OF THE MAYVALE LAND SYSTEM

(a) Survey Methods

Broad reconnaissance methods employing limited field traverses and photo interpretation were used to identify soils of the area. At 176 sites soils were described and classified (Northcote, 1971) and grouped into fairly broad soil associations. At 35 sites soils were sampled in 10 cm increments to 100 cm; the surface sample was a bulk of five subsamples. More detailed studies were made at nine sites, where soils were described to 200 cm and samples taken from the deep subsoil. Surface samples were collected from five sub-sites at each of these nine sites to enable assessment of within-site variability. Surface soil from these nine sites was used in nutrient pot experiments in the glasshouse. Results from these experiments are to be presented elsewhere.

As the primary aim of the present survey was to delineate and describe the major soils of the area, the collection of vegetation data was less detailed. At all sites where a soil profile was described, a check list of the major species was made. At 50 sites detailed data were collected using the proforma and methodology as described by Walker, Ross and Beeston (1973). These were either sites chosen for detailed examination of soil chemical factors or sites representative of vegetation types recognizable after the preliminary soils survey.

As was found by Walker (1972), the limitation of time available to record each site was such, that it was found best for one person (G. Beeston) to record the data on woody species, while another (T. Hall) collected plant specimens and recorded data on herbaceous species.

(b) Analytical Methods

Profile samples were analysed for pH, soluble salts, available phosphorus, total nitrogen, organic carbon, exchangeable cations (for 20 profiles), cation exchange capacity, and particle size (nine profiles).

Electrical conductivity, pH and chloride were measured on a 1:5 soil-water suspension at 25°C. Exchangeable cations were extracted by a leaching method with normal ammonium chloride. Cation exchange capacity was obtained by determination of exchanged ammonium from the ammonium saturated sample remaining after the leaching for exchangeable cations. After addition of strontium chloride, exchangeable cations were measured using a Techtron AA4 atomic absorption spectrophotometer. Total nitrogen was determined on a Kjeldahl digest and organic carbon by the Walkley-Black method (Piper, 1950). Available phosphorus was extracted with 0.01N sulphuric acid (Kerr and Von Stieglitz, 1938) and measured on a Unicam SP600 spectrophotometer. Particle size analysis was carried out using the pipette method and a modified exchange resin method of Edwards and Bremner (1965).

Analyses of variance were carried out on surface data from 35 sites in four groups to compare differences in attributes among soil groups. Variances among sites within soil groups were homogeneous for all attributes (Bartlett's test). On this basis the pooled within-group variances were used in F tests to test the significance of variability among soil group means. Data from a subset of nine sites with five subsamples per site were used to obtain estimates of within-site variances for all attributes.

(c) Soil and Vegetation Classification

The soils of the Mayvale land system were described previously by Sleeman (1964) as red and yellow earths, and red and yellow podzolics. Isbell, Webb and Murtha (1968) mapped the same area as dominantly deep sandy, or occasionally loamy mottled, grey earths with associated sandy yellow and grey earths. The vegetation of the area has been classified as either paperbark low woodland, Bylong low woodland, or fringing woodland (Perry and Lazarides, 1964).

In this report four main profile forms have been recognized. Although these are quite distinct morphologically they have many features in common, and grade from one to the other. Intergrade soils exhibiting properties of more than one of the forms described below are common. The four soil profile forms which have been recognized are:

(i) duplex soils with moderate to abundant ironstone nodules throughout the B horizon (Timora association).

(ii) grey earths with moderate ironstone nodules in the B horizon (Blackbull association)

(iii) sandy yellow and grey earths (Gum Creek association)

(iv) sandy-surfaced duplex soils with a thick ($>$ 40 cm) A horizon (Gum Creek association)

Features which are common to all major soils are light textured surface horizons (sand to sandy loam), A_2 horizon almost invariably moderately bleached, massive A horizons, mottled B horizons, ironstone nodules present in the solum, and a D horizon. On limited examination it appears that all soils are underlain by a highly structured D horizon which is usually an olive medium or heavy sandy clay.

For the purposes of mapping broad units, four soil associations are described.

The structural classification of the vegetation used is based on the scheme of Specht (1970). However, several modifications have been made to his definitions of tree and shrub. A tree, as defined in the present report, is any woody plant more than 4.5 metres (m) tall. A shrub is defined as any woody plant less than 4.5 m tall. The life form of seedling has been added to Specht's classification for the purposes of this report because a large proportion of the trees of the area are in an immature form. Land clearance of similar communities in other parts of the State has shown that these seedlings will constitute the major regrowth problem, so in this report they are separated from the shrubs.

The floristic classification is based primarily on the presence or absence of species. Some emphasis is also placed on the relative density of a species.

Preliminary sorting for the floristic classification was carried out using both the normal and inverse sections of the analysis of the programme CENTCLAS (Williams et al., 1966). Four floristic associations are recognized and although these associations intergrade into one another, they represent, in most cases, discrete entities with definite soil preferences.

The major foristic associations are:

(i) Melaleuca viridiflora - Petalostigma banksii

(ii) Melaleuca acacioides - Bauhinia carronii - Terminalia spp.

(iii) Melaleuca nervosa - Erythrophleum chlorostachys

(iv) Eucalyptus microtheca - Melaleuca viridiflora

5. MAJOR SOIL ASSOCIATIONS

(a) Timora Association

Soil

This association covers very gently undulating to almost flat plains with shallow drainage lines and some small creeks. Dominant soils are duplex soils with a thin to moderately thick A horizon and a mottled B horizon.

Associated are mottled grey earths described in the Blackbull association and small discrete areas of sandy earths and deep sandy duplex soils of Gum Creek association. The major soils exhibit a clear (sometimes gradual) texture change in the upper part of the profile.

The A_1 horizon is a very dark greyish brown (10YR 3/2m), dark greyish brown (10YR 4/2m), greyish brown (10YR 5/2m) or brown (10YR 5/3m) loamy sand or sandy loam which is massive and earthy with a slightly hard to very hard consistence (dry). Below 5 to 10 cm this grades into a brown (10YR 5/3m), pale brown (10YR 6/3m) or light yellowish brown (10YR 6/4m) moderately bleached A_2 horizon with similar characters to the A_1. Overall thickness of the A horizon ranges from 10 to 40 cm but usually is 20 to 30 cm. Often ironstone concretions up to 10 mm are present in small amounts on the surface and in the A horizon; less often profuse concretions (10 to 20 mm) occur. The change to the B horizon is clear or occasionally gradual.

The upper B horizon is usually light brownish grey (10YR 6/2m) to light yellowish brown (10YR 5/4m) sandy clay loam to sandy clay with moderate yellow mottles. It has weak to moderate subangular blocky structure, 20 to 30 mm in diameter. Fabric is usually earthy and consistence (dry) is extremely hard. Ironstone concretions of 10 to 20 mm diameter are common. In the lower B, colour and texture may change slightly to very pale brown (10YR 7/3) or very light grey (10YR 7/2m) sandy clay with more red and yellow mottling. Structure may be stronger and fabric may become smooth ped. Consistence is extremely hard, and often the soil is weakly cemented. Profuse ironstone concretions are common and these may form a prominent layer. Below 120 to 160 cm, a gradual change occurs to a D horizon; this is a pale olive (5Y 6/4m) medium heavy clay or sandy clay which is highly pedal and has moderate manganiferous segregation on ped faces. Some soft carbonate accumulations may be present. Consistence is usually extremely hard, and weakly cemented layers may occur. This persists below 200 cm. At a few sites coarse columnar macro structure was evidence in the B horizon of the duplex soil. The columns did not exhibit well developed domes and their diameters varied from 200 to 350 mm across the tops.

It apears that soils in the lower positions of the landscape have more concretions throughout the profile, and thinner A horizons. In some cases the B horizon is gleyed throughout; this is particularly so in low lying areas where water may lie for some time during the wet season.

Principal profile forms (Northcote, 1971) recognized were Dy 3.41, Dy 3.42, Dg 2.41, Dg 2.42 and Dy 3.43 (less common).

* Colours determined on moist soil using a Munsell colour chart

Data for type profiles of the dominant soils are given in Appendix I, sites 108, 150 and 229.

Vegetation

The plant communities which occur on this soil association are either the low open forest or the low woodland of Melaleuca acacioides - Bauhinia carronii - Terminalia spp. These communities consist of a tree layer 4.5 to 6 m tall with emergent eucalypts to 9 m. The shrub layer is between 2 and 3 m tall and the ground layer is sparse to moderately dense in the more open community.

The tree layer consists of Melaleuca acacioides, Bauhinia carronii, Terminalia spp. with occasional Grevillea striata and Cochlospermum gregorii. The emergent species are Eucalyptus melanophloia and E. polycarpa.

Gardenia vilhelmii, Dodonaea physocarpa, Atalaya hemiglauca, and Petalostigma banksii are the main shrub species. Commonly the shrub layer in the low open forest community is very dense with a large proportion of Terminalia spp. present. This approaches a mixed shrub community.

The ground species are Heteropogon contortus, Chrysopogon fallax, Aristida spp. and Sorghum spp. which are very sparse in the low open forest community but become quite dense in the more open areas.

(b) Blackbull Association

Soil

This association occupies gently undulating plains. Dominant soils are mottled grey earths; associated are discrete areas of sandy grey and yellow earths and deep sandy duplex soils of Gum Creek association. In some areas a complex pattern of soils from Blackbull, Timora and Gum Creek associations is evident.

The mottled grey earths exhibit many of the characters of the duplex soils. The main differences are that horizon boundaries are gradual to diffuse and structure is not evident. These soils are distinguished from the sandy grey and yellow earths by their heavier texture, harder consistence and amount of mottling and ironstone concretions.

The A_1 horizon is generally 10 to 20 cm thick and is dark greyish brown (10YR 4/2m) or brown (10YR 4/3m) loamy sand, or occasionally sandy loam. It is massive, earthy and porous and is slightly hard (dry). A gradual change occurs to a moderately bleached A_2 horizon which is brown (10YR 5/3m) to pale brown (10YR 6/3m) or light yellowish brown (10YR 6/4m) sandy loam to light sandy clay loam with some weak yellow mottles. It is massive, earthy and porous with a hard or occasionally very hard consistence. Below the A_2 a diffuse change occurs to a very light grey (10YR 7/2m), light grey (10YR 6/1m) or light brownish grey (10YR 6/2m) sandy clay loam with moderate yellow and red mottling. With depth, texture continues to increase gradually to sandy clay. The soil is massive and earthy with extremely hard consistence. Ironstone concretions are common and may form a prominent layer in the lower part of the profile. Often weak cementing of the B horizon is evident. Below 120 to 160 cm a gradual change occurs to a D horizon. This is a pale olive (5Y 6/4m) medium heavy clay or sandy clay with a strong pedality and manganiferous segregation on ped faces.

Principal profile forms recognised were Gn 2.94 and Gn 2.95 with a few Gn 2.81 and Gn 2.82.

Data for type profiles of dominant soils are given in Appendix 1, sites 101 and 275.

Vegetation

The plant community established on this soil association is a low open woodland of Melaleuca viridiflora - Petalostigma banksii, with Melaleuca acacioides and M. stenostachya occurring in small numbers. The community consists of a tree layer 6 m tall with emergent eucalypts to 9 m. The shrub layer is between 2 and 3 m tall and the ground cover is sparse to moderately dense.

The tree layer consists of Melaleuca viridiflora, M. acacioides, M. stenostachya, with occasional Terminalia spp. and Cochlospermum gregorii. The emergent eucalypts are Eucalyptus polycarpa, E. grandifolia and E. tectifica. The shrub layer consists mainly of Petalostigma banksii.

The ground cover is made up primarily of Sorghum spp., Aristida spp., and Schizachyrium sp.

(c) Gum Creek Association

Soils

This association comprises sandy rises which appear to be old infilled channels or outwash fans. Dominant soils are deep sandy grey and yellow earths and sandy duplex soils with a thick A horizon. At the scale of mapping employed these two groups of soils could not be separated. Occuring with these soils are small areas of soils from the Blackbull and Timora associations.

(i) Sandy grey and yellow earths

The sandy earths exhibit weak profile differentiation and are massive, earthy, highly porous soils with gradual to diffuse horizon boundaries.

The A_1 horizon is generally 10 to 20 cm thick, is very dark greyish brown (10YR 3/2m) or dark brown (10YR 4/3) with a texture of sand or loamy sand. This is soft, (dry) massive and earthy. Below the A_1 the profile grades into a paler horizon which is usually moderately bleached. The soil is very pale brown (10YR 7/3m), pale brown (10YR 6/3m), or light yellowish brown (10YR 6/4m) sand or loamy sand which is massive, earthy and porous with a soft or slightly hard consistence (dry). Below approximately 40 cm the profile grades into a pale brown (10YR 6/3m), light yellowish brown (10YR 6/4m) or light grey (10YR 7/1, 7/2m) massive, earthy, and porous B horizon. This usually has from 10 to 30% yellow and red mottling. Texture grades from sandy loam in the upper part to sandy clay loam or sandy clay in the lower part. Consistence usually grades from slightly hard to extremely hard (dry), but may be soft to firm (moist). Ironstone concretions up to 15 mm diameter often occur above 100 cm. Below 100 cm the profile usually grades into a prominent concretionary layer which may be compact and weakly cemented. A gradual change occurs below 150 cm to a D horizon which is pale olive (5Y 6/4m), highly pedal medium heavy clay or sandy clay with moderate amounts of manganiferous segregation on the ped faces. Consistence is usually extremely hard and in many cases part of it is weakly cemented. In some cases mottling is not prominent and ironstone concretions may be absent.

Principal profile forms recognized were Gn 2.94, Gn 2.95, Gn 2.81, Gn 2.82, Gn 2.62, Gn 2.21, Gn 2.32 and Gn 2.22.

Data for type profiles of dominant soils are given in Appendix 1, sites 115 and 231.

(ii) Sandy duplex soils with a thick A horizon

The sandy duplex soils exhibit a gradual to clear texture change with depth. Like the sandy earths they are massive, earthy, and highly porous soils in the upper part.

The A horizon is sand or loamy sand and ranges from 40 to 80 cm thick. The upper 10 cm is dark greyish brown (10YR 4/2m), dark grey (10YR 4/1m) or brown (10YR 4/3m) and this grades into a brown (10YR 5/3m), pale brown (10YR 6/3m), or light grey (10YR 6/1m) moderately bleached A_2 horizon. The soil is massive, earthy and porous with a soft or slightly hard consistence (dry). Below the A_2 horizon a gradual to clear change occurs to light grey (10YR 6/1m), pale brown (10YR 6/3m) or light yellowish brown (10YR 6/4m) sandy clay loam or sandy clay with prominent yellow mottles. Where the A horizon is thinner, red mottling also occurs. The B horizon is massive, earthy and porous with a very hard or extremely hard consistence (dry); when moist it is firm. The lower part of the B horizon may be weakly cemented. Ironstone concretions up to 20 mm diameter usually occur throughout the B horizon and may occur in the lower part of the A_2. Below 100 cm a prominent ironstone concretionary layer occurs. This grades to a pale olive (5Y 6/4m), highly pedal, medium heavy clay or sandy clay D horizon. Moderate manganiferous segregation occurs on ped faces. The D horizon persists beyond 200 cm.

It is suspected that, in some cases where the texture contrast is large, for example where a loamy sand overlies a sandy clay, and the change is abrupt, coarse columnar structure may occur.

The B horizon is occasionally gleyed throughout. Principal profile forms recognised were Dy 3.81, Dy 3.82, Dg 2.82 and Dg 2.81.

Data for a type profile are given in appendix 1, site 265.

Vegetation

The plant communities which occur on this soil association are either a low open forest or a low woodland of Melaleuca viridiflora - Petalostigma banksii. These communities consist of a tree layer 6 to 8 m high with emergent eucalypts up to 12 m tall. The shrub layer is 3 m high with a moderately dense ground layer.

The tree layer has Melaleuca viridiflora, Cochlospermum gregorii, Dolichandrone heterophylla and Erythrophleum chlorostachys as its main constituents with occasional Melaleuca stenostachya, M. acacioides and Grevillea parallela.

The emergent eucalypts are Eucalyptus polycarpa, E. grandifolia, E. confertiflora and E. melanophloia. The shrub layer is mainly Petalostigma banksii with occasional Eucalpytus pruinosa, Maytenus cunninghamii, Dodonaea physocarpa, Margaritaria sp. and Acacia. The ground cover is mainly Aristida spp. and Sorghum sp.

In several areas the dominant species is Melaleuca nervosa and it forms a low woodland community to 6 m with Erythrophleum chlorostachys Melaleuca viridiflora may also be present with emergents to 9 m of Eucalyptus polycarpa and E. grandifolia. The shrub layer is usually only 1 m high and consists of Dolichandrone heterophylla and Carissa lanceolata.

(d) Unnamed Association A.

Soil

This association is restricted to narrow plains fringing major creeks and rivers. The major soils are loamy or silty surfaced duplex soils. A horizons are 5 to 15 cm thick, and are dark brown (10YR 4/3m) to very dark greyish brown (10YR 3/2m) sandy loam, silty loam or fine sandy clay loam. Some platey structure may be evident in the top 5 cm but usually the A horizon is massive and extremely hard or hard. A thin conspicuously bleached A_2 horizon usually occurs at the base of the A_1.

An abrupt change occurs to a dark clay B horizon which is structured (blocky?) and has an extremely hard consistence (dry).

Associated are some sandy earths similar to those in Gum Creek association. Fringing some channels are duplex soils from Timora association. These may be a major soil in some areas. Usually the A horizon is approximately 10 cm thick and may be sandy loam, or occasionally fine sandy loam, which is massive and extremely hard. Ironstone concretions may be evident at the surface. Principal profile forms recognized were Dy 3.41, Dy 3.42, Dy 3.81, Db 2.43 and Dy 3.43.

Data for two profiles are given in Appendix 1, sites 238 and 276.

Vegetation

The plant community which occur on this soil association is the low open woodland of Eucalyptus microtheca - Melaleuca viridiflora. The structure of this community is extremely simple with scattered low trees about 7 m above moderately dense to open ground cover. In some areas the community opens into grassland. Shrubs are rare, but in small areas along the Norman River flood plain Melaleuca symphyocarpa forms a dense shrub layer.

The common trees are Eucalyptus microtheca, E. tectifica, Melaleuca viridiflora and Exoecaria parvifolia. The ground cover consists of Triodia pungens, Eulalia fulva, Eriachne glauca and Chrysopogon fallax. In some areas especially along Belmore Creek seedlings of Melaleuca viridiflora are present and often formed dense stands, which inhibit any grass growth.

(e) Chemical Characteristics of the Soils

Analytical data for 10 profiles representative of the major soils described earlier are presented in Appendix 1. Limited sampling was carried out in the Unnamed Alluvial association and only data from two profiles are presented.

Data for surface soils are given in Table 3 for the full set of 35 sites arranged in four groups. This table also shows the mean within site (C.V.) for the nine sites where detailed subsampling was carried out.

In Table 3 the soil groups have been numbered 1 to 4 and represent soils from the associations as shown:

Group 1 - duplex soils from Timora association.

Group 2 - grey earths from Blackbull association.

Group 3 - deep sandy grey and yellow earths from Gum Creek association.

Group 4 - sandy surfaced duplex soils with a thick A horizon from Gum Creek association.

Differences among soil groups for all attributes for 35 sites was non-significant. Means, ranges, standard deviations and coefficients of variation for the attributes are presented in Table 3.

TABLE 3

Chemical characteristics, standard deviations (S.D.) and coefficients of variation (C.V.) of surface soils (0 to 10 cm) in four groups for the 35 Sampling Sites

Determination	No. of sites	Mean	Range of site means	Among Sites S.D.	Among Sites C.V.	Mean within sites C.V.
Phosphorus (p.p.m.)						
Group 1	12	3	1- 6	1.64	52	32
2	9	4	1- 8	2.50	68	26
3	7	4	1-11	3.24	79	38
4	7	2	1- 4	1.21	57	75
All	35	3		2.21	67	
Nitrogen (%)						
1	12	0.027	0.021-0.039	0.0065	24	26
2	9	0.026	0.018-0.039	0.0077	29	30
3	7	0.025	0.018-0.033	0.0058	23	19
4	7	0.021	0.015-0.027	0.0050	24	10
All	35	0.025		0.0065	25	
Organic Carbon (%)						
1	12	0.22	0.05 -0.50	0.145	67	51
2	9	0.24	0.05 -0.50	0.157	64	114
3	7	0.29	0.05 -0.60	0.232	81	58
4	7	0.18	0.05 -0.30	0.115	64	101
All	35	0.23		0.164	71	
C:N ratio						
1	12	10	3-17		47	
2	9	9	2-22		66	
3	7	10	3-20		62	
4	7	9	4-19		62	
All	35	10			56	

TABLE 3

Chemical characteristics, standard deviations (S.D.) and coefficients of variation (C.V.) of surface soils (0 to 10 cm) in four groups for the 35 Sampling Sites

Determination	No. of sites	Mean	Range of site means	Among sites		Mean within sites C.V.
				S.D.	C.V.	
C.E.C. m. equiv./100 g						
1	12	1.7	1-3	0.65	39	16
2	9	2	1-4	1.12	56	39
3	7	2.1	1-3	0.89	42	20
4	7	1.7	1-3	0.76	44	37
All	35	1.9		0.86	46	
Exch. Calcium m. equiv./100 g						
1	6	1.2	0.8-1.7	0.330	27	33
2	6	0.9	0.1-1.6	0.626	70	50
3	5	1.3	0.8-2.4	0.640	44	33
4	4	1.0	0.1-1.6	0.675	69	50
All	21	1.1		0.550	50	
Exch. Potassium m. equiv./100 g						
1	12	0.10	0.01-0.50	0.142	146	28
2	9	0.05	0.01-0.22	0.073	138	82
3	7	0.17	0.01-0.57	0.190	114	71
4	7	0.14	0.01-0.52	0.204	150	115
All	35	0.11		0.154	143	
Exch. Magnesium m. equiv./100 g						
1	6	0.3	0.1-0.4	0.015	42	54
2	4	0.3	0.2-0.5	0.150	46	73
3	5	0.3	0.2-0.5	0.123	41	34
4	4	0.3	0.2-0.4	0.096	35	99
All	19	0.3		0.112	39	

pH and exchangeable cations

Median pH value and ranges for surface soils in the four groups are listed below (Table 4). The duplex soils of the Timora association (group 1) tend to have a higher surface pH than do the other major soils.

Table 4

pH of surface soils (0 to 10 cm)

Soil Group	Median value	Range
1	6.0	5.4-6.5
2	5.8	5.4-6.2
3	5.8	5.6-6.7
4	5.7	5.5-6.0

In all of the major soils, pH is generally acid throughout the profile with some soils becoming neutral (6.5 to 6.6) at depth. Some of the alluvial soils are alkaline at depth.

Cation exchange capacities are extremely low for surface and subsurface soils. Exchangeable basic cations are invariably low and deficiency problems could arise with some species. The value of 0.2 m.-equiv. K per 100 g of soil has been used extensively as a critical deficiency value in assessing the potassium status of soils (Piper and de Vries, 1960; Williams and Lipsett, 1960). Use of this standard would result in most soils examined being deficient in potassium. Exchangeable sodium levels are low in all soils. However exchangeable sodium as a percentage of C.E.C. is moderate to high in some soils of the Timora, Blackbull and Gum Creek associations. Soluble salts (E.C. and Cl) are extremely low in all soils.

Samples from the D horizon are quite distinct in that exchangeable cations, pH, cation exchange capacity and soluble salts are higher than they are in the overlying soil. Exchangeable sodium levels are high and as a percentage of C.E.C. are very high to extremely high.

Phosphorus

Available phosphorus values in the surface and subsurface soils are extremely low for all sites (table 3 and Appendix 1). They are in the severe deficiency range. Similar levels have been reported by Isbell and Gillman (1973) in their studies on deep sandy soils in Cape York Peninsula.

Organic carbon and total nitrogen

Values for organic carbon and total nitrogen are extremely low for surface soils (table 3). The C:N ratios are moderately wide but considerably lower than those quoted by Isbell and Gillman (1973).

(f) Physical Characteristics

Particle sizes for type profiles are shown in Appendix 1. In no soil does clay reach a high level and the dominant particles in all soils are fine and coarse sand. The sandy earth (site 231) has lower clay content at depth than the other soils. This is a general characteristic which is described in the soil morphology for Gum Creek association - sandy earths.

All soils have hard setting surfaces when they are dry and this is especially evident in major soils of the Timora, and to a lesser extent, the Blackbull association.

A cemented highly sodic clay D horizon seems to occur under most of the soils. It has subplastic properties. In particle size analysis it was noted that complete dispersion was not obtained for some D horizon samples and some undispersed fine material remained in the coarse sand fraction.

(g) General Discussion

Soil Morphology

Components of the soil associations are related to the soil families of Sleeman (1964) and to the great soil groups of Stace *et al*. (1968). The sandy earths of the Gum Creek association are reasonably characteristic of the Yellow Earths of Stace *et al*. (1968). The other major soils of the Timora, Blackbull and Gum Creek associations do not closely relate to any great soil group. They may be regarded as variants of gleyed podzolics, soloths and yellow podzolics.

The major soils of the Timora and Blackbull associations approximate to the Mayvale and Wallabadah families described by Sleeman (1964). The major soils of the Gum Creek association were recognized as Stawell and Elliot soil families (Sleeman, 1964).

In previous reports (Sleeman, 1964; Isbell, Webb and Murtha, 1968), structured duplex soils of the Timora association were not described. They had been classed as massive soils. Grade of structure in the B horizon of these soils varies among sites from weak to moderate subangular blocky.

The cemented highly sodic clay in the D horizon would have a major effect on the soil moisture characteristics over the area. Water movement would be impeded markedly and it seems quite probable that a perched water table would occur during the wet summer months.

Chemical Characteristics

The within-site variability of the attributes for the different soil groups and over all soil groups varies from attribute to attribute. Within-site variability for nitrogen, phosphorus, C.E.C. and exchangeable calcium is generally low. Among-soil-group variability is low to moderate for nitrogen, C.E.C. and exchangeable magnesium. For other attributes it is moderate to very high.

Within-site variability is generally lower than among-site variability for phosphorus, C.E.C., exchangeable calcium and exchangeable potassium.

Both within-site and among-site variability for exchangeable potassium are markedly higher than that for exchangeable calcium and magnesium. This contrasts with the results of Isbell and Gillman (1973) in their studies on the deep sandy soils in Cape York Peninsula.

The mean and range of analytical values for the attributes studied indicate that little overall difference exists between the different soil groups with respect to chemical properties. All soils have extremely low levels of organic carbon, nitrogen, phosphorus, exchangeable cations and soluble salts.

The probability of plant species suffering from numerous nutrient disorders is high; results from glasshouse studies to be published elsewhere support this hypothesis.

Relationship and Distribution of the Flora

The description of the vegetation in the survey area is similar to that given by Perry and Lazarides (1964). However in this survey it was possible to describe discrete floristic associations and to delineate their soil preferences. The problems encountered by Pedley and Isbell (1971) and Story (1970) regarding the identification of the Melaleuca species were also encountered in this instance. However, due to the length of time spent in the area, identification became easier as the survey progressed.

The plant communities of the area are closely related to the communities of Cape York Peninsula as described by Pedley and Isbel (1971) and Story (1970). The use of Specht's classification by Pedley and Isbell (1971), as in this survey, enabled direct comparison. Table 5 shows the major plant communities of the survey area along with the floristic and structural data used in their classification.

The low open forest and low woodland structural formations of Melaleuca viridiflora and Petalostigma banksii of this survey are identical to those described by Pedley and Isbell (1971) with regar to the floristics and structure of the tree and shrub layer. They are also very similar to the community described by Story (1970) as a paperbark woodland.

The Melaleuca acacioides communities described in this report seem to have no counterpart further north in Cape York Peninsula. Story (1970) described a paperbark scrub of Melaleuca acacioides with associates of Eucalyptus microtheca, bloodwoods and deciduous scrub species occuring mainly on colluvial foot slopes or alluvial plains, from only seven sites. Pedley and Isbell (1971) found no similar community in their survey area. Speck and Lazarides (1964) and Specht (1958) described Melaleuca acacioides alliances occuring on the coastal areas of the West Kimberleys and Arnhem Land. However their descriptions seem more closely related to that of Story (1970).

The Melaleuca acacioides community in some parts of the survey area had almost equal numbers of deciduous tree species, such as Terminalia spp., Bauhinia carronii, Cochlospermum gregorii, and Melaleuca spp. The floristic association of Melaleuca acacioides - Bauhinia carronii - Terminalia spp. had a distinct soil preference evident only on the Timora association, which chiefly consisted of duplex soils. Wherever Melaleuca acacioides occurred in association with other Melaleuca spp. the soils always tended towards a duplex type.

Melaleuca nervosa also showed a very strong soil preference occurrin only on soils of the Gum Creek association. Melaleuca symphyocarpa as was recorded by Pedley and Isbell (1971) and Story (1970), was found along the banks of depressions and billabongs. Melaleuca stenostachya was found scattered throughout the communities in small numbers and it was not possible to accurately define its soil preference.

The Eucalyptus microtheca - Melaleuca viridiflora community with the ground layer of Triodia pungens is an example of the role edaph factors can play in plant distribution as discussed by Pedley and Isbell (1971). Although this community is flooded during the wet season the drought condition of the soils during the remainder of the year allows only Triodia pungens to survive in any appreciable amount.

A small shrub about 1 m tall occurred at about a quarter of the detailed vegetation sites. It is from the genus Margaritaria and constitutes a new recording for Australia. As with many of the other plants in the survey area, it showed distinct soil preferences, occurring only on the Timora and Gum Creek associations.

TABLE 5

Major plant communities

Structural classification	Floristic association	Other common species	Trees /ha	Shrubs /ha	Seedlings /ha	Grass cover %	Number of observations
1A Low open forest	*Melaleuca viridiflora* - *Petalostigma banksii*	*Eucalyptus polycarpa*, *Dolichandrone heterophylla*, *Cochlospermum gregorii*, *Aristida* spp., *Sorghum* spp.	1 200	500	600	35	9
1B Low open forest	*Melaleuca acacioides* - *Terminalia* spp. - *Bauhinia carronii*	*Dodonaea physocarpa*, *Atalaya hemiglauca*, *Grevillea* spp., *Sorghum* spp., *Aristida* spp.	690	820	200	20	5
2A Low woodland	*Melaleuca viridiflora* - *Petalostigma banksii*	*Eucalyptus polycarpa*, *Dolichandrone heterophylla*, *Erythrophleum chlorostachys*, *Sorghum* spp., *Aristida* spp.	375	375	275	50	11
2B Low woodland	*Melaleuca nervosa* - *Erythrophleum chlorostachys*	*Eucalyptus polycarpa*, *Aristida* spp.	400	500	100	50	4
2C Low woodland	*Melaleuca acacioides* - *Bauhinia carronii* - *Terminalia* spp.	*Gardenia vilhelmii*, *Grevillea* sp., *Petalostigma banksii*, *Dolichandrone heterophylla*, *Margaritaria* sp., *Sorghum* spp., *Heteropogon contortus*	500	475	275	60	10
3 Low open woodland	*Eucalyptus microtheca* - *Melaleuca viridiflora*	*Eucalyptus tectifica*, *Exoecaria parvifolia*, *Triodia pungens*, *Eriachne* spp.	350	-	800	40	6

Constituents of the ground layer

A ground layer of grasses is present over most of the survey area although at varying heights and densities, and of differing floristic composition, appears closely associated with soils and upper-storey communities.

Sorghum plumosum, 1 to 2 m tall, is the emergent species through extensive areas of the mid-height grass layer in the low woodland and open forest communities, being more dominant in the Melaleuca viridiflora - Petalostigma banksii associations. There are small areas of pure stands on the mottled grey earths to the west of the surveyed area. Chrysopogon fallax, Aristida spp. such as A. muelleri, and Schizachyrium obliqueberbe are the common mid-height grass species where S. plumosum occurs.

On the duplex soils of the Timora association, Sorghum plumosum and Aristida spp. are the most wide spread grasses with Eriachne obtusa, E. armittii, Eragrostis tenellula, Setaria surgens, Enneapogon robustissimus and Thaumastochloa rariflora occurring frequently but never as dominant types. These species are often associated with a shrub layer of Dodonaea physocarpa.

Triodia pungens also occurs on eroded Norman River frontage towards the western boundary of the surveyed area, while Eriachne glauca occurs in pure stands in low lying, partly swampy, areas on this frontage country.

Heteropogon contortus occurs sparsely on all soil associations. It is more common along road sides and under Eucalyptus polycarpa and Erythrophleum chlorostachys in the Gum Creek association. Although Heteropogon triticeus is widely distributed in Cape York Peninsula (Pedley and Isbell, 1971), it is not evident in the surveyed portion of the south eastern Gulf of Carpentaria.

Sedges, Fimbristylis squarrulosa and F. densa, are associated with the deep sandy earths of the Gum Creek association, occurring as a minor constituent of the Aristida hygrometrica and A. pruinosa dominant grass layer. Native legumes, Austrodolichos errabundus, and Polymeria ambigua form a layer with the Aristida species on these deep sands in some areas.

Small areas of the introduced legume Stylosanthes humilis are found along roads where it has become naturalized. There are no other introduced species occurring naturally in the surveyed area.

5. LAND USE OF THE MAYVALE LAND SYSTEM

(a) Present Land Use

The land use of the survey area has been discussed previously by Perry (1964) as part of the Leichhardt-Gilbert Report. Although some changes in pasture management have occurred, such as the introduction of Townsville stylo (Stylosanthes humilis) into selected areas (Bishop, 1972), the main land use of the area is still the extensive grazing of native pasture by beef cattle.

The beef industry is based on low capitalization with small return per hectare. Properties in the area are large, and have few fences and permanent watering points. These factors lead to under utilization of most of the country with the exception of the banks of lagoons and stream frontages which are severely overgrazed.

(b) Factors Affecting Land Utilization

Gunn and Story (1970) and Perry (1964) stress that the major problem to be overcome is the provision of quality pasture during the dry season. Gunn and Story (1970) further stress that the conventional ways of overcoming this pasture quality problem are uneconomic under present conditions.

It is considered by workers conversant with the area that the introduction of a legume is the most promising way of improving pasture quality. The legume which has shown the most promise is Townsville stylo (Stylosanthes humilis). Bishop (1973), Gunn and Story (1970), Howard (1966) and Perry (1964) have all stated that increased production during the dry season and overall improvements in carrying capacity can be expected on Townsville stylo improved native pastures. Perennial Stylosanthes spp., particularly browse type species might complement Townsville stylo or replace it for oversowing in tall vigorous native grasses.

The plant communities suitable for the introduction of Townsville stylo without timber treatment are the low woodlands of Melaleuca viridiflora - Petalostigma banksii (2A) and Melaleuca nervosa - Erythrophleum chlorostachys (2B) and the low open woodland of Eucalyptus microtheca - Melaleuca viridiflora (3). In the other communities competition from the shrubs and trees would greatly inhibit the establishment of the legume.

The chemical and physical properties of the soils discussed previously indicate that the soils have a very low fertility. The hard setting nature of the soils particularly those in the Timora association would be conducive to movement of seeds by water and could be a problem where seed is flown on when soils are dry. The restriction of water movement through the soil profile due to a cemented nodular layer or high clay content in the soil profile (e.g. Timora association) or the cemented D horizon, could be an important factor in controlling growth of plants, particularly in years where annual rainfall is below average. The sandy upper horizons of the major soils of the Gum Creek association would provide poor growing conditions in such years. However, in years where rainfall is above average the moisture supply could be quite adequate for plant growth.

The very low nutrient status of the soils is a major factor affecting the introduction of pasture species into the area. Bishop (1973) has reported increased production of Townsville stylo after phosphorus application in a field experiment on a grey earth (Blackbull association).

Results of pot experiments from a number of sites, to be reported elsewhere, have indicated that a range of nutrients (P, S, K, Zn and Cu) may be deficient.

The most suitable plant communities for grazing in the natural state are the low woodlands of Melaleuca viridiflora - Petalostigma banksii, Melaleuca nervosa - Erythrophleum chlorostachys (2A) and the low open woodland of Eucalyptus microtheca - Melaleuca viridiflora (3). This is mainly due to the presence of Chrysopogon fallax, Sorghum spp. and Aristida spp. as a moderate to dense ground cover. However, as Bishop (1973) states, these species form a low quality pasture inadequate for balanced animal nutrition.

Some areas of the low open woodland of Eucalyptus microtheca - Melaleuca viridiflora (3) are less suitable as they have Triodia pungens as the main ground cover and usually a large number of Melaleuca viridiflora seedlings. (Plate 4, figure 2).

Although in the more open parts of the survey area it would be possible to introduce a legume without timber treatment, most areas will require some timber treatment to allow legume introduction. Two methods of timber treatment are available for use in the community types found in the survey area. One is to push or pull the trees using tractors and subsequently to rake, stack and burn the timber. The cleared area is then ploughed and a pasture planted with a fertilizer dressing. The second method is to inject the trees with the chemical 'Tordon 105' followed by aerial application of the seed and fertilizer. Anderson and Beeston (1974) discuss and compare the two methods for similar Melaleuca communities in other Queensland districts. The data collected during this survey show there is no apparent reason why similar methods should not be used on the communities of the area. However, because of timber density, the low open forest communities and the low woodland community of Melaleuca acacioides - Terminalia spp. - Bauhinia carronii (2C) could only be economically cleared by the mechanical method. Also wherever Triodia pungens is the dominant ground cover a total replacement of pasture species would be necessary.

Little timber clearing has so far taken place in the survey area and only two areas could be surveyed in an attempt to ascertain the woody weed regrowth problem, which could develop after clearing. Both areas are at Glenore in the Blackbull association.

One area had the timber pushed and windrowed and was ripped in April 1968. The treated area was counted in April 1970 and again during this present study. An area adjacent to the treated area was also counted during this survey. These counts and the species in the area are presented in Table 6.

The mature trees in the second area were ringbarked in July 1967 and the area counted in April 1970 and again during this survey. These counts and the species of this region are given in Table 7.

The figures in Table 6 indicate that even when the clearing technique is to push and rip, a regrowth problem develops. A reduction of only 23% over the density of the original vegetation was obtained indicating that clearing of timber by mechanical methods would be expensive and several ploughings would be necessary.

The figures in Table 7 show, that even though the original trees can be effectively killed by ringbarking, a Melaleuca seedling problem can develop. These seedlings are present in the original vegetation, but are suppressed by the mature trees, until these are killed. In the Melaleuca viridiflora communities a population of suppressed seedlings equivalent to the original population was usually found. These seedling populations have been found to limit the useful life expectancy of the pasture in other Melaleuca dominated areas, when the chemical method of timber clearance is used (Anderson and Beeston, 1974).

In addition to the woody weed regrowth problems which these two treated areas illustrate, two species which have become major woody weeds in cleared land elsewhere are present. Atalaya hemiglauca and Acacia farnesiana are both present and in some areas have quite high densities even in the virgin vegetation. Those areas which have been burnt out or subjected to regular firing now carry densities approaching 1 000/ha of wattle species such as Acacia torulosa (Plate 3, figure 2). This could indicate that land clearing techniques involving fire may create an Acacia problem of some magnitude.

The ecology of the major shrub species is also little known and experience in the Melaleuca dominated communities in the north-west of Western Australia has shown Erythrophleum chlorostachys to be a potentially serious problem in cleared country (Wilcox personal communication). Also van Rijn (1965) found that Erythrophleum Chlorostachys was not effectively controlled by either 2-45T ester or Monuron even when the suckers are less than 1 year old.

TABLE 6

Plant counts in treated and untreated areas at Glenore

Species	Pushed and Ripped Area		Untreated Area
	April 1970	July 1972	July 1972
Melaleuca viridiflora	25	18	36
Melaleuca symphocarpa	40	62	42
Melaleuca acacioides	5	-	2
Other species	42	30	41
Petalostigma banksii	-	25	52

TABLE 7

Plant counts in treated areas at Glenore

Species	Ringbarked Area		
	July 1967	April 1970	July 1972
Melaleuca viridiflora (mature)	62*	7	-
Melaleuca viridiflora (seedlings)	-	-	150
Melaleuca symphocarpa	-	-	80
Petalostigma banksii	-	-	50
Other species	-	-	37

* Counts before ringbarking

\+ All numbers expressed in trees/ha

6.

(a) Conclusions

Fencing and watering facilities will need to be provided for better utilization of existing native pastures. However, a marked increase in beef production is unlikely to occur without pasture improvement.

The survey has shown that:

(i) soils are very infertile and multiple plant nutrient deficiencies may exist. Plant yield data from glasshouse experiments support this conclusion.

(ii) the physical properties indicate soil moisture may be a major factor limiting pasture growth.

(iii) a clay D horizon underlying the soils of the area is probably responsible for causing a perched water table and consequent waterlogging in very wet years.

(iv) the low open forest and low woodland of *Melaleuca acacioides*, *Terminalia* spp., and *Bauhinia carronii*, and some areas of the low open forest of *Melaleuca viridiflora*, and *Petalostigma banksii* are too dense for pasture introduction without timber treatment.

(v) an increase in the number of seedlings of *Melaleuca* spp. and other shrub species occurs wherever the plant communities have been cleared by chemical or mechanical methods. In areas which have suffered severe fires, *Acacia* spp. and *Melaleuca viridiflora* seedlings have formed dense stands.

(b) Recommendations

As a result of the foregoing it is recommended that:

(i) a comprehensive nutrient screening programme be implemented to determine minimum plant establishment and maintenance fertilizer requirements on the major soils of the area.

(ii) moisture characteristics of the major soils be evaluated as they may have an overriding influence on species persistence and production.

(iii) experiments be undertaken in all major plant communities to determine the development procedure which produces a stable pasture and minimum woody weed regrowth.

(iv) permanently marked observation areas be established in each community to assess the effects of fire on the woody and herbaceous vegetation.

(v) since the communities with *Melaleuca acacioides* as dominant or co-dominant species are unique to the South-eastern Gulf region, an area be set aside as a National Park before extensive land development occurs.

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BIBLIOGRAPHY

ANDERSON, E.R. and BEESTON, G. (1974). Timber control for pasture development and maintenance in Central Queensland. Qd agric. J. 100 (in press).

BISHOP, H.G. (1972). Townsville Stylo in the Gulf country. Qd agric. J. 98; 212-214

BISHOP, H.G. (1973). Gulf country pastures. 3. Sandy forest country Qd agric. J. 99; 363-368.

DOUTCH, H.K. et al. (1972). Progress Report on the geology of the Central Carpentaria Basin. Dept. National Devel. Bur. Min. Res. Geol. Geophysics Record 1962/64.

EDWARDS, A.P. and BREMNER, J.M. (1965). Dispersion of mineral colloids in soils using cation exchange resins. Nature 205; 208-209.

GUNN, R.H. and STORY, R. (1970). Land use in the Mitchell-Normanby area. in Lands of the Mitchell-Normanby area, Queensland. C.S.I.R.O. Aust. Land Res. Series No. 26, 89-98.

HOWARD, K.F. (1966). Producing beef in North-western Queensland. Qd agric. J. 92; 132-145.

ISBELL, R.F., WEBB, A.A., and MURTHA, G.G. (1968). Atlas of Australian Soils. Sheet 7. North Queensland. With explanatory data. (C.S.I.R.O. and Melbourne Univ. Press. Melbourne).

ISBELL, R.F. and GILLMAN, G.P. (1973). Studies on some deep sandy soils in Cape York Peninsula, North Queensland. 1. Morphological and chemical characteristics. Aust. J. exp. Agric. Anim. Husb. 13; 81-88.

KERR, H.W. and von STIEGLITZ, C.R. (1938). The laboratory determination of soil fertility. Qld. Bur. Sugar Expt. Stns. Tech. Comm. No. 9.

NORTHCOTE, K.H. (1971). A factual key for the recognition of Australian Soils. 3rd Ed. (Rellim Tech. Publs. Glenside, S.A.).

PEDLEY, L. and ISBELL, R.F. (1971). Plant Communities of Cape York Peninsula. Proc. R. Soc. Qd. 82; 51-74.

PERRY, R.A. (1964). Land use in the Leichhardt-Gilbert Area in General Report on Lands of the Leichhardt-Gilbert Area, Queensland, 1953-54. C.S.I.R.O. Aust. Land Res. Series No. 11, 192-213.

PERRY, R.A. and LAZARIDES, M. (1964). Vegetation of the Leichhardt-Gilbert Area in General Report on Lands of the Leichhardt-Gilbert Area, Queensland. 1953-54. C.S.I.R.O. Aust. Land Res. Series No. 11, 152-191.

PERRY, R.A. et al. (1964). General report on lands of the Leichhardt-Gilbert Area, Queensland, 1953-54. C.S.I.R.O. Aust. Land Res. Series No. 11.

PIPER, C.S. (1950). Soil and Plant Analysis. (Univ. of Adelaide Press. Aust.).

PIPER, C.S., de Vries, M.P.C. (1960). The availability of potassium in some Tasmanian soils. 2. Exhaustive cropping in relation to potassium reserves in the soil. Aust. J. agric. Res. 11; 774.

RIJN, P.J. van. (1965). Observations on the chemical control of tree suckers on Cockatoo sand in the Ord River Valley. Aust. J. exp. Agric. Anim. Husb. 5, 65-67.

SLATYER, R.O. (1964). Climate of th- Leichhardt-Gilbert Area in General Report on Lands of the Leichhardt-Gilbert Area, Queensland, 1953-54 C.S.I.R.O. Aust. Land Res. Series No. 11, 90-104.

SLEEMAN, J.R. (1964). Soils of the Leichhardt-Gilbert Area in General Report on Lands of the Leichhardt-Gilbert Area, C.S.I.R.O. Aust. Land Res. Series No. 11, 129-151.

SPECHT, R.L. (1958). The climate, geology, soils and plant ecology of the northern portion of Arnhem Land. Rec. Am-Aust. Scient. Exped. Arnhem Ld. 3; 333-413.

SPECHT, R. (1970). Vegetation. In 'The Australian Environment'. 4th Ed. (C.S.I.R.O. and Melb. Univ. Press. Melbourne).

SPECK, N.H. and LAZARIDES, M. (1964). Vegetation and pastures of the West Kimberley Area. in General report of Lands of the West Kimberley Area, W.A. C.S.I.R.O. Aust. Land Res. Series No. 9, 140-174.

STACE, H.C.T., et al.(1968). A Handbook of Australian Soils. (Rellim Tech. Publs. Glenside, S.A.).

TWIDALE, C.R. (1964). Geomorphology of the Leichhardt-Gilbert Area in General Report on Lands of the Leichhardt-Gilbert Area, Queensland, 1953-1954. C.S.I.R.O. Aust. Land Res. Series No. 11, 129-151.

TWIDALE, C.R. (1966). Geomorphology of the Leichhardt-Gilbert Area of N.W. Qld. C.S.I.R.O. Aust. Land Res. Series No. 16.

WALKER, J. (1972). Vegetation of the Shoalwater Bay Area in Shoalwater Bay Area, Queensland, 1972 C.S.I.R.O. Aust. Div. Land Res. Tech. Mem. 72/10, 85-106.

WALKER, J., ROSS, D.R. and BEESTON, G.R. (1973). The collection and retrieval of plant ecological data. Woodland Ecology Unit, C.S.I.R.O., Publication No. 1.

WILLIAMS, W.T., LAMBERT, J.M. and LANCE, G.M. (1966). Multivariate Methods in Plant Ecology. V. Similarity Analyses and Information Analysis. J. Ecology 54; 427-445.

WILLIAMS, C.H., LIPSETT, J. (1960). The build-up of available potassium under subterranean clover pastures on a podzolic soil. Aust. J. agric. Res. 11, 473.

APPENDIX

List of Plant Species found in Survey Area

Acacia farnesiana	mimosa bush
Acacia hammondii	
Acacia sericata	
Acacia torulosa	
Acacia umbellata	
Aeschynomene indica	
Alloteropsis semialata	
Aristida ingrata	a wire grass
Aristida latifolia	feather-top wire grass
Aristida muelleri	
Aristida pruinosa	
Arundinella nepalensis	reed grass
Bauhinia carronii	
Bothriochloa sp.	
Capparis lasiantha	nipan or split jack
Cochlospermum gregorii	
Commelina lanceolata	
Cymbopogon bombycinus	silky heads
Cyperus castaneus	
Cyperus haloschoenus	
Dichanthium fecundum	blue grass, curly
Digitaria nematostachya	
Dodonaea hansenii	
Dodonaea physocarpa	a hop bush
Dolichandrone alternifolia	
Dolichandrone heterophylla	
Enneapogon robustissimus	
Eragrostis confertiflora	
Eragrostis tenax	
Eragrostis tenellula	a love grass
Eragrostis sp.	
Eriachne armittii	a wanderrie grass
Eriachne glauca	a wanderrie grass
Eriachne obtusa	a wanderrie grass
Eremophila longifolia	berrigan
Erythrophleum chlorostachys	ironwood
Eucalyptus camaldulensis	river red gum
Eucalyptus confertiflora	
Eucalyptus grandifolia	bastard bloodwood
Eucalyptus melanophloia	silver-leaved ironbark
Eucalyptus microtheca	coolibah
Eucalyptus microneura	

Eucalyptus polycarpa	long fruited bloodwood or inland bloodwood
Eucalyptus pruinosa	kullingal or silver-leaved box
Eucalyptus tectifica	Macarthur River box
Eulalia fulva	browntop, silky
Excoecaria parvifolia	
Fimbristylis densa	
Fimbristylis squarrulosa	
Gardenia vilhelmii	
Glycine tomentella	hairy glycine
Gomphrena flaccida	
Grevillea glauca	
Grevillea parallela	silver oak
Grevillea pteridiifolia	ferny-leaved silky oak
Grevillia striata	
Haemodorum coccineum	bloodroot
Hakea arborescens	
Heteropogon contortus	black or bunch spear grass
Maytenus cunninghamii	
Margaritaria sp.	
Melaleuca acacioides	scrub tea-tree
Melaleuca nervosa	a tea-tree
Melaleuca stenostachya	
Melaleuca symphocarpa	
Melaleuca viridiflora	broad-leaved tea-tree
Panicum airoides	panic, creeping
Panicum mindanaense	
Paspalidium rarum	
Petalostigma pubescens	quinine berry
Santalum lanceolatum	plumwood, true sandalwood or commercial sandalwood
Setaria surgens	
Sorghum plumosum	plume sorghum
Sorghum laxiflorum	
Terminalia carpentariae	
Terminalia subacroptera	
Terminalia volucris	rosewood
Thaumastochloa rariflora	
Triodia pungens	spinifex, soft
Waltheria indica	
Zornia muriculata	

Profile Morphology and Analytical Data

Soil association Timora

Site no. 108

Great soil group podzolic

Location.

Parent material

Principal profile form Dy 3.42

Landform plain

Vegetation Low woodland Melaleuca acacioides, Bauhinia carronii, Terminalia spp., Eucalpytus pruinosa (250 trees/ha); shrub layer 3 m tall of Petalostigma banksii, Gardenia vilhelmii, Margaritaria sp., Carissa lanceolata (675 shrubs/ha); ground cover (10%) Heteropogon sp., Aristida sp.

Profile Morphology

0-10 cm	dark greyish brown (10YR 4/2)	loamy sand	hard setting, massive, hard, earthy, few ironstone nodules
10-20	greyish brown (10YR 5/2)	sandy loam	massive, hard, conspicuously bleached, few ironstone nodules
20-70	pale brown (10YR 6/3) (yellow and red mottle)	sandy clay	weak sub-angular blocky, extremely hard, profuse ironstone nodules
70-100	pale brown (10YR 6/3) (red mottle)	sandy clay	moderate sub-angular blocky, extremely hard, prominent ironstone nodular layer (weakly cemented)
120-200	pale olive (5Y 6/4)	medium clay	strong sub-angular blocky, cemented, manganiferous segregation

Depth	pH	E.C. micromhos /cm	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable cations Ca	Mg	K	Na	C.E.C.	Particle size CS	FS	Silt	Clay
							m. equiv. per 100 g					%			
0-10	6.0	16	0.004	0.5	0.027	4	1.0	0.1	0.10	0.1	2	48	43	3	6
10-20	6.0	7	0.004			1	0.6	0.8	0.05	0.1	2	43	44	3	10
20-30	6.2	10	0.004			1	2.2	1.2	0.2	0.1	5	42	37	3	18
50-60	6.5	12	0.004			1	3.2	1.2	0.05	0.1	6	49	31	2	18
80-90	6.4	13	0.005			1	2.6	2.0	0.2	0.1	5	38	36	1	25

Profile morphology and analytical data

Soil association Gum Creek

Great soil group yellow earth

Parent material

Landform plain

Site No. 115

Location

Principal profile form Gn 2.34

Vegetation low woodland of Melaleuca viridiflora, Melaleuca nervosa, Eucalyptus polycarpa, Ertyhrophleum chlorostachys (350 trees/ha); shrub layer 3 m tall of Gardenia vilhelmii, Petalostigma banksii, Dolichandrone heterophylla (520 shrubs/ha); ground cover (50%) Aristida spp., Heteropogon contortus, Schizachyrium sp.

Profile morphology

0- 10 cm	dark greyish brown (10YR 4/2)	loamy sand	hard setting, massive, soft, earthy
10- 30	light yellowish brown (10YR 6/4)	sandy loam clay	massive, soft, earthy, conspicuously bleached
30- 60	yellowish brown (10YR 6/5)	light sandy/loam	massive, soft, earthy
60-100	brownish yellow (10YR 6/6)	sandy clay loam	massive, soft, earthy

Depth	pH	E.C. micromhos /cm	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable cations Ca	Mg	K	Na	C.E.C.	Particle size CS	FS	Silt	Clay
							m. equiv. per 100 g					%			
0-10	5.9	7	0.005	0.6	0.021	1	1.2	0.2	0.5	0.1	3	48	43	3	6
10-20	5.9	4	0.004			5	1.0	0.4	0.05	0.1	1	43	44	3	10
20-30	5.8	4	0.003			1	1.0	0.2	0.28	0.1	2	42	41	3	14
50-60	5.5	7	0.006			4	1.4	0.6	0.13	0.1	2	45	34	2	18
80-90	5.6	7	0.006			1	0.6	1.0	0.28	0.1	2	42	36	1	21

Profile morphology and analytical data

Soil association	Blackbull	**Site No.**	101
Great soil group	soloth	**Location**	
Parent material	unconsolidated coarse sediments; source mainly sandstone	**Principal profile form**	Gn 2.94
Landform	plain		
Vegetation	low woodland of *Melaleuca viridiflora*, *Eucalyptus microtheca* (450 trees/ha); shrub layer 2.5 m tall of *Petalostigma banksii*, *Dolichandrone heterophylla*, *Margaritaria* sp., *Melaleuca symphocarpa*, *Wrightia saligna* (1 600 shrubs/ha); ground cover (30%) *Sorghum plumosum*, *Schizachyrium* sp., *Aristida* spp., *Crysopogon fallax*		

Profile morphology

Depth (cm)	Colour	Texture	Structure
0- 10 cm	greyish brown (10YR 5/2)	loamy sand	hard setting, massive, earthy
10- 40	light yellowish brown (10YR 6/4)	sandy loam	massive, slightly hard, earthy, conspicuously bleached
40- 60	very pale brown (10YR 7/3) (yellow mottle)	sandy clay loam	massive, hard, earthy, few ironstone nodules
60-100	light grey (10YR 7/2) (red mottle)	sandy clay	massive, extremely hard, earthy, few ironstone nodules
100-180	as above	sandy clay	as above with profuse ironstone nodules
180-200	pale olive (5Y 6/4) (yellow mottle)	medium clay (sandy)	strong blocky, (cemented) manganiferous segregation

Depth	pH	E.C. micromhos /cm	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable cations Ca (m. equiv. per 100 g)	Mg	K	Na	C.E.C.	Particle size CS (%)	FS	Silt	Clay
0- 10	5.5	9	0.001	0.3	0.03	8	0.6	0.1	0.10	0.1	1	45	43	5	4
10- 20	5.5	5	0.001			10	0.6	0.1	0.08	0.1	1	45	44	4	6
20- 30	5.3	13	0.001			8	0.6	0.1	0.08	0.1	2	42	46	6	7
50- 60	5.8	12	0.002			4	1.8	1.4	0.08	0.13	3	39	32	3	27
80- 90	6.1	15	0.004			3	1.4	1.8	0.10	0.40	4	36	31	5	29
180-190	6.1	56	0.007			12	1.6	3.4	0.15	2.0	11	-	-	-	-

<u>Profile morphology and analytical data</u>

Soil association	Timora	**Site No.**	150
Great soil group	podzolic	**Location**	
Parent material		**Principal profile form**	Dy 3.41
Landform	plain		

Vegetation low woodland of *Melaleuca acacioides*, *Bauhinia carronii*, *Terminalia* spp., *Eucalyptus grandifolia*, *Dolichandrone heterophylla* (350 trees/ha); shrub layer 2.5 m tall of *Melaleuca acacioides*, *Petalostigma banksii*, *Gardenia vilhelmii*, *Atalaya hemiglauca*, *Carissa lanceolata*, *Santalum lanceolatum* (920 shrubs/ha); ground cover (70%) *Sorghum* spp., *Aristida* spp., *Schizachyrium* sp.

Profile morphology

0- 10 cm	dark greyish brown (10YR 4/2)	loamy sand	hardsetting, massive, slightly hard, earthy
10- 30	light grey (10YR 6/3)	loamy sand	massive, slightly hard, earthy, conspicuous bleach, few ironstone nodules
30- 70	light brownish grey (10YR 6/2) (red mottling)	sandy clay	strong sub-angular blocky, extremely hard, profuse ironstone nodules
70-140	pale brown (10YR 6/3) (red mottle)	light medium clay (sandy)	strong sub-angular blocky, extremely hard, profuse ironstone nodules
140-200	pale olive (5Y 6/4)	medium clay (sandy)	strong blocky, extremely hard, with manganiferous segregation

Depth	pH	E.C. micromhos /cm	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable cations Ca	Mg	K	Na	C.E.C.	Particle size CS	FS	Silt	Clay
							m. equiv. per 100 g					%			
0- 10	5.6	9	0.003	0.2	0.033	4	0.6	0.1	0.50	0.1	2	39	49	6	6
10- 20	5.8	7	0.003			6	1.0	0.2	0.05	0.1	1	38	50	6	7
20- 30	6.0	6	0.003			7	0.6	0.2	0.27	0.1	2	27	44	5	23
50- 60	6.2	7	0.003			6	2.8	1.6	0.12	0.1	6	33	30	5	33
80- 90	6.4	14	0.004			4	1.6	1.6	0.27	0.1	3	33	29	6	32
*180-200	8.4	165	0.02			7	4.2	5.0	0.27	3.8	13	-	-	-	-

*D horizon

Profile morphology and analytical data

Soil association	Timora	**Site No.**	229
Great soil group	soloth	**Location**	
		Principal profile form	Dy 3.42
Parent material			
Landform	plain		

Vegetation low open forest *Melaleuca acacioides*, *Terminalia* spp., *Bauhinia carronii*, *Melaleuca stenostachya*, *Eucalyptus pruinosa* (850 trees/ha); shrub layer 3 m tall of *Petalostigma banksii*, *Gardenia vilhelmii* (950 shrubs/ha); ground cover (5%) *Aristida pruinosa*

Profile morphology

0- 10 cm	greyish brown (10YR 5/2)	loamy sand	hard setting massive, slightly hard, earthy
10- 30	pale brown (10YR 6/3)	sandy loam	massive, hard, earthy, conspicuously bleached
30- 40	pale brown (10YR 6/3) (yellow mottle)	sandy clay loam	massive, extremely hard, earthy, few nodules
40- 80	light grey (10YR 7/2) (yellow mottle)	sandy clay	weak sub-angular blocky, extremely hard, few ironstone nodules
80-200	pale olive (5Y 6/3)	medium clay (sandy)	strong sub-angular blocky, extremely hard, cemented, moderate manganiferous segregation on ped faces

Depth	pH	E.C. micromhos /cm	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable cations Ca	Mg	K	Na	C.E.C.	Particle size CS	FS	Silt	Clay
							m. equiv. per 100 g					%			
0- 10	6.0	12	0.004	0.1	0.027	5	1.2	0.2	0.10	0.5	2	37	50	3	11
10- 20	6.1	8	0.004			1	1.0	0.4	0.05	0.3	2	35	48	2	16
20- 30	6.0	8	0.004			1	1.2	0.6	0.10	0.3	3	34	39	2	25
50- 60	6.3	11	0.004			1	1.8	1.4	0.05	0.4	5	30	31	2	38
80- 90	6.1	20	0.005			1	1.4	1.6	0.05	0.75	4	30	32	3	36
*190-200	8.9	190	0.019			1	3.8	6.6	0.18	7.0	15				

* D Horizon

Profile morphology and analytical data

Soil association	Gum Creek	**Site No.**	231
Great soil group	yellow earth	**Location**	
Parent material		**Principal profile form**	Gn 2.94
Landform	plain		

Vegetation low woodland *Melaleuca viridiflora*, *Melaleuca nervosa*, *Melaleuca stenostachya*, *Eucalyptus polycarpa*, *Eucalyptus confertiflora*, *Eucalyptus melanophoia* (450 trees/ha); shrub layer 2 m tall of *Erythrophleum chlorostachys*, *Petalostigma banksii*, *Margaritaria* sp., *Dodonaea physocarpa* (550 shrubs/ha); ground cover (30%) *Aristida* spp., *Sorghum* sp., *Schizachyrium* sp.

Profile morphology

0- 10 cm	dark greyish brown (10YR 4/2)	loamy sand	hard setting, massive, soft, earthy
10- 50	pale brown (10YR 6/3)	loamy sand	massive, soft, earthy, conspicuously bleached
50- 70	yellowish brown (10YR 6/5)	sandy loam	massive, hard, earthy
70-130	pale brown (10YR 6/3) (yellow mottle)	sandy clay loam	gradual change to massive, extremely hard, earthy
130-180	as for 70-130		prominent ironstone nodular layer, cemented
180-200	pale olive (5Y 6/4)	medium clay (sandy)	strong blocky, extremely hard, maganiferous segregation

Depth	pH	E.C. micromhos /cm	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable cations Ca (m. equiv. per 100 g)	Mg	K	Na	C.E.C.	Particle size CS (%)	FS	Silt	Clay
0- 10	5.8	10	0.002	0.3	0.021	32	0.6	0.2	0.15	0.1	2	57	37	1	6
10- 20	6.0	7	0.003			8	0.2	0.1	0.10	0.1	1	55	38	1	7
20- 30	6.1	7	0.002			7	0.2	0.2	0.08	0.1	1	48	42	1	8
50- 60	6.4	8	0.002			4	0.6	0.6	0.08	0.1	2	43	39	1	16
80- 90	6.4	9	0.003			4	0.2	1.2	0.05	0.1	3	42	39	1	19
*180-200	8.7	240	0.031			5	1.2	3.6	0.15	5.5	12	-	-	-	-

* D horizon

Profile morphology and analytical data

Soil association Alluvial

Great soil group

Parent material

Landform plain

Vegetation low open woodland, *Eucalyptus microtheca*, *Melaleuca viridiflora*, *Grevillea* sp; ground cover (40%) *Triodia pungens*

Site No. 238

Location

Principal profile form Dy 3.41

Profile morphology

0- 7 cm	dark brown (10YR 3/3)	silt loam	hard setting, weak platy, hard, thin conspicuous bleach, abrupt boundary to
7- 40	yellowish brown (10YR 5/4) (yellow mottle)	silty clay	weak sub-angular blocky, extremely hard
40-100	light yellowish brown (10YR 6/4)	sandy clay	massive, extremely hard, few to moderate ironstone nodules.

Depth	pH	E.C. micromhos /cm	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable cations Ca	Mg	K	Na	C.E.C.	Particle size CS	FS	Silt	Clay
							m. equiv. per 100 g					%			
0- 7	5.8	20		0.1	0.042	5	2.0	1.6	0.35	0.1	2				
10- 20	5.4	16				5	1.4	1.8	0.15	0.15	4				
20- 30	5.4	16				8	1.2	1.7	0.15	0.4	4				
50- 60	5.8	18				4	0.4	1.4	0.05	0.55	3				
80- 90	6.2	310				3	0.1	2.4	0.05	1.30	3				

Profile morphology and analytical data

Soil association	Gum Creek	Site No.	265
Great soil group	soloth	Location	
Parent material		Principal profile form	Dy 3.82
Landform	plain		

Vegetation: low open forest *Melaleuca viridiflora*, *Melaleuca acacioides*, *Eucalyptus polycarpa*, *Terminalia* spp., *Cochlospermum gregorii*, *Grevillea striata* (450 trees/ha); shrub layer 1.5 m tall of *Carissa lanceolata*, *Margaritaria* sp., *Dolichandrone heterophylla*, *Hakea arborescens* (970 shrubs/ha); ground cover (60%) *Sorghum* sp., *Schizachyrium* sp., *Aristida* spp., *Eragrostis* sp.

Profile morphology

0- 10 cm	dark greyish brown (10YR 4/2)	loamy sand	hard setting, massive, slightly hard, earthy
10- 30	light yellowish brown (10YR 6/4)	loamy sand	massive, soft, earthy, conspicuously bleached
30- 40	light yellowish brown (10YR 6/4)	light sandy clay loam	massive, hard, earthy, conspicuously bleached
40- 60	pale brown (10YR 6/3) (yellow mottle)	sandy clay	massive, extremely hard, earthy, few ironstone nodules
60-100	light grey (10YR 7/2) (yellow & red mottle)	sandy clay	massive, extremely hard, earthy, few ironstone nodules, weakly cemented
100			prominent ironstone layer, cemented.

Depth	pH	E.C. micromhos /cm	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable cations m. equiv. per 100 g Ca	Mg	K	Na	C.E.C.	Particle size % CS	FS	Silt	Clay
0- 10	5.7	15	0.002	0.1	0.018	3	0.8	0.3	0.05	0.1	1	43	48	3	8
10- 20	6.0	9	0.003			1	0.2	0.1	0.33	0.1	1	45	46	2	8
20- 30	6.0	6	0.002			1	0.4	0.2	0.20	0.1	1	44	44	2	11
50- 60	6.6	18	0.002			1	1.6	1.6	0.20	0.5	4	34	28	1	38
80- 90	6.5	30	0.004			1	1.2	1.8	0.05	0.6	3	35	28	2	37
*180-200	9.2	350	0.024			1	3.8	6.6	2.2	6.8	16	-	-	-	-

* D horizon

Profile morphology and analytical data

Soil association Blackbull

Site No. 275
Location
Principal profile form Gn 2.94

Great soil group soloth

Parent material

Landform plain

Vegetation low woodland of *Melaleuca viridiflora*, *Melaleuca acacioides*, *Eucalyptus polycarpa*, *Terminalia* sp. (520 trees/ha); shrub layer 2.5 m tall of *Petalostigma banksii*, *Erythrophleum chlorostachys*, *Dolichandrone heterophylla* (500 shrubs/ha); ground cover (50%) *Sorghum* sp., *Chrysopogon fallax*, *Aristida* sp., *Schizachyrium* sp.

Profile morphology

0- 20 cm	brown (10YR 5/3)	loamy sandy	hard setting, massive, earthy
20- 40	pale brown (10YR 6/3)	sandy loam	massive, hard, earthy, conspicuously bleached
40- 60	pale brown (10YR 6/3) (yellow mottle)	sandy clay loam	massive, extremely hard, earthy, few ironstone nodules, conspicuously bleached
60-110	light grey (10YR 7/1) (yellow & red mottles)	sandy clay	massive, extremely hard, earthy, few ironstone nodules
110-140	as above	sandy clay	prominent nodular layer (cemented)
140-200	pale olive (5YR 6/4)	medium clay (sandy)	strong blocky, extremely hard, cemented, manganiferous segregation

Depth	pH	E.C. micromhos /cm	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable cations m. equiv. per 100 g Ca	Mg	K	Na	C.E.C.	Particle size % CS	FS	Silt	Clay
0- 10	5.8	8	0.002	0.1	0.021	1	0.2	0.2	0.05	0.25	1	47	42	4	8
10- 20	5.7	6	0.003			1	0.2	0.1	0.05	0.25	1	46	42	4	8
20- 30	5.4	8	0.002			1	0.2	0.2	0.13	0.25	4	39	43	4	16
50- 60	5.9	13	0.004			1	0.2	1.4	0.05	0.50	4	40	30	2	30
80- 90	6.3	16	0.002			1	0.2	1.6	0.05	1.0	4	40	29	3	30
*160-180	7.9	130	0.020			4	1.4	4.8	0.18	5.5	12	-	-	-	-

* D horizon

Profile morphology and analytical data

Soil association Alluvial

Great soil group

Parent material

Landform plain

Vegetation low open woodland of *Eucalyptus microtheca*, *Terminalia* spp. and *Bauhinia carronii*; ground cover 20% *Aristida* spp.

Site No. 276

Location

Principal profile form Dy 3.42

Profile morphology

0- 10	dark greyish brown (10YR 4/2)	loamy sand	hard setting, massive, hard, few ironstone nodules
10- 30	brown (10YR 5/3)	loamy sand	massive, hard with few ironstone nodules, conspicuous bleach clear boundary to
30- 60	yellowish brown (10YR 5/4) yellow mottle	sandy clay	weak subangular blocky, extremely hard, few ironstone nodules
60-100	light brownish grey (10YR 6/2) (yellow and red mottle)	sandy clay	moderate subangular blocky, extremely hard, moderate ironstone nodules

Depth	pH	E.C. micromhos /cm	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable cations Ca (m. equiv. per 100 g)	Mg	K	Na	C.E.C.	Particle size CS (%)	FS	Silt	Clay
0- 10	6.0	13		0.2	0.039	4	0.8	0.4	0.05	0.05	2				
10- 20	6.0	7				4	0.4	0.4	0.05	0.1	1				
20- 30	5.8	6				4	0.4	0.4	0.05	0.15	1				
50-60	6.1	13				4	1.4	1.6	0.15	0.3	4				
80-90	6.5	32				2	1.4	1.6	0.05	0.5	4				
90-100	6.6	51				2	1.4	1.6	0.05	0.9					

FIGURE 1. LOW OPEN FOREST OF MELALEUCA ACACIOIDES, TERMINALIA SPP., AND BAUHINIA CARRONII ON A DY 3.42 OF THE TIMORA ASSOCIATION. SITE 229.

FIGURE 2. LOW WOODLAND OF MELALEUCA VIRIDIFLORA, MELALEUCA ACACIOIDES PETALOSTIGMA BANKSII ON A GN 2.94 OF THE BLACKBULL ASSOCIATION. SITE 275.

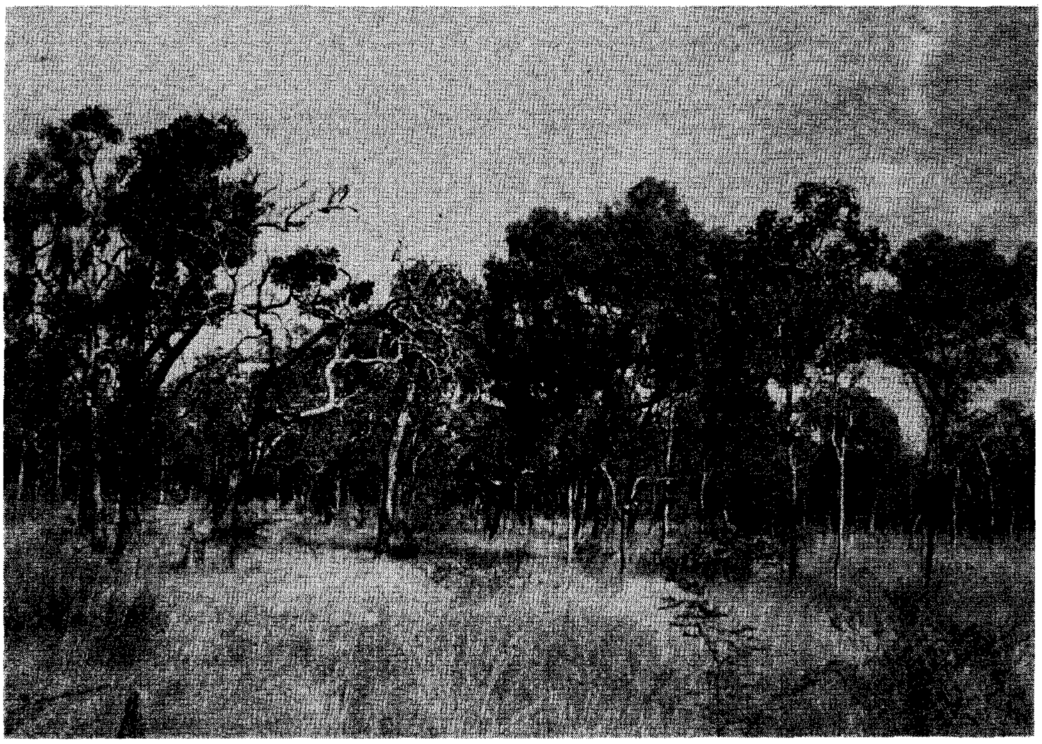

FIGURE 1. LOW WOODLAND OF MELALEUCA VIRIDIFLORA, EUCALYPTUS POLYCARPA, AND PETALOSTIGMA BANKSII ON A GN 2.34 OF THE GUM CREEK ASSOCIATION. SITE 115.

FIGURE 2. LOW OPEN WOODLAND OF EUCALYPTUS MICROTHECA AND MELALEUCA VIRIDIFLORA ON A DY 3.42 OF THE UNNAMED ALLUVIAL ASSOCIATION ALONG STATION CREEK.

FIGURE 1. MELALEUCA VIRIDIFLORA REGROWTH IN A 'BURNT-OUT' AREA ALONG BELMORE CREEK.

FIGURE 2. ACACIA TORULOSA REGROWTH IN A 'BURNT-OUT' AREA APPROXIMATELY NINE MILES EAST OF GLENORE CROSSING.

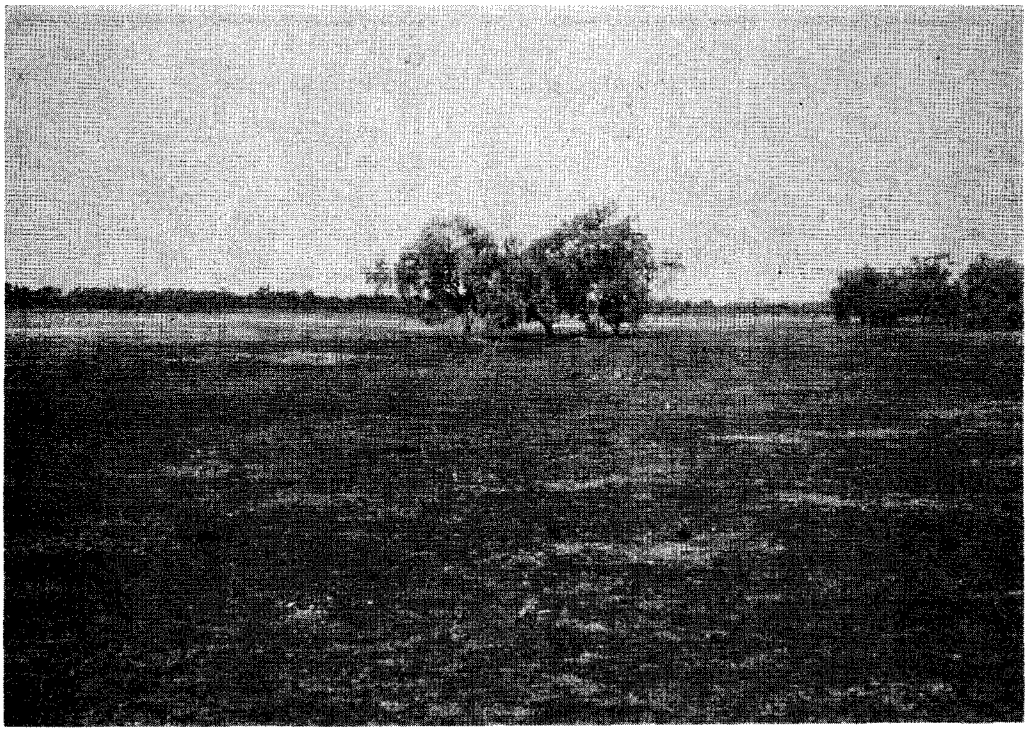

FIGURE 1. INTENSIVELY GRAZED AREA ADJACENT TO A WATERHOLE APPROXIMATELY EIGHT MILES SOUTH OF GLENORE CROSSING.

FIGURE 2. TRIODIA PUNGENS GROUND COVER IN THE EUCALYPTUS MICROTHECA MELALEUCA VIRIDIFLORA COMMUNITY.