COOYAR GRAZING LANDS STUDY

BY B.E. VANDERSEE

TECHNICAL BULLETIN NO. 34

DIVISION OF LAND UTILISATION

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Queensland Government Technical Report

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COVER PHOTO: Gully erosion in the East Cooyar Land System resulting from over clearing and over grazing.

SUMMARY

The land resources of the Parish of Cooyar in South East Queensland comprising an area of approximately 72 000 ha were mapped and classified with particular emphasis on the grazing lands of the area.

Approximately 56 000 ha were classified as grazing land and mapped into 13 land systems.

The resources of the area including climate, geology, geomorphology, drainage, land systems, vegetation and soils are discussed.

Present land use is discussed and potential land use examined.

Land degradation is recorded. Gully erosion, salinity, land slips, tree and shrub regrowth and pasture degradation were the main forms identified. The extent and location of each form is discussed together with the probable causes. Corrective and/or preventative measures are recommended. The major portion of the lands currently being cultivated have favourable soils and topography, the protection of soil conservation measures where necessary and are stable.

Lands currently used for grazing show varying degrees of gully erosion. The most pronounced erosion occurs on poorly managed and overstocked lands, and on areas previously cultivated but now returned to pasture because of erosion resulting from the previous use.

It is apparent that the current management and land use practices are leading to degradation of large parts of the area. Attempts to stabilise this area to maintain long term productivity are therefore justified.

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1. INTRODUCTION

Depressed cattle prices and rising production costs in recent years have resulted in increasing pressure to convert large areas of traditional grazing lands to cash cropping. Many of these areas are marginal for cropping and are not suited to continuous cropping. Once cultivated, these areas are often highly susceptible to erosion. This resulted in a need to carry out studies of the grazing lands to document the resources present, the degradation occurring or likely to occur, and to recommend practices likely to maintain or restore productivity.

1.1 OBJECTIVES OF STUDY

This study aimed to:-

(a) Map and describe the land resources present in the grazing lands of the Yarraman - Cooyar area.

(b) Indicate the type of degradation occurring on each land type.

(c) Map the extent of land degradation.

(d) Establish the causes of each form of degradation.

(e) Describe land use, outline land use alternatives and management practices for the various land types.

(f) Prepare recommendations for control of land degradation and reclamation of existing degradation.

1.2 LOCATION AND EXTENT

The study area comprises the catchments of Yarraman and Cooyar Creeks. It forms part of the South Burnett Region of southern Queensland. The southern extremity of the area is approximately 8 km south of Cooyar and the northern extremity is approximately 12 km north of Yarraman. It is based on division four of Rosalie Shire and includes the whole of the parish of Cooyar. It is bounded on the south-eastern side by the Blackbutt Range, the south-western side by the Great Dividing Range, and on the north-western side by the Cooyar Range.

The area of the catchments in this study was assessed as 71 936 hectares. Some 56 000 hectares of this were classed as grazing lands, the main subject of this study. The remaining 16 000 hectares of agricultural land have been included in the mapping for sake of completeness. However no detailed investigations were made on the agricultural lands and the pertaining information is of a very broad nature. These agricultural lands warrant further more detailed investigation.

1.3 COMMUNICATIONS AND AREA FEATURES

Yarraman (approximate population 600) is the main centre while Cooyar (approximate population 60) is the only other centre of importance. The total population is approximately 1500.

The New England Highway services the area from the south and the D'Aguilar Highway from the east and north. Many kilometres of other well constructed roads also service the area.

Yarraman is connected to Brisbane by a rail link down the Brisbane Valley.

Electricity and telephone services are connected to most of the properties in the area. A good mail service is also provided. There are no major airfields in the area.

1.4 SURVEY METHODS

Literature and articles relevant to the study area were collected and reviewed. This included the material of Hill and Tweedale (1955), Isbell *et al* (1967), Cranfield and Schwarzbock (1976), Murphy *et al* (1975), Fardon (1960), Gradwell (1948) Jones and Rees (1972), Wilson *et al* (1974), Tommerup (1934) and White (1920).

Following a familiarization reconnaissance of the area, air photo interpretation on both colour and black and white 1:30 000 photographs (1974-75) was undertaken.

Land system boundaries were marked out according to photo pattern. This was followed by a field survey to verify the mapping and to collect the land resource information. Detailed information was collected at 113 sites while 26 soil profiles were sampled at standard depths for chemical analyses. Land resource information was recorded in computer compatible form after Dawson (1972).

The scale of the land system map is 1:50 000

2. RESOURCES OF THE SURVEY AREA

2.1 CLIMATE

The climate of the Cooyar area was classified as sub-humid, having annual rainfalls between 500 and 750 mm. Areas along the crest of the Blackbutt and Cooyar Ranges may be classified as humid, having annual rainfall greater than 875 mm (Brunt, 1961). The climatic features described for the eastern Downs by White (1975) are generally applicable to this area.

Rainfall in this area is summer dominant. The major restriction on plant growth is rainfall and this is almost always more important than the combined effect of the other climatic factors of frost, excessive heat, winds, humidity.

Average annual rainfall varies considerably with the highest values being recorded along the ranges. Average annual rainfall for five centres located in or adjacent to the area are listed in Table 2.1.

TABLE 2.1

Average Annual Rainfall for Selected Centres

(Standard Period 1931-1960)

Centre	Rainfall (mm)
Yarraman Creek	838
Blackbutt	872
Benarkin Forest	969
Googa Creek	945
Nanango	787

Source: "Rainfall Statistics, Queensland" Bureau of Meteorology, 1966.

Climatic data for Nanango, approximately 7 km north of the area, are presented in Table 2.2. Nanango is the closest centre with comprehensive climatic records.

TABLE 2.2

Climatic Data for Nanango

Location: Latitude 26° 41' S, Longitude 152° 0' E. Elevation 345.0 m.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Mean Daily Max. Temp °C	30.3	28.4	27.8	25.7	22.4	20.1	19.3	21.4	22.9	26.4	29.0	29.5	
Mean Daily Min. Temp °C	17.7	17.3	15.2	10.9	7.1	4.0	2.7	4.5	7.5	11.8	14.2	16.5	
Mean Rainfall mm	114	105	90	47	40	46	43	34	41	65	75	105	805
Median Rainfall mm	100	86	73	36	34	34	30	25	35	56	65	95	770
Mean No. Rain Days	10	10	10	7	6	5	5	5	5	7	7	9	86

Source: "Climatic Averages Queensland, Metric Edition, 1975, Bureau of Meteorology"

The average date of the first frost ($0^{o}C$) at Nanango is June 8th and the last frost ($0^{o}C$) is September 15th. The average number of days per month with a minimum temperature of $0^{o}C$ or less are May 1.0, June 7.7, July 9.1, August 8.3, September 2.3 and October 0.1, giving a yearly average of 28.5. (Foley 1945).

2.2 GEOLOGY

The Geology section was prepared by J. van der Zee.

2.2.1 INTRODUCTION

A field reconnaissance survey was conducted to determine the geology, and its relationship to the drainage pattern, geomorphology and soils.

Aspects of the geology have been covered by Gradwell (1948) and Fardon (1960). The geological maps and reports of Cranfield *et al* (1976) and Murphy *et al* (1975) were used as the basis for the field survey.

The survey area forms part of the Yarraman Block. Elevation within the area varies between 300 and 900 metres above sea level. Much of the catchment lies between 400 and 550 metres above sea level. Generally the relief increases to the north and west.

2.2.2 GEOLOGICAL HISTORY

Sediments deposited in the Tasman geosynclinal trough underwent low grade alteration, due to compressional stress (Day *et al* 1974). These rocks form the undifferentiated Maronghi Creek Beds and the Sugarloaf Metamorphics. They are the oldest in the area and outcrop north and south of Yarraman, and west and north - east of Cooyar.

The Maronghi Creek Beds mainly consist of phyllites with excellent flat cleavage. Some could be called slates. Other rock types are sub-greywackes, mudstones, fine grained shales, siliceous shales, quartzites, red jaspers, and near granite contacts mica schists and low-grade hornfels.

The Sugar loaf Metamorphics differ from the Maronghi Creek Beds in that they are blockily jointed so that they outcrop differently. They consist of laminated shales, silicified shales, spotted altered shales and near granitic contacts, micaceous shales and hornfels. Alteration by tonalite is common. The Sugarloaf Metamorphics are probably marginally older than the Maronghi Creek Beds (Forbes, 1974).

Compression in the Late Carboniferous and the Middle Permian further metamorphosed the pre-Permian sedimentary sequences. During this time the marine, volcanic Gilla Andesite was probably emplaced. The andesite uncomformably overlies the metamorphics (Gradwell, 1948).

The Gilla Andesite is a tough, dark rock, normally irregularly jointed, so that outcrops of small blocks are plentiful. Associated with the andesite are agglomeratic andesites, andesitic tuffs, rhyolitic tuffs, rhyolites and dacites.

Numerous vertical rhyolite dykes, associated with the Upper Permian Taromeo Tonalite have intruded the andesite. Other dykes such as aplite, diorite micro-diorite and gabbro also intrude the andesite.

Extensive uplift and granitic intrusion in the Permian occurred (Day *et al* 1974). In this area the Woolshed Mountain Granodiorite, the Tarameo Tonalite and the Boondooma Igneous Complex intruded below the land surface which had been recently uplifted from the sea.

The Woolshed Mountain Granodiorite is a predominantly coarse grained hornblende-biotite granodiorite. Dykes consisting of aplites, trachytes and micro-granites intrude the granodiorite.

The Taromeo Tonalite is usually coarse grained and exhibits considerable variation. The most common types are those of granitoid texture of which the coarse grained, hornblende-biotite tonalite is dominant.

The Boondooma Igneous Complex occurs as scattered, relatively small outcrops in the western half of the survey area. The main areas of outcrops are centred around Cooyar. The Boondooma granites can be separated into two broad, easily distinguishable groups, the normal granites and the granodiorite-diorite complex centred on Cooyar (Fardon 1960). The normal granites are typically low lying, occurring in the creek beds and on lower slopes whereas the granodiorites show in ridges (Fardon 1960).

Denudation of the Triassic terrestrial landscape was followed by deposition of the upper Tarong Beds as river and swamp deposits. The Tarong Beds have been subdivided into a lower, dominantly coarse grained section with conglomerates and sandstones, and an upper dominantly fine grained section with shales, coal seams, sandstones and conglomerates. These lithological subdivisions correspond with the Tarong land system (lower Tarong Beds) and Palms land system (upper Tarong Beds). The Tarong Beds outcrop in the middle of the survey area, with lower Tarong Beds south of Cooyar Creek and upper Tarong Beds north of Cooyar Creek.

The Early Jurassic Woogaroo Sub-Group outcrops on the western side of the Tarong Beds in the centre of the survey area. This sub-group belongs to the lower part of the Bundamba Group. The rocks are massive medium grained or coarse, angular, poorly sorted quartzose sandstones, some cemented with ferruginous materials, others banded, suggesting cyclic changes in deposition.

The upper member of the Bundamba Group, the Marburg Formation, outcrops west of the Woogaroo Sub-Group. The Marburg Formation is predominantly sandy, but the sandstones are more labile than those of the Woogaroo Sub-Group (Day *et al* 1974). Siltstones, mudstones, oolitic ironstone and coal constitute minor rock types. Towards the end of the Jurassic Period, sedimentation ceased and the survey area became an erosional landscape again.

In the Lower Tertiary, the sandstones were intruded by rhyolites some of which outcrop towards the western boundary of the survey area.

The eroded landscape was covered in the Miocene by numerous basalt flows of the Main Range Volcanics and to a lesser extent by associated tuffs, rhyolite and agglomerate. Fardon (1960) and Zeissink (1972) consider that the area was a basalt covered plateau from which basins and valleys have been eroded, consequently re-exposing and pre-Tertiary landscape and further eroding it. Numerous isolated basalt caps throughout the area are evidence of the formerly existing plateau. The basalt cappings become less abundant towards the tonalite and andesite suggesting that the plateau did not extend so far or that denudation in the eastern part of the survey area progressed more rapidly due to the tilting of the 'Yarraman Tableland' in a north-easterly direction (Sussmilch, 1933).

The basalts of the Main Range Volcanics as described by Fardon (1960) are similar to those described from Toowoomba by Stevens (1969).

Outcrops of undifferentiated tertiary sediments occur towards the south-western boundary of the survey area. Their presence indicates considerable post basaltic uplift and erosion. The material is not basalt derived since it contains abundant quartz.

Laterities occur widely throughout the area and are principally developed on basalt, and to a lesser extent on tuff and granite. Zeissink (1972) suggests the laterites are not true laterite since none of the profiles show any strong increase in either iron or alumina, or a strong depletion of silica. Various ages have been assigned to the laterites. The main laterite in the area, developed on basalt, are probably of Miocene age. Some younger post-laterite basalt flows are probably present also.

Grey silcrete, consisting mainly of fine to pebbly quartz, occurs in small outcrops. Theories about its age and origin are divided however it is most likely of pre-basaltic age.

Erosion in recent times has led to the Quarternary alluvial deposits found along Cooyar and Yarraman Creeks as well as other minor tributaries. The type of alluvial deposit present is determined by the geological units contributing to its formation.

2.3 GEOMORPHOLOGY AND DRAINAGE

The Geomorphology and Drainage section was prepared by J. van der Zee.

2.3.1 GEOMORPHOLOGICAL RELATIONSHIPS

Although the geology is complex there is very good correlation of geology with land form and drainage throughout the area. The geology has been used as a basis for land resource and soils mapping. Generally the land forms are directly related to the lithologies, the north-north-west regional strike, joint systems, the north-east tilt of the tableland, and the natural runoff pattern created by the Great Dividing Range.

2.3.1.1 METAMORPHICS

Although the topography is irregular, the regional trend of the slates and the phyllites can clearly be seen on the air photos. Generally the terrain is rugged and hilly, and where the rocks have been contact metamorphosed, deeply incised valleys and ridges with steep slopes occur. In a few places the shales have formed broad convex slopes. The schists of the Sugarloaf Metamorphics, where hardened by silicification, form steep hills, but normally do not outcrop except where exposed by erosion. Drainage follows a dendritic pattern, with overall trend following the strike.

2.3.1.2 GILLA ANDESITE

The andesite gives rise to steep-sided hills, which are usually well-rounded. Along the banks of Cooyar and Yarraman Creeks the andesite stands up as high rocky cliffs. Rapids in the creek beds are common and often the streams are rejuvenating. Steep "v-shaped" gullies have been formed adjacent to the hills. Rhyolite dykes form resistant ridges.

2.3.1.3 GRANITES

The granites, comprising the Woolshed Mountain Granodiorite, the Taromeo Tonalite, and the Boondooma Igneous Complex, are generally represented by rolling hills of moderate to low relief, interspersed with broad alluvial flats. Occasional creeks cut through steep walled areas. Outcrop consists mainly of clusters of tors on hillsides. Large granite boulders are rare, though masses greater than one hundred tonnes occur in some localities.

Changes in topography are due to changes in lithology. The granite forms rounded ridges, and also steep-sided valleys or gorges which are associated with the headwaters of tributary creeks. The granodiorite forms areas which are relatively flat with little relief. When basalt cappings are present, there is a change in slope at the basalt-granite boundary.

Between Yarraman and Blackbutt the Taromeo Tonalite forms typical granite country, with gently rolling boulder-strewn hills. Here the junction of andesite and granite is marked by a sudden change of slope. However, to the north, especially about Cooyar Creek, and near the junction of this creek and Yarraman Creek, the tonalite forms steep, high hills, and in some cases cliff faces comparable with those of the andesite.

2.3.1.4 TARONG BEDS

On the aerial photos the lower Tarong Beds, comprising dominantly coarse material, occur south of Cooyar Creek and give rise to a herringbone ridge pattern with "v-shaped" valleys and sharp ridges. The Oakey Creek area shows this best, and the stream pattern on the map gives some indication of these features.

The upper Tarong Beds, comprising dominantly fine material, occur to the north of Cooyar Creek, and are equally different on the aerial photos, showing razor back ridges with broad concave valley slopes.

2.3.1.5 WOOGAROO SUB-GROUP

The topography is somewhat similar to a Karst topography. Flat plateau , rounded in plan, fall away in cliffs and very steep slopes to flat bottomed valleys. There are far fewer streams than in the other sandstones. The north-westerly strike, parallel to the steep-sided ridges, is expressed in the residual landform.

2.3.1.6 MARBURG FORMATION

The Marburg Formation has a gentler relief than the Woogaroo Sub-Group and steep-sided hills only occur where conglomerate is abundant. As with the Woogaroo Sub-Group, the north-westerly strike runs parallel to the ridges. The air photos show a slight change in slope at the basalt-sandstone boundary.

2.3.1.7 MAIN RANGE VOLCANICS

The Cooyar Range and the Blackbutt Range, forming the catchment divides, are the main physiographic features of the survey area. The Cooyar Range meets the Great Dividing Range at the southern edge of the Bunya Mountains and it is here that the greatest elevation and most broken topography occurs. The Blackbutt Range is relatively narrow in form throughout its length and drops away fairly quickly from its crest.

The Cooyar Range is quite acute in shape towards the Great Dividing Range and also higher than the Blackbutt Range. North of Cooyar, where the main area of laterite occurs, the crest of the range becomes rounded in form and then slopes away from the crest much more gently than before. Towards the north-eastern edge of the area the range crest becomes more acute again but is still much less angular in shape than north-west of Cooyar. In the central portion of the Cooyar Range the basalts have been completely lateritized. The southern extremity of the lateritized area is delineated by a clear scarp with very steep slopes (greater than 35%). This scarp face has an appearance similar to that of the western end of the Cooyar Range and is more or less continuous with the southern slopes of that part of the range. This scarp continues eastwards until it virtually disappears east of Yarraman.

Throughout the area, basalt cappings are easily distinguished as their characteristic level crests dip down steeply to the underlying rocks. The hills are rounded on top, though some flat mesas occur. Basalt ridges occur towards the Cooyar Range north-west of Cooyar and have a north-west orientation. The slopes are varied by contour scarps of 6 to 15 metres, especially on the steeper south-western sides, marking different flows.

2.3.2 DRAINAGE

The main drainage channel in the area is Cooyar Creek, flowing in a general north-easterly direction to join the Upper Brisbane River. The creek rises in the Bunya Mountains and through the survey area is joined by a large number of tributaries. The total area drained by this portion of Cooyar Creek is approximately 540 km^2. The two other major streams are Yarraman Creek and Rocky Creek, of which Yarraman Creek is the larger. Both of these creeks rise in the red soil areas north-west of Yarraman, and both flow approximately parallel to Cooyar Creek.

The course of Cooyar Creek appears to be determined by faults or joints in the underlying rock. This is suggested by the general angular shape of the meanders, of which the dominant orientation is N.W. - S.E. or N.E. - S.W. Above the junction with Yarraman Creek, the deeply incised channel of Cooyar Creek is exceptionally straight, suggesting flow along a major joint.

The Yarraman Tableland is drained by a series of parallel streams which flow in a north-easterly direction. Sussmilch (1933) has suggested that the Tableland may have a tilt in a north-east direction and that the streams are consequent streams. The steeper appearance of the south-western slopes of the hills is consistent with this suggestion. However, the general drainage pattern was probably determined by the pattern preceeding the basalt, and by the topography of the basalt plateau. This north-east trend is roughly perpendicular to the divide created by the basalt, and is the natural runoff pattern.

Continued, minor post-Pliocene uplift is suggested by downcutting of streams and tributary channels into the bedrock and by regularly occurring remnants of alluvial fans along the creeks. However, the widespread occurrence of gully erosion may be attributed to recent land use.

2.4 LAND SYSTEMS AND LAND ZONES

2.4.1 INTRODUCTION

The land system as described by Christian and Stewart (1953) has been used as the mapping approach in this survey. Wills (1976) summarised the history of the land system concept and its use.

Fifteen land systems have been defined for the area. These correspond favourably to the subdivisions of the area defined by James

et al (1974) in the Moreton study, where the Cooyar area was divided into three map areas, and these areas were divided into a total of twelve map units. Thirteen of the fifteen land systems defined in this survey are classed as grazing areas and two as agricultural areas. Only limited data are provided for the agricultural areas and further study is warranted in these areas.

The land systems, together with their land units, are described in Appendix 1. Land units are given a land capability rating using criteria in Appendix III. A diagrammatic cross section is provided to show the relationship of the various land units within a land system. Where applicable the reference number and location of fully described soil profiles are indicated. Botanical names for any vegetation species mentioned in this section are given in section 2.5 and Appendix II.

2.4.2 LAND SYSTEMS

A land systems map at a scale of 1:50 000 accompanies this report.

The fifteen land systems have been grouped into seven major land zones based primarily on parent material. Each zone is discussed briefly in the following sections.

2.4.2.1 ALLUVIUM LAND ZONE

Alluvium occupies approximately 5% of the area and is mapped as the Kooralgin land system (3 164 ha). Areas too small to map are included in other land systems. The Kooralgin land system includes the alluvial deposits along Cooyar and Yarraman Creeks as well as small areas along some of the minor tributaries in the area. These lands are a product of weathering and erosion of the Tertiary basalts and to a lesser extent the Jurassic shales and sandstones.

The soils of this land system are predominantly deep, dark, cracking, clays and are extensively cropped. Originally they carried a grassy open woodland of Queensland blue gum with areas of gum-topped box and broad-leaved apple.

2.4.2.2 LATERITE LAND ZONE

This land zone occupies approximately 18% of the area. It is mapped as the Upper Yarraman land system (13 102 ha) although it is expected that more detailed study would result in further subdivision of this particular system.

It is located along the crest of the Cooyar and Blackbutt Ranges as well as other elevated positions in the form of undulating plateau and plateau remnants of the lateritic parent material. Soils are predominantly moderately deep to deep, red, structured earths. Plant communities of this land system vary from layered open forest to closed forests and consist of "scrub species" and/or eucalypt forests.

The major cropping lands of the study area are found in this land system. Portions are controlled by the Department of Forestry and have been cleared and established to plantations of pine trees.

2.4.2.3 BASALT AND COMPLEX AREAS, LAND ZONE

Land of this zone occupies approximately 22% of the study area. Three land systems, Blackbutt (777 ha), Trevanna (12 513 ha) and Wutul (2 776 ha) were recognized.

The Blackbutt land system is composed of a hilly area along the north-western edge of the Blackbutt Range. It is derived from mixed

laterite, basalt and sandstone parent material and carries a layered open forest to closed forest of predominantly "scrub species".

Soils vary from shallow,stony,brown and black clays to areas of texture-contrast soils and red, structured earths. The major use of this land system is for pine plantations while limited areas are cleared and used for grazing or agriculture.

The Trevanna land system with its mountainous to hilly terrain is formed mainly from basalts of the Main Range Volcanics. It is located predominantly in the south and south-east of the area, particularly along the Great Dividing Range and parts of the Cooyar and Yarraman Ranges.

Vegetation communities vary from grassy open woodland to woodland of eucalypt species, particularly narrow-leaved ironbark and grey gum, to closed forests of "scrub species". Soils are predominantly moderately deep to deep, dark, cracking clays with areas of shallow, stony, loamy lithosols.

Large areas of this land system have been cleared or partially cleared and used for grazing with small areas being used for agriculture.

Undulating to hilly terrain is a feature of the Wutul land system which comprises mixed basalt and sandstone parent material. Soils are predominantly shallow to moderately deep, grey and brown clays with smaller areas of texture-contrast soils. Vegetation communities vary from open forests of belah, brigalow or narrow-leaved ironbark to closed forests of "scrub species".

The majority of this land system has been cleared or partially cleared and used for grazing. A considerable proportion (approximately 50%) of the area was originally cultivated. Steep slopes and lack of soil conservation measures allowed severe erosion to occur resulting in the return of many of these areas to pasture.

2.4.2.4 AGGLOMERATE-TUFF LAND ZONE

Lands formed from agglomerate and tuff occupy approximately 1% of the area. They were mapped as the Fair Hill land system (773 ha). Landform varies from hills to deeply dissected terrain and vegetation from open forest of eucalypt species (narrow-leaved ironbark, brush box, mahogany, bloodwood and gum-topped box) to closed forest of "scrub species". Soils vary from shallow, stony, loamy lithosols to moderately deep, texture-contrast soils. Areas of rock cliffs and outcrops are common.

Vegetation has been cleared or partially cleared over much of the area and the land used for grazing of native pastures.

2.4.2.5 SANDSTONES-SHALES LAND ZONE

The sandstone lands occupy approximately 23% of the area. Four land systems, East Cooyar (3 856 ha), Mt. Binga (3 885 ha), Tarong (4 847 ha) and Palms (4 010 ha) were included in this land zone. These lands occur in the south-eastern and central portions of the area.

Topography ranges from low hills to hilly terrain in the East Cooyar, Mt. Binga and Tarong land systems to deeply dissected terrain in the Palms land system.

Texture-contrast profiles dominate the soils of these land systems although areas of shallow stony lithosols are common. Shallow siliceous sands are common in the Mt. Binga land system while brown clays occur in parts of the Palms land system.

Open forests of narrow-leaved ironbark and/or gum-topped box occur on the East Cooyar land system. Extensive areas have been cleared

or partially cleared and used for grazing of native pastures. Very limited areas of sown pastures or cultivation occur.

The Mt. Binga land system has plant communities forming open forests to layered open forests. Dominant species are broad-leaved ironbark, bloodwoods, stringybarks, mahogany, narrow-leaved ironbark and rusty gum. These communities have been extensively cleared or partially cleared and used for grazing of native pastures. Portion of the area forms a camping reserve and has been subjected to limited logging. Small areas of sown pastures and cultivation occur.

Narrow-leaved ironbark open forests dominate the Tarong land system although many of the species mentioned in the Mt. Binga land system are found. This land system is extensively cleared and the native pastures used for grazing. The steep hills to deeply dissected terrain and the closed forests of "scrub species" are features of the Palms land system. This land system has been extensively cleared and is used for grazing of both sown and native pastures. Considerable land slips are evident. Excessive clearing of these steep slopes is considered to be a major cause.

2.4.2.6 GRANITE, TONALITE AND ANDESITE LAND ZONE

These lands occupy approximately 18% of the area. They are located in the vicinity of Cooyar in the south and Gilla and Yarraman in the north-east of the area.

Three land systems, Cooyar (1 749 ha), Pidna (6 780 ha) and Gilla (4 508 ha) were recognised in this land zone. Topography ranges from low hills to hilly terrain and vegetation from woodland to open forests with silver-leaved ironbark and/or narrow-leaved ironbark as the dominant species.

Soils vary from shallow, stony lithosols to texture-contrast soils with red, yellow or grey clay subsoils.

The Cooyar land system is formed on granites and granodiorites. Extensive clearing has taken place and the land is either cropped, sown to introduced pastures or maintained as native pastures for grazing.

The Pidna land system is formed on tonalite. Native vegetation has been extensively cleared and the resulting native pastures are grazed.

Andesites form the basis of the Gilla land system. Extensive clearing or timber treatment has taken place and the land used for grazing of native pastures. Small areas of sown pastures and cultivation exist.

2.4.2.7 QUARTZITE-SLATE-GREYWACKE LAND ZONE

These are metamorphic rocks and occupy approximately 13% of the area. They are located in the vicinity of Cooyar and to the north and north-east of Yarraman. Two land systems, Back Creek (6 716 ha) and Rocky Creek (2 480 ha) were recognized.

Both land systems exhibit hilly terrain.

The Back Creek land system supports woodland to open forest communities with narrow-leaved ironbark, grey gum, mahogany and gum-topped box being the dominant species. The Rocky Creek land system supports a layered open forest to low closed forest community with "scrub species", narrow-leaved ironbark and gum-topped box as the dominant species.

Soils of both land systems vary from shallow stony lithosols to texture-contrast soils with yellow, red or grey clay subsoils. Areas of red and brown clays occur in the Rocky Creek land system.

The Back Creek land system is extensively cleared and used for grazing of native pastures. Extensive clearing has also taken place in the Rocky Creek land system and the land used for grazing of native pastures. Significant areas of sown pastures and cultivation, mainly for grazing crops also occur.

2.5 VEGETATION

2.5.1 INTRODUCTION

Plant species and communities within the area have been described in broad terms by Durrington (1974). Reference was made to the vegetation species in parts of the study area by White (1920) and Tommerup (1934). The natural vegetation over much of the area has been cleared or partially cleared either for agriculture or grazing. Significant areas have been cleared and planted to introduced species by the Forestry Department. Plant communities not modified in some way by man are now difficult to find.

The species and formations associated with each land system, and units of the land system are presented in Appendix I. Only the dominant trees, shrubs and in some cases grasses were recorded. The vegetation of the area was classified into eleven major communities.

The more common tree species recorded in the area are listed together with their common names in Appendix II.

2.5.2 PLANT COMMUNITIES

2.5.2.1 QUEENSLAND BLUE GUM OPEN FOREST

This community occurs on the alluvial flats, particularly the Kooralgin land system and minor drainage lines of many of the other land systems. It also occurs on slope positions scattered throughout the area. Soils vary from deep clays to texture-contrast soils.

On the alluvial flats, Queensland blue gum *(Eucalyptus tereticornis)* may form pure stands. Frequently, broad-leaved apple *(Angophora subvelutina)* occurs as an understorey or associated species. Small areas of gum-topped box *(E. moluccana)* occur intermixed with this community.

A community of weeping bottle brush *(Callistemon viminalis)* and river oak *(Casuarina cunninghamiana)* occurs along the banks and channels of many of the permanently running fresh water streams.

2.5.2.2 GUM-TOPPED BOX OPEN FOREST

This community occurs throughout the area and in most land systems. Large areas of pure stands occur within the East Cooyar land system, usually on mid and lower slope positions. It is also found frequently along the water courses and minor drainage lines of the Fair Hill, Mt. Binga, Tarong, Palms, Back Creek and Rocky Creek land systems. Soils are usually texture-contrast with small areas of grey clays.

Species often associated with this community include Queensland blue gum, narrow-leaved ironbark *(E. crebra)* and occasional broad-leaved ironbark *(E. siderophloia)*. A scattered understorey of "scrub species" and wattles *(Acacia spp.)* occurs.

Fuzzy box *(E. conica)* and broad-leaved apple occur in association with the gum-topped box on the lower slopes and alluvial areas of the Rocky Creek land system.

Regrowth problems commonly follow the clearing of this community.

2.5.2.3 NARROW-LEAVED IRONBARK WOODLAND TO OPEN WOODLAND

This community occurs as pure stands on the mid and upper slope positions of the Back Creek, Cooyar, Tarong, East Cooyar, Gilla and Trevanna land systems. Soils vary from texture-contrast to shallow uniform dark clays.

Associated species include gum-topped box, silver-leaved ironbark *(E. melanophloia)*, Moreton Bay ash *(E. tessellaris)* and rusty gum *(Angophora costata)*. Black cypress pine *(Callitris endlicheri)* occurs as an understorey species in isolated areas. Grey gum *(E. major)*, Queensland blue gum and grass trees *(Xanthorrhoea spp.)* occur as associated species on the steep rocky upper slopes of the Trevanna land system. An understorey of "scrub species" and lantana *(Lantana spp.)* is common on many upper slope positions of the Trevanna land system.

2.5.2.4 SILVER-LEAVED IRONBARK OPEN FOREST TO WOODLAND

Silver-leaved ironbark communities occur on parts of the Cooyar and Gilla land systems with small areas in the Pidna land system. Soils are usually texture-contrast often with reddish clay subsoils.

Associated species include narrow-leaved ironbark and Queensland blue gum. Silver-leaved ironbark occurs as an associated species more often than as an individual community.

2.5.2.5 BELAH, BRIGALOW, "SCRUB SPECIES" OPEN FORESTS TO CLOSED FORESTS

Communities of belah *(Casuarina cristata)* or brigalow *(Acacia harpophylla)* or mixed brigalow and belah occur scattered throughout the Wutul land system. The belah tends to be associated with lower slope positions and drainage lines whereas the brigalow is confined usually to the lower slopes. Soils are usually deep, grey clays with minor areas of texture-contrast soils.

An associated understorey of "scrub species" commonly occurs with this community. Other associated species include narrow-leaved ironbark, bottle trees *(Brachychiton rupestre)* and gum-topped box.

Regrowth frequently becomes a problem following clearing of this community.

2.5.2.6 NARROW-LEAVED IRONBARK, WHITE BLOODWOOD, WHITE MAHOGANY, GREY GUM AND SMALL-FRUITED GREY GUM OPEN FOREST

This community occurs in the Cooyar, Pidna, Gilla and Back Creek land systems. It is found mainly on mid to upper slope positions with shallow-surfaced, hard-setting, texture-contrast soils.

Dominant species vary considerably. The major ones are narrow-leaved ironbark, white bloodwood *(E. trachyphloia)*, white mahogany *(E. umbra* or *E. acmenoides)*, grey gum *(E. punctata)*, small-fruited grey gum *(E. propinqua)* and tumbledown gum *(E. dealbata)*.

Associated species which commonly occur are gum-topped box, rusty gum, Queensland blue gum, pink bloodwood *(E. intermedia)*, forest she-oak *(Casuarina torulosa)* and black she-oak *(C. littoralis)* with scattered wattles and "scrub species".

Regrowth frequently becomes a problem following clearing of this community.

2.5.2.7 BROAD-LEAVED IRONBARK, WHITE MAHOGANY AND PINK BLOODWOOD OPEN FOREST

This community is usually found on upper slopes, ridge crests and rocky scarps of the Mt. Binga and Tarong land systems with small areas occurring in the Back Creek land system. Soils are generally shallow, stony or rocky lithosols or shallow, texture-contrast soils.

While pure stands of broad-leaved ironbark occur as small areas it generally occurs as the dominant species in communities which include white mahogany and pink bloodwood.

Associated species include narrow-leaved ironbark, rusty gum and occasional gum-topped box and Moreton Bay ash. Understorey species of forest she-oak, dogwood *(Jacksonia scoparia)* and wattles occur.

2.5.2.8 BRUSH BOX, WHITE MAHOGANY OPEN FOREST

This community occupies the steep upper slopes and rocky outcrops of the Fair Hill and Gilla land systems. Soils are shallow, frequently stony or rocky, loamy lithosols. Dominant species are brush box *(Tristania conferta)* with some white mahogany. Associated species include narrow-leaved ironbark, grey gum, rusty gum and wattles.

2.5.2.9 NARROW-LEAVED IRONBARK AND "SCRUB SPECIES" LAYERED OPEN FOREST TO CLOSED FOREST

This community is found in all slope positions on the hilly terrain of the Blackbutt land system. Smaller areas occur on the upper slope positions of the Trevanna, Wutul, Palms and Rocky Creek land systems. Soils are generally shallow, brown, black or red clays with smaller areas of red, structured earths and texture-contrast soils.

Dominant species are narrow-leaved ironbark and 'Scrub species". (Individual scrub species were not identified in this survey).

Associated species include gum-topped box, grey gum, scattered fuzzy box, Queensland blue gum and lantana.

2.5.2.10 "SCRUB SPECIES" CLOSED FOREST TO LOW CLOSED FOREST

This community occurs on most slope positions, particularly upper slopes, of the Upper Yarraman, Palms and Rocky Creek land systems. Small areas occur in the Trevanna, Blackbutt and Wutul land systems. Soils vary from deep, red,structured earths to shallow to moderately deep,grey, brown or red clays. Individual "Scrub species" have not been identified however crow's ash *(Flindersia australis)* is one which is easily recognized and commonly occurs.

Associated species include hoop pine *(Araucaria cunninghamii)*, narrow leaved-ironbark, gum-topped box, wattles and lantana. Regrowth frequently becomes a problem following clearing of this community.

2.5.2.11 LAYERED OPEN FORESTS TO CLOSED FORESTS OF RAIN FOREST SPECIES

This community occurs on most slope positions of the Upper Yarraman land system. Soils are usually deep to very deep, red, structured earths. Species occuring in this community were not studied in detail as this land system did not form part of the grazing lands.

Species recorded include Blackbutt *(E. pilularis)*, tallowwood *(E. microcorys)*, pink bloodwood, white stringybark *(E. eugenioides)*, *(E. phaeotricha)* Sydney blue gum *(E. saligna)* and grey gum. Scattered species of hoop pine, Queensland blue gum, brush box and narrow-leaved ironbark were also recorded.

2.6 SOILS

2.6.1 INTRODUCTION

Broad scale mapping of this area was undertaken by Isbell *et al* (1967) for the Atlas of Australian Soils at a scale of 1:2 000 000. Brief mention was also made of the soils by staff of the Division of Land Utilisation (1974) as part of Moreton Region non-urban land suitability study.

Profile descriptions for the soil sites described in full are presented in Appendix VI. Analytical data for the 26 representative profiles collected for analysis are also presented in Appendix VI.

2.6.2 SOIL CLASSIFICATION

Soils recorded during this study have been described according to the principal profile forms of Northcote (1971) and the Great Soil Groups of Stace *et al* (1968).

Soils have been grouped into Great Soil Groups or nearest equivalent group. Within each Great Soil Group, soil families have been recognised mainly on the basis of depth and texture of surface horizons, soil reaction trend, and structure and colour of subsoils.

2.6.3 RELATIONSHIP BETWEEN SOILS AND GEOLOGY

Parent material is a major factor determining the character and distribution of soils in the area. The distribution of soils is related to the lithology and weathering status of the parent rocks and materials and the geomorphic history of the landscape.

Red structured earths with small areas of yellow earths are the dominant soils formed on the laterite parent material. The Main Range Volcanics have produced predominantly dark cracking clays while shallow, uniform-textured lithosols and loamy surfaced, texture-contrast soils occur on the Nutgrove Agglomerate.

Uniform coarse sands are a feature of the Woogaroo Sub-Group. Sandy-surfaced, texture-contrast soils predominate on the Marburg Formation and the lower Tarong Beds. The upper Tarong Beds tend to produce uniform, fine-textured soils.

Soils on the Boondooma Igneous Complex and the Taromeo Tonalite tend to be texture-contrast soils with some areas of uniform coarse textured soils. Gilla Andesite also produces texture-contrast soils which frequently have loamy surfaces in comparison to the sandy-textured surfaces of the above groups.

The Maronghi Creek Beds produce shallow, frequently stony, loamy lithosols and texture-contrast soils. A range of soils occur when there is mixed parent material and in the vicinity of major creeks, deep, dark, cracking clays have formed on the alluvial deposits.

2.6.4 SOIL GROUPINGS

The soils recognised have been placed in eight Great Soil Groups or nearest equivalent groups. Each group has an alphabetical symbol to represent the Great Soil Group i.e. Siliceous Sands (S). Within each group, soil families have been recognized and these have been designated a numerical number as well for ease of description. Table 2.3 lists the appropriate or approximate equivalent Great Soil Group of Stace *et al* (1968), the soil family and summary description, principal profile forms (Northcote, 1971) recorded and the land system and land unit where located.

TABLE 2.3

Great soil group or equivalent, soil families, summary description, principal profile forms and land system/land units where recorded for the Cooyar area.

GREAT SOIL GROUP OR EQUIVALENT GROUP	FAMILY	SUMMARY DESCRIPTION	PRINCIPAL PROFILE FORMS	LAND SYSTEM/LAND UNITS
ALLUVIAL SOILS (A)	A1	Deep, black to brownish-black, cracking clays. Neutral to alkaline soil reaction trend.	Ug 5.12	1(1) *
	A2	Deep, brownish-black cracking clays with sand and gravel intermixed. Neutral soil reaction trend.	Ug 5.12, 5.13	1(3)(5)
BLACK EARTHS (B)	B1	Shallow, brownish-black or brown cracking clays over decomposing parent material. Neutral soil reaction trend.	Ug 5.12, 5.13, 5.14 Ug 5.22, Ug 5.32	3(1)(2); 4(1)(7); 5(1)
	B2	Moderately deep to deep brownish-black to brown cracking clay becoming browner or yellowish-brown with depth. Neutral to alkaline soil reaction trend.	Ug 5.13, 5.14, 5.15 Ug 5.23, Ug 5.33	1(2); 4(2)(4)(5); 5(5)(6); 6(6); 9(5) 14(5)
	B3	Moderately deep to deep, brownish-black to brown, clays becoming brown or yellowish-brown with depth. Neutral to acid soil reaction trend.	Ug 5.13, Ug 5.32	5(2)(3); 10(1)(2); 11(7)
GREY, BROWN AND RED CLAYS (C)	C1	Moderately deep to deep, brown cracking clays over brown, yellowish-brown or reddish-brown clays. Neutral to alkaline soil reaction trend.	Ug 5.32, 5.34, 5.37	1(4); 4(3); 10(6); 12(2).
	C2	Moderately deep to deep reddish-brown and red clays overlying red clays. Acid to neutral soil reaction trend.	Ug 5.37	3(2)(4)
SOLODIZED SOLONETZ AND SOLODIC SOILS				
Dark or Brown (D) Sub-Soils	D1	Texture-contrast soils with hardsetting loamy A horizons and whole coloured B horizons. Neutral to alkaline soil reaction trend.	Dd 1.13, 1.22, 1.23	6(2)(4)
Yellow Sub-Soils	D2	Texture-contrast soils with hardsetting loam or sandy loam A horizons and mottled B horizons. Alkaline to neutral soil reaction trend.	Dy 3.12, 3.13, Dy 3.33, 3.43, Dy 3.22, 3.42	5(4); 7(2)(3)(4)(5); 11(7); 13(4)(6); 14(3)
	D3	Texture-contrast soils with hardsetting loam or sand loam A horizons and whole coloured B horizons. Neutral to alkaline soil reaction trend.	Dy 2.12, 2.13 Dy 2.32, 2.33 Dy 2.42, 2.43	5(3); 7(2)(5); 13(1); 14(2)(4)(5); 15(2)
	D4	Texture-contrast soils with hardsetting loam or sandy loam A horizons and whole coloured B horizons. Neutral to acid soil reaction trend.	Dy 2.11, Dy 2.12 Dy 2.41, Dy 2.42	6(5); 15(5)
	D5	Texture-contrast soils with hardsetting loamy A horizons over mottled B horizons. Acid to neutral soil reaction trend.	Dy 3.21 Dy 3.31, 3.32 Dy 3.41, 3.42	8(2)(4); 9(1)(2)(3);10(5); 15(2)
	D6	Texture-contrast soils with loose, sandy textured A horizons over whole coloured B horizons. Acid soil reaction trend.	Dy 4.11, Dy 4.21, 4.22	8(4);15(6)
	D7	Texture-contrast soils with loose, sandy textured A horizons over mottled B horizons. Acid to neutral soil reaction trend.	Dy 5.11, 5.12; Dy 5.21 Dy 5.31, 5.32	10(4)(5); 11(3); 12(1)(5);14(1)
Red Sub-Soils	D8	Texture-contrast soils with loamy textured hardsetting A horizons over mottled or whole coloured B horizons. Neutral soil reaction trend.	Dr 2.32, 2.33 Dr 3.41, 3.42 Dr 3.33	12(3); 13(5); 14(2)
	D9	Texture-contrast soils with loose sandy textured A horizons over whole coloured B horizons. Neutral to alkaline soil reaction trend.	Dr 4.12, 4.13	13(2)
YELLOW AND RED (P) PODZOLICS AND INTERGRADES	P1	Texture-contrast soils with loamy or sandy loam, usually hardsetting, A horizons over mottled B horizons. Acid soil reaction trend.	Db 2.21; Db 4.21	11(1)(5)
	P2	Texture-contrast soils with hardsetting loamy A horizons over mottled B horizons, Neutral to alkaline soil reaction trend.	Dr 3.12; Dr 3.21, 3.22. Dy 5.12	11(1)(4)(5); 12(2)(5)
LITHOSOLS (L)	L1	Shallow brownish-grey, light grey or reddish-brown loams and light clays. Neutral soil reaction trend.	Um 5.41, Uf 1.41	3(3)(4)
	L2	Shallow to very shallow brownish-black loams frequently stony. Neutral soil reaction trend.	Um 1.41, 1.42, 1.43 1.44	6(1)(3); 14(1); 15(3).
	L3	Shallow brownish-black sandy loams, frequently stony. Neutral soil reaction trend.	Um 6.11, 6.12 Um 5.41, 5.51	7(1); 9(4); 15(1).
	L4	Shallow brownish-grey loamy sands, frequently stony. Acid soil reaction trend.	Uc 1.21, 1.22 Um 1.21 Uf 1.21	8(5); 9(4); 10(3); 11(6); 12(4); 13(3)
SILICEOUS SANDS (S)	S1	Shallow to moderately deep, brownish-grey, loamy, coarse sands over yellowish-brown to orange coarse sands. Neutral to acid soil reaction trend.	Uc 1.21, 1.22	8(1)(3)(6).
RED STRUCTURED EARTHS (KRASNOZEMS - EUCHROZEMS) (E)	E1	Deep, very dark reddish-brown clay loams grading into reddish-brown light to medium clays. Acid soil reaction trend.	Gn 2.11, Gn 3.11, 3.12	2(1)(3)(5); 4(6); 5(7)
	E2	Deep, very dark reddish brown light clays or clay loams (sometimes snuffy) over dark reddish-brown or reddish-brown light clays. Acid soil reaction trend.	Gn 2.41, 2.42 Gn 4.11, Uf 6.12	2(2)(4)(7)
	E3	Deep, brownish-black to dark reddish-brown light clays over brownish-grey clays. Alkaline to neutral soil reaction trend.	Gn 3.93 Uf 6.12	2(4)(6)

* 1 (1) represents Kooralgin Land System, Land Unit (1).

Soils vary in erodibility from the highly erodible Solodized Solonetz and Solodic Soils; through the moderately erodible Grey, Brown and Red Clays, Black Earths, Red Structured Earths, Lithosols, and Yellow and Red Podzolics; to the Siliceous Sands which are least erodible.

2.6.4.1 ALLUVIAL SOILS

Soils in this group occur on recent alluvial deposits and show a minimum of profile development. They occur near present stream channels. Two families were recognised based mainly on texture differences.

These soils are moderately to highly fertile and are cultivated and cropped. Undisturbed areas need to be retained adjacent to creek lines to maintain bank stability.

2.6.4.2 BLACK EARTHS

These soils have uniform-textured profiles, and are dark cracking clays varying in depth, colour and soil reaction trend. Some of the soils in this group form intergrades with the grey, brown and red clays. Usually they are located on mid and lower slope positions.

Recognition of the three soil families was based mainly on profile depth and soil reaction trend.

Soils in this group are moderately to highly fertile and hence many areas have been cleared and cultivated for cropping. Suitability for cultivation is determined by land slope, soil depth and stoniness.

2.6.4.3 GREY, BROWN AND RED CLAYS

Soils in this group have uniform-textured profiles, with little profile development and are usually deep cracking clays. They are located on lower slope positions.

Two soil families were recognised with differences in soil colour and soil reaction trend.

Total area of these soils is small and individual occurrences are small. These soils have a moderate fertility status and as a result some areas have been cleared and cultivated for crops. However, most areas support native pastures and are used for grazing.

Moderate erosion occurs on these soils, particularly where cultivated on steep slopes.

2.6.4.4 SOLODIZED SOLONETZ AND SOLODIC SOILS

Soils in this group have texture-contrast or duplex profiles. Depth and texture of the A horizon varies considerably as does colour of the B Horizon. These soils occupy the major portion of the area and are found in almost all slope positions but more commonly on mid and lower slope positions.

These soils have been divided into three sub-groups depending on colour of the B horizon. Nine soil families were recognised - one within the sub-group with dark or brown B horizons - six within the sub-group with yellow B horizons and two within the sub-group with red B horizons. Families within each sub-group were determined by considering features of the A horizon, such as hardsetting, mottling of the B horizon and the soil reaction trend.

Soils in this group have a low and in some cases moderate fertility status. They have been extensively cleared or had timber treatment and are used for the production of native pastures for grazing. Limited areas are cultivated and used for cropping. These are predominantly the groups

with red or dark B horizons. Some areas have been cultivated to establish sown pastures.

Severe gully erosion is common on this group of soils, particularly where overgrazing and excessive clearing have taken place.

2.6.4.5 YELLOW AND RED PODZOLIC-LITHOSOL INTERGRADES

These soils have texture-contrast profiles with brown, yellowish brown or reddish brown clay B horizons and an acid soil reaction trend. They are located on mid and lower slope positions particularly in those areas with granitic parent material.

Two soil families have been recognised based mainly on colour of the B horizon.

Soils within this group have a moderate fertility status. Most areas have been cleared and used for grazing of native pastures or cultivated for cropping and/or the establishment of improved pastures.

2.6.4.6 LITHOSOLS

These soils are shallow, frequently gravelly or stony, sands, loams and clay loams overlying weathered parent material. They are located on upper slope positions and ridge crests. Frequently they are associated with rock outcrops.

Four soil families were recorded based mainly on texture, colour, depth and profile development.

Soils in this group have a low to very low fertility status. Many areas have been cleared or partially cleared for grazing of native pastures although this would not be generally recommended.

2.6.4.7 SILICEOUS SANDS

These soils have uniform coarse-textured profiles varying in colour and depth. They are located on low slope gradients usually on mid and lower slope positions.

A moderate area of these soils occurs. Only one soil family was recognised although colour and depth do vary.

Even though soil fertility status is very low, considerable timber treatment has taken place to encourage native pasture growth. Small areas on the low slope gradients have been cropped and in some cases introduced pasture species planted.

2.6.4.8 RED STRUCTURED EARTHS (INCLUDES KRASNOZEMS AND EUCHROZEMS)

These soils have gradational-textured profiles, weak horizon differentiation, weak to moderate structure development and predominantly acid soil reaction trend. They are found in all slope positions on the undulating plateau and plateau remnants in the area.

Three soil families were recognised mainly on the basis of colour, texture and soil reaction trend.

These soils cover a significant proportion of the area and form the major agricultural area. Most of these soils, with the exception of those under State Forest have been cleared and extensively cultivated. They have a moderate to high fertility status which tends to decline with continual cropping. As indicated previously further study is required on this soil group to adequately define the families and/or soil types present.

2.6.5 SOIL CHEMICAL AND PHYSICAL PROPERTIES

2.6.5.1 CHEMICAL PROPERTIES

Analytical data for the soil profiles representing the major units of the land systems are presented together with the detailed profile descriptions in Appendix VI. The criteria used for rating the nutrient status are listed in Appendix V.

Table 2.4 lists the land systems together with the parent material, dominant great soil group, soil profiles analysed and analytical ratings. No soil samples were analysed for the Upper Yarraman, Blackbutt or Rocky Creek land systems.

Results in Table 2.4 show that the soils of Kooralgin and Trevanna land systems have a high fertility status. These soils are used for cropping wherever practicable. Although no chemical data are available for the soils of the Upper Yarraman land system they would be classed as having a high fertility status. Soils within this high fertility group will respond to fertilizer applications where continuous cropping is carried out.

The soils of all of the remaining land systems can be classed as having a low to moderate fertility status. These soils are used predominantly for native pasture production. Responses could be expected to fertilizer applications. However under the present conditions the economics of such practices are doubtful.

None of the soil profiles analysed can be classed as saline however several are classed as sodic or strongly sodic. Soils of the Wutul, East Cooyar and Gilla land systems were strongly sodic whereas those of the Back Creek, Pidna, Tarong, and Kooralgin land systems are sodic. Saline outbreaks were recorded in the Upper Yarraman, Tarong and Gilla land systems.

The Kooralgin and Trevanna land systems have very high available soil water capacities thus enabling cropping to be carried out successfully. Soils of the Fair Hill; Gilla, Tarong and Back Creek land systems have a moderate to high available soil water capacity. Total available soil water in these soils is often greatly reduced by shallow soil depths. Soils of the remaining land systems have low to moderate available soil water capacities. This, together with the low fertility status of these soils, may account for native pastures being the predominant land use.

2.6.5.2 SOIL PHYSICAL PROPERTIES

Hard-setting and surface sealing

These conditions have been defined by Northcote (1971). Surface sealing and hard-setting usually become more pronounced when vegetation cover has been removed. Surface sealing may reduce the rate of water entry into the soil resulting in higher runoff during rainfall. Continuous heavy grazing and indiscriminate use of fire will contribute to decreasing the surface cover to levels which allow these conditions to develop.

Soils in this area which may exhibit these features are those of the Solodized Solonetz and Solodic Soil group, Lithosols and some of the yellow and red Podzolic - Lithosol intergrade group.

Soils with finer textured surfaces i.e. loams and clay loams, tended to hard-set and surface seal whereas those with coarser textures i.e. loamy sands and sands, did not. These observations agreed with the findings of Lutz (1952) and Vandersee (1977).

TABLE 2.4

Parent material, dominant great soil group, profiles analysed and analytical ratings for each land system.

Land System	Parent Material	Dominant Great Soil Groups	Profiles Analysed + (Site No.)	Analytical Ratings					
				Nitrogen	Phosphorus	Potassium	Soil Salinity	Soil Sodicity	Available Soil Moisture
KOORALGIN	Alluvium	Alluvial Soils & Black Earths	12, 70	Very fair	Very high	High	Non-saline	Sodic	Very High
UPPER YARRAMAN	Lateritised Basalt	Red Structured Earths	-	-	-	-	-	-	-
BLACKBUTT	Mixed laterite, basalt & sandstone	Red Structured Earths, Black Earths & Solodic Soils	-	-	-	-	-	-	-
TREVANNA	Main Range Volcanics	Black Earths	10,47	Very fair - high	Very high	High	Non-Saline	Non-Sodic	Very High
WUTUL	Mixed basalt & sandstone	Grey Brown & Red Clays and Solodic Soils	30	Low	Low	High	Non-Saline	Strongly sodic	Low-medium
FAIR HILL	Nutgrove Agglomerate	Lithosols & Black & Brown Earths	3	Low-fair	Medium	High	Non-saline	Non-sodic	High (shallow profiles
EAST COOYAR	Marburg Formation	Solodized Solonetz & Solodic Soils	43,58,59	Low	Very low	Fair-very fair	Non-saline	Strongly sodic	Low surface-high subsoil
MT BINGA	Woogaroo Sub-Group	Siliceous Sands & Solodic Soils	61,63,64	Very low - low	Very low	Very Low	Non-saline	Non-sodic	Very low-low
TARONG	Tarong Beds (Lower)	Solodized Solonetz & Solodic Soils	65,68,69	Low-very fair	Medium-high	Low-fair	Non-saline	Non-sodic -sodic	Medium-high
PALMS	Tarong Beds (Upper)	Lithosolic - Podzolic Intergrades & Solodic Soils	71	Very fair	Medium	High	Non-saline	Non-sodic	Medium
COOYAR	Boondooma Igneous Complex & Woolshed Mountain Granodiorite	Yellow Podzolics & Solodic Soils	46,74	Fair	Very low-low	Very fair	Non-saline	Non-Sodic	Low-medium
PIDNA	Taromeo Tonalite	Solodic Soils & Podzolic Intergrades	75,78	Low	Very low	Fair	Non-saline	Non-sodic -sodic	Low-medium
GILLA	Gilla Andesite	Lithosols & Solodic Soils	76,77,79	Low-fair	Low-medium	Fair	Non-saline	Sodic-strongly sodic	Medium-high
BACK CREEK	Maronghi Creek Beds	Lithosols & Solodic Soils	55,72,73	Low-fair	Low-medium	Very fair-high	Non-saline	Non-sodic-sodic	Medium high-(often shallow)
ROCKY CREEK	Maronghi Creek Beds	Solodic Soils & Grey, Brown or Red Clays	-	-	-	-	-	-	-

+ Where possible profile analysis was considered on relatively undisturbed sites.

Bulk Density

High bulk densities are frequently found in the B horizons of many of the soils of the Solodized Solonetz and Solodic soil group. Bulk densities of 1.5 - 1.6 g/cc reduce root penetration and 1.8 - 1.9 g/cc exclude root penetration (Veihmeyer and Hendrickson, 1948, Stace *et al*, 1968 and Vandersee, 1977).

Although no bulk density measurements were made for the soils of this area, field observations indicated that roots did not penetrate the B horizons of many of the soils of the East Cooyar and Tarong land systems. Structure and consistence of these soils recorded during profile descriptions indicated that bulk densities were high.

Dispersible B Horizons

Dispersible B horizons are one of the main causes of accelerated erosion on soils of the East Cooyar, Tarong and Back Creek land systems. Once the A horizon has been removed, either mechanically or by erosion, the dispersible B horizons erode at accelerated rates.

Soils with high exchangeable sodium percentages and high electrical conductivity levels are usually dispersible. This was demonstrated by Vandersee (1977).

Analytical data obtained during this survey indicate that the soils of the Wutul, East Cooyar and Gilla land systems would be very dispersible while many of those of the Back Creek, Pidna, Tarong and Kooralgin land systems will also disperse.

Gilgai

Both linear and nuram gilgai forms are found in the area. Linear gilgai are located on the lower sloping positions of the Trevanna land system. Nuram gilgai occasionally occur on very low sloping to flat areas of the Trevanna and Kooralgin land systems.

Both gilgai types are of such a small magnitude that they do not present any major problems if the areas are otherwide considered suitable for cultivation.

Soil Cracking

Soil cracking, while having beneficial effects in allowing greater entry of water during early summer storms, can present problems with contour bank design.

Soils which crack extensively will require broad base banks to prevent cracks extending through the banks. Soils of the Trevanna land system frequently crack hence broad base or broad base top side contour banks may be required where these soils are cultivated.

Most other soils, which are cultivated, do not crack sufficiently to warrant the use of broad base bank designs. Broad base banks can be used on lower sloping areas where it is desired to cultivate the bank area itself. This is a fairly common practice on soils of the Upper Yarraman land system.

2.7 LAND CAPABILITY CLASSIFICATION

2.7.1 INTRODUCTION

A land capability classification has been completed for all land units recorded during the study. The land capability classification for agricultural purposes of Rosser *et al* (1974) was used. The classification groups land into eight classes and contains three distinct divisions based on the degree of limitation for agricultural purposes. The eight classes are allotted to the three divisions on the following basis:-

Division A	Agricultural land	arable	Classes I-IV
Division B	Agricultural land	pastoral	Classes V-VII
Division C	Non Agricultural land		Class VIII

To determine the land capability class the fourteen limiting factors (Appendix III) are assessed for each land unit. The land capability classes and sub-classes indicate the degree and kind of limitation to agricultural use of the area. The land capability class together with the sub-classes are presented for each land unit of each land system in Appendix I.

2.7.2 DISTRIBUTION OF AGRICULTURAL LAND CAPABILITY CLASSES

Due to the complex nature of many of the land units described a range of land capability classes for each unit is common. To provide an overall view of the land capability of the study area those areas exhibiting a range of land capability have been allocated proportionally to the relevant classes.

The land classes, area of land within each class and percentage of the total study area are presented in Table 2.5.

TABLE 2.5

Area and Percentage of Total Area of Each Land Capability Class

	Land Capability Class						
	II	III	IV	VI	VII	VIII	Total
Area (ha)	7832	9584	16 832	21 563	10 795	5330	71 936
% of Total	10.9	13.3	23.4	30.0	15.0	7.4	100.0

It is obvious from the figures in Table 2.5 that almost 70% of the area has been classed as primarily pastoral land (i.e. classes IV to VII). Less than 25% of the area is classed as land suitable for continuous agriculture. (i.e. classes II and III) however a considerable proportion of this area is not cultivated at present. Class IV land is suitable for occasional cropping. No land has been classed as class I as it was considered that those areas likely to fall in this class were affected by occasional overflow flooding or wetness sufficient to place them in class II.

Thirty percent of the land has been classed as class VI land and this together with class IV land occupies greater than 50% of the study area. This indicates the large area of predominantly pastoral land capable of being improved using machinery and improved pasture species.

3. LAND USE

3.1 PRESENT LAND USE

3.1.1 INTRODUCTION

A variety of enterprises are carried out in this area. Approximately 15% of the area is cultivated and cropped to grain, peanut and bean crops. Cattle enterprises occupy almost all of the remaining area with the exception of the areas of State Forest, National Park, town and road reserves.

3.1.2 AGRICULTURE

Most of the cash crops are grown on the Upper Yarraman and Kooralgin land systems.

The major crops are grain sorghum, peanuts, maize, soybeans and navy beans during the summer months and barley during the winter months. Peanuts are not grown on the dark, cracking, clays on the Kooralgin flats. Fertilizer applications are required for successful cropping on most soils used for continuous cropping. Both phosphorus and nitrogen fertilizers are used. Application rates are usually determined using results of soil analysis.

Fodder crops are grown on the Kooralgin, Trevanna, Wutul, East Cooyar and Cooyar land systems to varying extents. Grazing oats is the usual winter crop grown and forage sorghum the main summer crop. Lucerne is grown for both hay and forage on parts of the Kooralgin land system.

Irrigation is used to supplement natural rainfall on many of the properties along the major creek lines.

3.1.3 PASTORAL

Pastoral enterprises involve about 70% of the area. These are in the form of mixed dairying and cropping enterprises and beef producing enterprises.

Dairying

There are less than 10 dairy farms operating in the area although extensive areas have been used for dairying in the past. Most of the dairying today is carried out on the Wutul land system with some areas on the Kooralgin land system.

Many of the dairying enterprises are mixed cropping - dairying systems with considerable emphasis on the cropping side wherever area and soils are suitable. Amalgamation of many of the original dairy farms has occurred and a change made in the farm enterprise.

Beef Cattle

Approximately 60% of the land area is now used for beef production, involving both breeding and fattening. Land systems such as East Cooyar, Fair Hill, Mt. Binga, Tarong, Cooyar, Pidna, Gilla and Back Creek are used almost entirely for beef cattle production.

Most beef production is based on native pastures. However improved pastures such as Rhodes grass *(Chloris gayana)*, green panic *(Panicum maximum* var. *trichoglume)*, kikuyu *(Pennisetum clandestinum)* and lucerne *(Medicago sativa)* are used (Rawson, 1967, Wilson *et al*, 1974). These are found currently on the Wutul, Cooyar, Gilla, Tarong and Rocky Creek land systems but are usually on small areas and are often poorly maintained.

Grazing crops such as oats and forage sorghums are grown where possible. These are used for fattening aiming at a quicker turn-off of stock for market.

Although some mixed beef cattle - cropping enterprises occur they are not very common. In these cases crop stubbles are grazed.

3.1.4 FORESTRY

Several State Forest reserves are located in the area. These include both native timber production and plantations of more productive timber species. Hoop pine *(Araucaria cunninghamii)* is the main plantation type with lesser quantities of *Pinus patula* and *Pinus radiata*.

Many of the State Forest reserves have steep sloping terrain and/or shallow soils. However State Forest reserves on the Upper Yarraman land system include soils and slopes similar to those used for agricultural crops. Most State Forest reserves include some form of grazing lease.

Timber for commercial and private use has been cut from most of the land systems. Quantities are still being removed from private land in the Mt. Binga, Rocky Creek and Trevanna land systems.

Timber mills are located at Yarraman and Cooyar as well as Blackbutt, Nanango and Benarkin just outside the area.

3.1.5 MINING

Mining is not of great importance in the area at the present time.

An area on the Cooyar Range is presently mined for bentonite. One of the uses of this material is for sealing dams to prevent leakage. Kaolin deposits are known but not being mined at present.

Various mining leases are current over portions of the survey area, but are not being used. Small coal seams have been noted in the area. It is not known if these are extensive and have commercial value similar to those in other catchments near the study area.

Numerous gravel quarries are operated throughout the area as a source of road building material.

3.1.6 PIGS AND POULTRY

Pigs and poultry enterprises are not major enterprises within the area although there is a small bacon factory at Yarraman.

3.1.7 RECREATION

The Palms National Park is located approximately 6 km north-east of Cooyar. It has a total area of just over 11 ha and provides a well maintained picnic area in close proximity to Cooyar and Yarraman.

Rogers Park, is a recreational park for picnicking and is maintained by the Forestry Department. It is located within the State Forest north of Yarraman.

3.2 POTENTIAL LAND USE

3.2.1 INTRODUCTION

There appears to be little scope for expansion of most enterprises in this area. Agricultural areas are almost fully developed and pastoral areas offer little scope other than to increase carrying capacities. Expansion of alternative enterprises such as pigs and poultry, horticulture, forestry and mining is also limited.

3.2.2 AGRICULTURE

Within this area there is little or no potential for a significant increase in the area of agricultural crops. There is more likely to be a decline as steeper more erodible areas are taken out of cultivation.

Changes in present land use will be in the proportion of different crops grown and the farming systems used. Crops grown will be of the types mentioned earlier with the area of each crop depending largely on market prices.

Rotational cropping is standard practice in the area. Opportunity cropping is being recommended and stubble retention and stubble mulching is gaining in popularity. Research is currently being undertaken to overcome problems encountered with existing machines and techniques for handling the quantities of stubble.

It is recognised that contour banks alone do not provide a complete soil erosion control measure. Contour banks combined with a stubble mulching programme is the recommended system.

3.2.3 PASTORAL

Dairying is expected to continue to decline as has been the trend over the last ten years.

Any expansion in the beef cattle industry will depend on increasing the carrying capacity of the existing grazing areas coupled with satisfactory market prices. Assuming that cattle prices return to satisfactory levels, expansion will be related to increased production from improved pastures or addition of legumes to native pastures.

Considerable scope exists for expansion of the areas of improved pastures. There are areas in all land systems which would be suitable for pasture establishment. Areas of steep eroded cultivation can frequently be reclaimed by using improved pastures.

Jones and Rees (1972) report that Rhodes grass, green panic, buffel grass *(Cenchrus ciliaris)*, siratro *(Macroptilium atropurpureum)* and lucerne yielded and persisted well on a site near Nanango. Soils and climatic conditions at Nanango are similar to much of the study area and thus these species could be expected to grow satisfactorily.

Further clearing of timber is not warranted in most of the area. Areas which have not been cleared are predominantly steep areas with shallow and often rocky soils. These areas are best left in their natural state. Clearing or timber treatment should be carefully considered as examples exist where the resulting regrowth is denser than the original stands.

3.2.4 IRRIGATION

There is little scope for increasing the area presently irrigated unless major water storages are built. The present irrigation areas draw supplies from major creeks and an occasional bore in the alluvium.

There appears to be little opportunity for the development of a large-scale irrigation scheme to benefit this area.

3.2.5 FORESTRY

The Forestry Department is continuing to clear natural vegetation on State Forests and replace it with plantations.

Other areas which may be considered for re-afforestation would be in the Palms land system. Much of this area is very steep and although it produces large amounts of pasture growth when cleared, it is susceptible to land slips. Land slips will probably continue to occur on this area until timber is re-introduced. The cost of reclamation and the problems encountered in harvesting timber on these steep slopes are unattractive features for such a proposal.

3.2.6 RECREATION

Part of the Fair Hill land system could be considered for a flora and fauna reserve. Although the area is partly cleared it would still provide a suitable habitat for wild life. This area is not very productive grazing country hence an alternative use could be considered.

4. LAND DEGRADATION

Land degradation in varying degrees and forms is present or has occurred in a range of sites and conditions in the area. The most common forms of degradation occurring are gully erosion, tree and shrub regrowth and salinity while land slips and pasture degradation are also of concern.

4.1 EXTENT AND CAUSES OF DEGRADATION

The locations of the major occurrences of gully erosion, saline outbreaks and land slips are indicated on the accompanying land systems map. This is an attempt to record the present location and to some degree the extent of the current situation.

4.1.1 GULLY EROSION

More than 80 individual areas suffering from gully erosion of sufficient extent to be seen on aerial photographs are recorded on the accompanying land systems map.

Gully erosion will occur on continuously cultivated, steep sloping areas if soil conservation measures are not applied. Within the present cultivation areas of the Upper Yarraman and Kooralgin land systems, gully erosion is negligible. Susceptible areas are well protected with mechanical soil conservation measures. Occasional gullies are found on badly maintained waterways or in association with acces tracks.

Severe gully erosion occurs in the cultivation areas of the Wutul and East Cooyar land systems. Approximately 50% or 1 400 ha of the Wutul land systems has been cultivated at some stage. Cultivation has been abandoned on most of this area because severe gully erosion had occurred or was starting to occur.

Within the East Cooyar land system, approximately 8-10% or 350 ha has been cultivated. Cultivation has ceased on many of these areas. Small areas of other land systems, particularly the Trevanna land system have also experienced severe gully erosion when cultivated.

Gully erosion has most likely resulted from the cultivation of land, with steep slopes, which was not suitable for continuous cultivation, and the fact that soil erosion control measures were never used.

In the grazing areas, severe gully erosion occurs particularly in the Back Creek and East Cooyar land systems. The worst erosion is associated with natural minor drainage lines. These are eroding due to over clearing of trees and shrubs along the drainage lines as well as complete clearing of the surrounding catchments. Stocking rates are usually too high resulting in poor ground cover and hence higher runoff rates. Sharp *et.al.* (1974) reported runoff rates from a heavily grazed watershed to be ten times greater than from a lightly grazed watershed.

Severe gullies occur in association with several of the roads in the area. These are usually due to the roadway diverting the water and increasing flow rates. Waterfall action as a result of cross drainage structures has also caused gullies to form.

4.1.2 SALINITY

Saline outbreaks were recorded in the Upper Yarraman, Tarong, East Cooyar, Cooyar and Gilla land systems. The major outbreaks appear to be associated with the lower slopes and drainage lines. In many cases the natural vegetation has been killed with resultant areas of bare ground.

The total area affected by saline outbreaks is approximately 50 ha. Individual outbreaks are usually small although the areas tend to be increasing slowly over the years. Nine saline or suspected saline outbreaks were recorded.

Jenkin and Irwin (1975) list several causes of salting in Victoria. The main cause is excessive clearing of upper slopes which allows more water to reach the saline ground water zone. This raises the water table and results in outbreaks in lower slope positions. Action which promotes infiltration such as deep contour ploughing and improvement of soil structure, will intensify this effect. The emergence of saline ground water is probably the principal cause of long term salting.

These factors would apply in this area as there has been extensive clearing of the upper slope positions and hill crests and in many cases the slopes have been ploughed, contoured and cropped. Ground water levels appear to have risen on the lower slopes bringing saline ground water to the surface.

4.1.3 LAND SLIPS

Land slips occur mainly on the Palms land system. While the total area of land slips is not very large, the frequency of occurrence is quite high. Occasional land slips are recorded in the Wutul and Trevanna land systems. A total of 22 land slips was recorded. However considerable soil movement which could be classed as minor land slips was also observed.

The largest land slip in the area measures about 1 ha while the majority occupy areas of 0.1 ha or less.

They are all found in the higher rainfall areas and on steeply sloping terrain. They occur on slopes of greater than 20% which have been completely cleared of trees and shrubs. Areas of weakness develop during very wet periods and result in land slips.

4.1.4 TREE AND SHRUB REGROWTH

Regrowth problems are common on the East Cooyar, Mt. Binga, Tarong and Palms land systems. The resulting communities are frequently as dense or denser than the original community. Regrowth problems are encountered on all land systems, except the Kooralgin land system, at some stage during their agricultural or pastoral development. Regrowth is part of the natural process of reverting to the climax community.

Lantana and in some cases "scrub species" cause the major problems in the Palms land system whereas wattles and ecualyptus species form the major problems in the Mt. Binga, Tarong and East Cooyar land systems.

Many of the areas where regrowth problems are severe are areas which were unsuitable for clearing or timber treatment. They are shallow, frequently rocky soils on steep slopes and scarps. Pasture production from these areas is very low and would not justify the expense involved in their treatment.

Regrowth problems are caused by clearing the native vegetation and the germination of seed reserves (often following fire) or inadequate clearing leaving partially removed or treated areas to recover. Regrowth may be aided by heavy stocking rates which eliminate the competition between the grass species and seedling trees and shrubs.

Regrowth problems may become very costly where the problem is not recognised in the early stage, or a lack of funds prevents treatment at the opportune time.

4.1.5 PASTURE DEGRADATION

Degraded pastures are found throughout the area, particularly in the Wutul land system.

Cotton bush *(Kochia spp.)* is a common invader of these areas. Many degraded areas are in close proximity to old dairies and yards where heavy grazing has occurred. Cotton bush has also invaded many of the areas of severely eroded cultivation which have reverted to native grasses. Couch grass *(Cynodon dactylon)* and pitted blue grass *(Bothriochloa decipiens)* are commonly found in these areas.

Many examples of degraded pastures occur in grazing areas. Pitted blue grass and wire grasses *(Aristida spp.)* are often dominant in the grazed areas while better quality kangaroo grass *(Themeda australis)* dominates on road and railway reserves which have not experienced heavy grazing. Examples are found on the Pidna, Gilla and Trevanna land systems. It is anticipated that most other land systems would exhibit a similar change in native species due to grazing if the ground flora were studied in more detail.

Pasture degradation can be related to excessive grazing pressure, indiscriminate use of fire and decreased soil fertility due to erosion.

Many areas of sown pastures, have deteriorated rapidly. This has resulted from the wrong choice of species, early heavy grazing on new pastures or continuous heavy grazing preventing the pasture setting seed for future persistence.

4.2 RECOMMENDED CORRECTION AND/OR PREVENTION METHODS

It is possible to reclaim or prevent almost all forms of degradation occurring in this area. Many of the methods or techniques which would have to be used to provide complete reclamation or prevention may not be economically feasible. Local soil conservation officers should be contacted for advice regarding practices to control degradation.

4.2.1 GULLY EROSION

Pastures are recommended to help reclaim severely eroded cultivation areas. Where possible gully lines should be filled. However this may not be practicable or economical where large gullies have formed.

Mechanical soil conservation measures may also be required to achieve stability of the filled gullies and steeply sloping land until pastures become established. Cultivation is the most successful means of establishing improved pastures. Nitrogen and in most cases phosphorus fertilizers will be necessary to boost pasture growth on these degraded areas. Species recommended for the Wutul land system include Rhodes grass, green panic, kikuyu and lucerne. Rhodes grass, buffel grass, kikuyu and lucerne may be more suitable on the East Cooyar land system.

Many of these gullies, in cultivated areas, could have been prevented by early recognition that these areas were never really suited to continuous cultivation. Application of soil conservation measures to those cultivation areas with a high erosion potential may have prevented gully erosion.

In the grazing areas it is not economical to fill gullies. Severely eroded areas should be fenced to allow re-vegetation to occur. In some cases, rocks dumped at the head of the gully may help trap silt as well as prevent headwards movement of the gully. Where possible grasses such as kikuyu and Rhodes grass should be established to help bind the soil.

Many gullies in grazing areas could have been prevented by allowing trees and shrubs to remain in the channel lines and banks and avoiding overgrazing in the surrounding catchments. Maintenance of sufficient ground cover in the surrounding catchments to prevent excessive runoff is a major factor in preventing erosion.

Gullies associated with road construction may have been prevented by using more care in choosing the site and location of cross drainage points. Construction of cross drainages to prevent a waterfall action occurring is very important as is location of the road itself to prevent excessive diversion of natural water flows.

4.2.2 TREE AND SHRUB REGROWTH

Many of the problem areas with tree and shrub regrowth are on shallow unproductive soils on steep slopes. These communities may have been more valuable in reducing runoff and hence erosion downstream than in the small and often short lived pasture production achieved when cleared. It is recommended that these types of areas should not be cleared and the presently cleared areas be allowed to revert to the native species.

When clearing is justified, regrowth should be controlled by using mechanical or chemical means before it becomes dense enough to reduce pasture growth and vigour.

Continued over grazing will reduce pasture vigour and encourage tree and shrub regrowth.

Selective use of fire as a means of suppressing regrowth in pasture areas together with a managed grazing system is recommended (Tothill 1971).

4.2.3 SALINITY

Reclamation of saline areas would not be economically feasible in most cases in this area. Drainage using underground and surface drains would only be considered where saline areas were occurring around farm buildings or where they affected water supplies.

Establishment of salt tolerant grass species such as *Pancium coloratum* may help lower the water table. However as the major cause appears to be over clearing of trees on the upper slopes the problem will most likely remain until these areas are revegetated by trees. This is unlikely to occur until the saline areas become large enough to significantly affect agricultural areas.

4.2.4 LAND SLIPS

Most land slips would not have occurred if the steep slopes had not been cleared of trees.

Land slips are difficult to reclaim. Planting of trees and grasses on the land slips may help stabilise the area. Planting of trees would not be economical because of the low value of the land however re-vegetation with native regrowth should be allowed to occur.

Consideration could be given to converting these steep land slip prone areas, such as parts of the Palms land system, to forest plantations. Harvesting of timber on these steep slopes would prove difficult, however re-afforestation of these areas may help reduce runoff

and hence erosion further downstream as well as having beneficial effects in reducing salinity in the lower slope positions of the landscape.

4.2.5 PASTURE DEGRADATION

Pasture composition and quality can be maintained by employing stocking rates suitable to the type of country and production possible. Most areas appear to be overstocked. Inadequate farm fencing results in little or no grazing management. A system of grazing management including rotational grazing to allow pastures to set seed and seedlings to establish is essential to maintain desirable species.

Fire is a necessary management tool but it should not be used indiscriminantly each year in an attempt to achieve fast green growth following rain.

Improved pastures should also be rotationally grazed with fertilizer being applied as necessary to maintain productivity, quality, and species. Native grass species will invade these pastures quickly if they are overgrazed or fertility is not maintained.

5. CONCLUSIONS

5.1 AGRICULTURAL LAND

Further study is required and justified on the agricultural areas, particularly the Upper Yarraman land system, to adequately define the soils, their properties and management requirements.

The main agricultural areas of the Upper Yarraman and Kooralgin land systems should be used according to their capability. Soil conservation measures should be applied where necessary and stubble mulching and minimum tillage are recommended with the aim of increasing moisture accumulation, reducing erosion and building up soil chemical and physical properties.

Steep eroding cultivation areas, particularly in the Wutul land system, would be best planted to pastures. Soil conservation measures are required if cultivation is to continue and a pasture phase would be desirable to help maintain stability.

Vegetable growing could be investigated as an alternative enterprise on parts of the Kooralgin land system where irrigation is available.

5.2 PASTORAL LAND

The beef cattle industry in this area is based primarily on utilisation of native pastures. Fodder crops are used in the fattening programme where ever possible. Expansion of the beef industry will depend on establishment and utilisation of more productive pastures. There are areas in almost all land systems which are suitable for improved pastures. Species recommended include Rhodes grass, green panic, buffel grass, kikuyu, siratro and lucerne.

Excessive grazing pressures which currently exist should be reduced in an attempt to maintain long term productivity and reduce soil erosion. Improved pastures require a managed grazing system in conjunction with fertilizer applications to ensure vigour and productivity are maintained. Consideration should be given to more internal fencing which will enable better grazing management to be achieved.

Severely eroded gully areas should be filled where practicable and vegetation cover established. Grazing animals can be excluded by fencing and allowing the areas to re-vegetate.

Clearing should not be carried out on drainage lines and any tree and shrub regrowth along these areas should be retained to aid in stabilisation.

Further clearing is not warranted in most of the study area. In fact over-clearing has taken place particularly on those areas with very steep slopes and shallow often rocky soils.

Over-clearing is the major cause of land slips in the Palms land system and one of the main causes of the outbreaks of salinity in the Upper Yarraman land system.

Regrowth of trees and shrubs do not warrant control on slopes over 20% and on very shallow rocky soils. These areas are more valuable as watershed protection areas.

Tree and shrub regrowth should be controlled early on those areas suitable for clearing. Neglect may lead to pasture degradation which may be expensive in terms of lost productivity and subsequent treatment costs.

Indiscriminate use of fire should be discouraged however the correct use of fire as a management tool may play an important part in maintaining pasture productivity.

5.3 FORESTRY AND PARK RESERVES

Consideration should be given to including the very steep portions of the Palms land system as State Forest. Re-afforestation of these areas should prevent land slips as well as reducing runoff and erosion further downstream. Re-afforestation may also have a beneficial effect in preventing expansion of, or reducing the saline areas occurring in the Upper Yarraman land system.

The Fair Hill land system could be considered for inclusion as a National Park or a flora and fauna reserve. It has many interesting rock outcrops, including columnar tuff, which would provide a suitable area as a flora and fauna reserve. It has only a low grazing potential.

Preservation of areas of natural vegetation which currently exist in the State Forest reserves is encouraged as future scientific and aesthetic reference areas.

5.4 SURVEY TECHNIQUES

It appears that the land system approach is adequate for recognition and description of the types of grazing land in the Cooyar area. It is doubtful if mapping on a more detailed scale would be warranted. However, description of the individual land units within the land systems is important.

The assessment of degradation based on land systems appears quite successful. More detailed work would be justified on the ground flora in future surveys to adequately describe the degradation of the pasture types.

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APPENDIX I

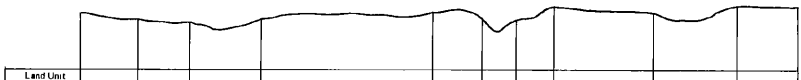
LAND SYSTEMS

1	Kooralgin
2	Upper Yarraman
3	Blackbutt
4	Trevanna
5	Wutul
6	Fair Hill
7	East Cooyar
8	Mt. Binga
9	Tarong
10	Palms
11	Cooyar
12	Pidna
13	Gilla
14	Back Creek
15	Rocky Creek

1. KOORALGIN LAND SYSTEM (3164 HA)

Landform: Flat alluvial plains
Geology: Recent alluvia. Qa.
Soils: Predominant soils are deep, dark, cracking clays and minor areas of texture-contrast soils.
Vegetation: Predominantly Queensland blue gum grassy open woodland with scattered gum topped box and broad-leaved apple. Some weeping bottle brushes and river oaks occur along channel lines. Largely cleared and cultivated.

(Data on this land system are very general and further study is required to provide more specific information).



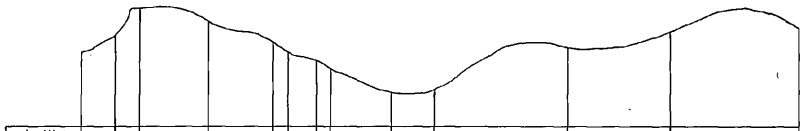
Land Unit and/or Land Systems	4	1	2	1	5	Creek	3	1	2	1
Described Site	109	42		70	49					

Land Unit	Est. % Area	Soils	Vegetation	Landform	Land Capability Class
1	75	Deep to very deep soils. Black to brownish black, cracking clays. Ug 5.12. Neutral to alkaline soil reaction trend.	Queensland blue gum grassy open woodland	Plain, valley floor. Less than 1% slope.	II f_2, w_2
2	13	Deep to very deep soils. Brownish black, cracking clays becoming browner with depth. Ug 5.15, Ug 5.13. Neutral to alkaline soil reaction trend.	Broad-leaved apple and gum topped box grassy open woodland.	Swales and old drainage lines. Less than 1% slope.	III f_2, w_{2-3}.
3	5	Deep to very deep soils. Brownish black, cracking clay soils. Some sand and gravel throughout profile. Ug 5.12, Ug 5.13. Neutral soil reaction trend.	Queensland blue gum grassy open woodland with some river oaks and weeping bottle brushes.	Terraces of drainage lines. Less than 2% slope to greater than 8% slope.	IV-VI f_3, t_4, g_3.
4	5	Moderately deep to deep soils. Brown cracking clays, Ug 5.34, or texture - contrast soils with a dark clay loam over brown or yellow brown clays. Dy 2.12, Db 1.12. Neutral soil reaction trend.	Gum-topped box grassy open woodland	Plains, slightly elevated above valley floor. 1-3% slope.	III k_3, e_2.
5	2	Deep to very deep soils. Black and brownish black, cracking clays. Ug 5.12, Ug 5.13. Neutral soil reaction trend.	Queensland blue gum grassy open woodland	Plains, alluvial levee bank. 1-3% slope.	III - IV f_{2-3}, k_3, e_2.

2. UPPER YARRAMAN LAND SYSTEM (13 102 HA)

Landform:	Undulating plateau and plateau remnants.
Geology:	Dissected lateritized basalts. Tm. Minor exposures of Tertiary basalts and Jurassic sandstones also occur.
Soils:	Predominantly moderately deep to deep, red, structured earths with minor areas of yellow earths.
Vegetation:	Varies from Blackbutt, stringybark, tallowwood, bloodwood and Sydney bluegum open forest to closed forests of "scrub species" with hoop pine. Wattle understoreys often occur. Extensively cleared and cultivated.

(Data on this land system are very general and further study is required to provide more specific information.)

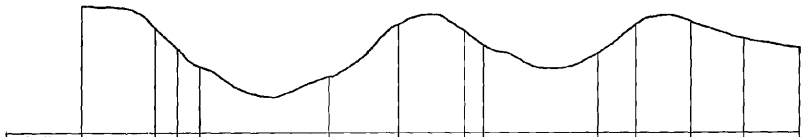


Land Unit and/or Land Systems	Palms	7	1	3	5	2	5	3	6	1	4	2
Described Site			111	110					113		112	

Land Unit	Est. % Area	Soils	Vegetation	Landform	Land Capability Class
1	35	Deep soils. Very dark reddish brown clay loams grading into dark reddish brown or reddish brown light to medium clays. Gn 2.11, Gn 3.11. Acid soil reaction trend. Some lateritic gravel may occur in the profile.	Predominantly "scrub species" closed forest with some hoop pine and narrow-leaved ironbark.	Broad ridge crests and some lower slope positions. 3 - 6% slope	II - III e_{2-3}
2	25	Deep soils. Very dark reddish brown light clays, or clay loams (sometimes smuffy) over dark reddish brown or reddish brown light to medium clays. Uf 6.12, Gn 2.41, Gn 4.11. Acid soil reaction trend.	Blackbutt, tallowwood, white bloodwood, brush box and scattered grey gum,narrow-leaved ironbark and forest she-oak open forest to layered open forest.	Broad ridge crests and lower slope positions. 3-6% slope	II-III e_{2-3}
3	20	Deep soils. Dark reddish brown clay loam grading into dark red or dark reddish brown light to medium clays. Gn 3.11, Gn 2.11, Gn 2.12. Acid soil reaction trend.	Mixed area of grey gum, small fruited grey gum, blackbutt, tallowwood, bloodwood and "scrub species", open forest to layered open forest. Scattered narrow-leaved ironbarks. Qld blue gum and hoop pine may occur.	Mid and lower slope positions. 6-8% slope.	III-IV e_{3-4}
4	10	Deep soils. Very dark reddish brown light clays grading into dark reddish brown medium to heavy clays at depth. Lateritic gravel may occur throughout the profile. Uf 6.12, Gn 2.41. Acid soil reaction trend.	Grey gum, Queensland blue gum, narrow-leaved ironbark and scattered other species, open forest.	Upper slope positions and some depression areas. 1-4% slope.	II - III e_2, w_2.
5	4	Shallow to moderately deep soils. Dark reddish-brown clay loams over light clays. Frequently associated with laterite outcrops. Gn 3.12, Gn 3.11. Neutral to acid soil reaction trend.	"Scrub species" closed forest with scattered grey gum and narrow-leaved ironbark.	Mid slope positions. 6-8% slope and steeper.	IV - VI e_{3-4}, d_3
6	3	Deep soils. Brownish black to dark reddish-brown light clays over brownish grey or greyish brown medium to heavy clays. Gn 3.93, Uf 6.12. Alkaline to neutral soil reaction trend.	Queensland blue gum, grey gum and broad-leaved apple open forest.	Drainage lines and lower slope positions. 1-4% slope.	IV - VI e_2,s_2, w_{3-4}.
7	3	Moderately deep soils. Brownish black to very dark reddish brown clay loams and light clays over dark reddish brown clays. Some surface stone. Um 6.13, Gn 2.42, Gn 4.11. Acid soil reaction trend.	"Scrub species" closed forest. Scattered hoop pine, grey gum and narrow-leaved ironbark.	Steep eroding scarps. 10-20% slope or steeper.	VII - VIII e_{6-7}, t_7, d_3,

3. BLACKBUTT LAND SYSTEM (777 HA)

Landform:	Hills with some deeply dissected terrain.
Geology:	Complex areas of fresh Tertiary basalt mixed with lateritized basalt and minor Jurassic sandstones. Tm/Jm
Soils:	Predominant soils are shallow brown and black clays with areas of gradational red earths and texture-contrast soils.
Vegetation:	Narrow-leaved ironbark, grey gum and gum-topped box layered open forest to closed forest of "scrub species". Partially cleared and planted to exotic species.

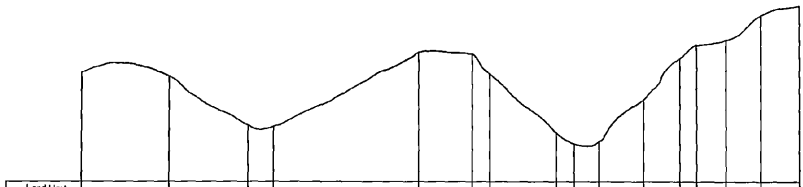


Land Unit and/or Land Systems	Upper Yarraman	1	4	3	2	1	4	2	4	1	3	Back Creek
Described Site			.									

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	30	Shallow to moderately deep soils. Brownish black or brownish grey clays. Ug 5.13, Ug 5.14. Neutral soil reaction trend.	Narrow-leaved ironbark, grey gum and "scrub species" layered open forest.	Upper slopes and hill crests. 5-10% slope.	VI e_6, d_{3-4}.
2	30	Moderately deep to deep soils. Brownish black clays, Ug 5.13, Ug 5.14, mixed with reddish brown clays. Ug 5.37. Some basalt and laterite rocks occur. Neutral soil reaction trend.	"Scrub species" and minor narrow-leaved ironbark and grey gum closed forest.	Mid to lower slope positions. 6-12% slope.	VI-VII e_{6-7}, d_3
3	30	Shallow to moderately deep soils forming a complex of brownish grey and light grey loams and light clays. Um 5.41, Uf 1.41. Neutral soil reaction trend.	"Scrub species" with scattered hoop pines and narrow-leaved ironbark closed forest.	Mid and lower slope positions. 6-12% slope.	VI-VII e_{6-7}, d_{3-4}.
4	10	Shallow to moderately deep soils. Reddish brown loams to light clays over red clays. Uf 1.41, Ug 5.37, Um 5.41, Dr 2.12. Acid to neutral soil reaction trend. Considerable laterite gravel occurs in profile in places.	"Scrub species" with scattered hoop pines and narrow-leaved ironbark, closed forest.	Mid to upper slope positions. 10-17% slope.	VII t_{6-7}, e_{6-7} d_{3-4}.

4, TREVANNA LAND SYSTEM (12 513 HA)

Landform: Mountainous to hilly terrain.
Geology: Predominantly basalt of the Main Range Volcanics. Tm.
Soils: Major soils are shallow, stony, loamy lithosols to moderately deep to deep, dark, cracking clays.
Vegetation: Narrow-leaved ironbark, grey gum, Queensland blue gum grassy open woodland to woodland and areas of closed forest of "Scrub species". Partially cleared.

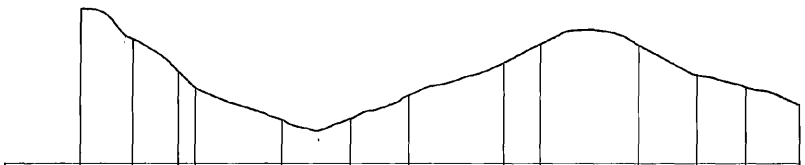


Land Unit and/or Land Systems	1	4	5	1	3	6	2	6	5	2	7	3	1	2	3
Described Site	86,28	19,20,21		10	91,92		25,18					48	47	93	9,22,53

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	30	Shallow to moderately deep soils. Brownish black uniform cracking clays. Often becoming browner with depth. Occassional basalt stone in profile. Ug 5.13, Ug 5.12. Neutral to alkaline soil reaction trend.	Narrow-leaved ironbark with scattered Queensland blue gum, grey gum and wattles, grassy open woodland.	Mid and upper slope positions and occassional ridge crests. 5-8% slope	IV - VI d_3, e_{3-4}, r_{3-4}
2	25	Moderately deep to deep soils. Brownish black, cracking clays frequently becoming brown or mottled brown with depth. Ug 5.12, Ug 5.13. Neutral to alkaline soil reaction trend. Stone often occurs on and in the profile.	Narrow-leaved ironbark, grey gum and grass tree, grassy open woodland.	Mid and lower slope positions. 12-25% slope or steeper in some areas.	VI-VII d_2, t_{6-7}, e_{6-7} r_{3-4}.
3	20	Shallow to very shallow soils. Brownish black or dark brown clays and light clays overlying decomposing basalt. Basalt stone occurs in and on the profile. Ug 5.32. Neutral soil reaction trend.	Narrow-leaved ironbark with scattered grey gum, gum topped box and grass trees, open woodland and occasional "Scrub species".	Flat topped hills and bread ridges and rock outcrops in mid slope positions. 1-5% slope.	VI d_{4-6}, r_4, e_2
4	10	Deep soils. Brownish black to black cracking clays becoming brown to dark brown with depth. Linear gilgai frequently occurs. Calcium carbonate occurs throughout the profile. Ug 5.13, Ug 5.33. Alkaline soil reaction trend.	Narrow-leaved ironbark, open woodland to grassy open woodland.	Mid to lower colluvial slopes. 3-6% slope.	III e_{2-3}
5	5	Deep soils. Brownish black cracking clays becoming greyish brown with depth. Ug 5.14. Neutral to alkaline soil reaction trend.	Queensland blue gum, broad-leaved apple, river oaks and wattles, grassy open woodland.	Valley floors and minor drainage lines. 0-2% slope.	II - III e_2, f_2
6	5	Shallow to moderately deep soils. Reddish brown and dull reddish brown gradational textured soils. Frequently associated with laterite outcrops. Gn 3.12, Gn 3.11. Neutral to acid soil reaction trend.	"Scrub species" with some narrow-leaved ironbark, closed forest.	All slope positions but frequently on upper eroding scarps or at base of slopes. 10-15% slope or steeper.	VII d_{3-4}, e_6, t_6
7	5	Shallow to moderately deep soils. Dark brown to greyish yellow brown clays over decomposing basalt. Basalt stone occurs on the surface and in the profile. Ug 5.22 Ug 5.32. Neutral soil reaction trend.	Narrow-leaved ironbark and grey gum, open woodland to low closed forest of "scrub species" and wattles.	Mid and lower slope positions. 15-25% slope or steeper.	VII - VIII t_{7-8}, d_3, e_{6-7}.

5. WUTUL LAND SYSTEM (2776 HA)

Landform: Undulating to hilly terrain.
Geology: Complex area of Tertiary basalt of the Main Range Volcanics and Jurassic shales and sandstones with some areas of lateritized basalts. Tav/Jm.
Soils: Major soils are shallow to moderately deep dark brown to greyish brown clays with areas of lithosols and loamy surfaced texture-contrast soils with yellowish clay subsoils.
Vegetation: Belah, brigalow or narrow-leaved ironbark open forests with areas of closed forest of "scrub species". Largely cleared and in some cases cultivated.

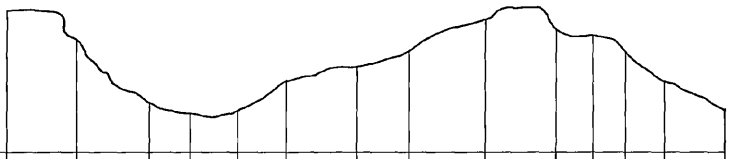


Land Unit and/or Land Systems	Trevanna	1	7	3	6	5	1	4	2	3	4	6
Described Site		2		8	12	11,38	37	39	1,31,36	34,35		

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	25	Moderately deep to deep soils. Brownish black to brown clays becoming brown or yellowish brown with depth. Some basalt stone on surface. Ug 5.13. Neutral soil reaction trend.	"Scrub species" closed forest with some narrow-leaved ironbark, gum topped box and hoop pine. A lantana understorey commonly occurs.	Mid and upper slope positions. 5-8% slope.	IV - VI d_2, m_2, e_{4-6}
2	20	Moderately deep to deep soils. Brownish black to brown clays becoming brown or yellowish brown over decomposing parent material. Ug 5.13, Ug 5.32. Neutral to acid soil reaction trend.	"Scrub species" closed forest with scattered narrow-leaved ironbark and lantana areas.	Broad ridge tops - frequently rounded. 3-6% slope.	IV d_2, m_2, e_{3-4}
3	20	Moderately deep soils. Brownish black or brown sandy loam to light clays, frequently a bleached A2 horizon over a bright brown or orange clay. Dy 2.42, Ug 5.13, Ug 5.32. Neutral to acid soil reaction trend.	"Scrub species" closed forest with scattered narrow-leaved ironbark, bottle tree, and belah with some lantana occurring.	Mid and lower slope positions. 5-8% slope.	IV - VI d_{2-3}, m_2, e_{4-6}
4	15	Moderately deep to deep soils. Brownish black loam or sandy loam overlying reddish brown or yellowish brown clay subsoil. Dy 3.22, Db 2.22. Neutral soil reaction trend.	"Scrub species" closed forest with scattered narrow-leaved ironbark, belah and bottle trees.	Mid and lower slope positions. 5-8% slope.	IV-VI e_{4-6}
5	15	Moderately deep to deep soils. Brownish black or brownish grey clays becoming brown or yellowish brown with depth. Ug 5.13, Ug 5.15, Ug 5.23. Alkaline soil reaction trend.	Brigalow with scattered belah, open forest. "Scrub species" may also occur.	Lower slope positions. 3-6% slope.	IV d_2, m_2, e_{3-4}
6	4	Moderately deep to deep soils. Brownish black clays becoming greyish yellow brown with depth. Ug 5.12, Ug 5.14. Alkaline soil reaction trend.	Belah open forest with scattered narrow-leaved ironbark and Queensland blue gum.	Lower slopes and alluvial valley floors. 0-2% slope.	II f_2, w_2
7	1	Shallow to moderately deep soils. Reddish brown and dull reddish brown gradational textured soils. Frequently associated with laterite outcrops. Gn 3.12, Gn 3.11. Neutral to acid soil reaction trend.	"Scrub species" closed forest with some narrow-leaved ironbark.	All slope positions but frequently on mid and upper slopes. 10-15% slope and steeper.	VII - VIII d_{3-4}, t_{6-7}, m_6 e_{6-7}

6. FAIR HILL LAND SYSTEM (773 HA)

Landform: Hills to deeply dissected terrain.
Geology: Agglomerate and tuff of the Nutgrove Agglomerate Member. Tmn. Some small areas of rhyolite. Tr.
Soils: Vary from rock outcrops to shallow, stony, loamy, lithosols to moderately deep loamy surfaced texture-contrast soils with dark clay subsoils.
Vegetation: Narrow-leaved ironbark, brush box, stringybark, bloodwood and gum topped box open forest with areas of closed forest of "scrub species" and wattles. Partially cleared.



Land Unit and/or Land Systems	1	3	2	6	2	3	4	2	1	4	3	2	5
Described Site	5,95		3		97		95		4,23			6	7

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	25	Rock outcrops to very shallow, stony, brownish black lithosols. Um 1.42, Um 1.41, Um 1.44. Neutral soil reaction trend.	Brush box, white stringybark, pink bloodwood with some wattles, dogwood and "scrub species" open forest to layered open forest.	Broad ridge crests and rocky scarps. 1-5% slope to greater than 100% on scarps.	VII-VIII r_5, d_6, m_6, t_{7-8}
2	25	Moderately deep soils with shallow, brownish black, loamy or light clay A horizons over brownish black and black clays. Dd 1.13 Uf 5.11. Alkaline soil reaction trend.	Brush box, narrow-leaved ironbark and gum topped box open forest.	Mid and lower slope positions. 4-8% slope.	VI d_{2-3}, m_{3-4}, e_{4-6}
3	25	Shallow to very shallow, brownish black loamy lithosols. Frequently covered with surface stone and rubble. Um 1.41, Um 1.42. Neutral soil reaction trend.	Brush box, narrow-leaved ironbark with "scrub species" layered open forest.	Mid and upper slope positions and bench positions of rock outcrops. 8-10% and steeper slopes.	VIII d_6, m_6, r_5, t_{6-8}
4	15	Moderately deep to deep texture-contrast soils with brownish black to black loamy A horizons over brownish black medium to heavy clays. Dd 1.13 Dd 1.22 Dd 1.23. Neutral to alkaline soil reaction trend.	Gum topped box, narrow-leaved ironbark and brush box open forest.	Mid slope positions. Often above rock outcrops. 3-6% slope.	IV - VI d_{2-3}, m_{3-4}, e_{3-4}
5	5	Moderately deep to deep texture-contrast soils with shallow, loamy brownish black A horizons, bleached A2 horizons over brownish grey clays. Dy 2.41, Dy 2.42. Neutral to acid soil reaction trend.	Gum topped box open forest with occassional narrow-leaved ironbark.	Lower slope positions. 3-6% slope.	III - IV d_{2-3}, m_{3-4}, e_{3-4}
6	5	Deep soils. Brownish black clays becoming browner with depth. Ug 5.13, Ug 5.15. Neutral to alkaline soil reaction trend.	Queensland blue gum, broad-leaved apple, with scattered gum-topped box and narrow-leaved ironbark open forest.	Drainage lines and minor water courses. 1-3% slope	II-III e_{2-3}, w_2

7. EAST COOYAR LAND SYSTEM (3856 HA)

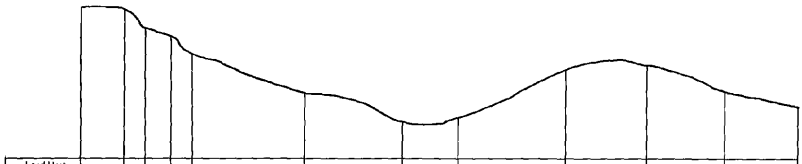
Landform: Low hilly terrain.
Geology: Sandstones and shales of the Marburg Formation. Jm.
Soils: Predominantly texture-contrast soils with sandy-textured A horizons over yellowish brown and dull yellowish-brown, clay subsoils.
Vegetation: Narrow-leaved ironbark and/or gum-topped box open forest. Areas of Queensland blue gum also occur. Predominantly cleared.

Land Unit and/or Land Systems	Trovanna or Wutul	1	2	3	5	3	4	1	2	4
Described Site			59,30	32,33		43	41,26,40		60,58	

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	30	Rock outcrops to shallow, brownish-black, sandy loam, lithosols to shallow texture-contrast soils with dark brown or dull yellowish brown, clay subsoils. Um 6.12, Um 6.11, Dy 4.12. Neutral soil reaction trend.	Gum-topped box and/or narrow-leaved ironbark open forest.	Broad ridge crests and steep upper slope positions. 8-10% slope.	VII-VIII d_{4-6}, t_{5-7}, r_6, e_7
2	30	Moderately deep texture-contrast soils with brownish-black, sandy loam or loamy A horizons, bleached A_2 horizon, over brown or yellowish brown clay subsoils. Dy 2.42 Dy 3.42, Dy 2.43. Neutral to alkaline soil reaction trend.	Gum-topped box with scattered narrow-leaved ironbark open forest.	Mid to upper slope positions. 6-8% slope.	IV-VI d_{3-4}, m_{3-4}, e_{4-6} k_2
3	25	Moderately deep to deep texture-contrast soils with brownish-black to dark brown, sandy loam or loam, A horizon, bleached A_2 horizon over bright yellowish brown or dull yellow orange clays. Dy 3.41, Dy 3.42. Acid to neutral soil reaction trend.	Gum-topped box open forest with scattered narrow-leaved ironbark.	Lower slope positions. 3-6% slope.	IV d_{3-4}, m_3, e_{3-4} k_2
4	10	Moderately deep to deep texture-contrast soils with brownish-black to dark brown sandy loam to loam A horizons, bleached A_2 horizons over red, reddish-brown or dull yellowish-brown clays. Dr 2.33, Dy 3.43, Dy 3.33. Alkaline soil reaction trend.	Gum-topped box open forest with scattered narrow-leaved ironbark and Queensland blue gum.	Mid and lower slope positions. 5-7% slope.	IV d_{2-3}, m_3, k_2 e_{3-4}
5	5	Deep texture-contrast soils with dark brown or dull yellowish-brown sandy loam or loam A horizons, frequently bleached A_2 horizons, over brown or yellowish brown clays. Dy 2.42, Dy 2.43, Dy 3.43. Small areas of dark uniform clays occur. Ug 5.13. Alkaline soil reaction trend.	Gum-topped box, Queensland blue gum and broad-leaved apple open forest.	Drainage lines and minor watercourses. 1-3% slope.	II-III e_{2-3}, k_2

8. MT BINGA LAND SYSTEM (3885 HA)

Landform: Low hills to hilly terrain.
Geology: Sandstones, shales and conglomerates of the Woogaroo Sub Group. R-Jw
Soils: Major soils are coarse sandy lithosols, shallow uniform coarse sands and moderately deep texture-contrast soils with yellowish-brown clay subsoils.
Vegetation: Broad-leaved ironbark, pink and white bloodwood, white mahogany, broad-leaved stringybark, grey gum with areas of narrow-leaved ironbark, rusty gum and gum-topped box with an understorey of wattles and black she-oaks, open forest to layered open forest. Partially cleared or logged.

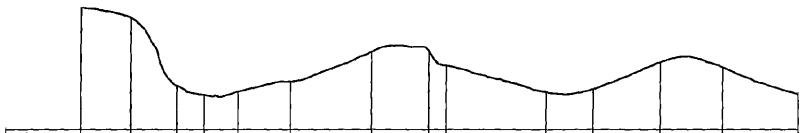


Land Unit and/or Land Systems	2	5	2	6	1	3	6	1	2	4	3
Described Site	61				66,101	63	62	64,100		102	

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	30	Shallow to moderately deep soils. Brownish-black to brownish-grey, loamy, coarse sands over greyish-yellow brown or dull yellowish-orange coarse sands. Uc 1.21, Uc 1.22. Neutral to acid soil reaction trend.	Broad-leaved ironbark with rusty gum, white mahogany and scattered Moreton Bay ash, narrow-leaved ironbark and wattles, open forest.	Mid and upper slope positions. 5-8% slope.	VI d_3, m_{4-6}, k_2 e_{2-3}
2	25	Frequently very stony or rock outcrops, or very shallow brownish-black to brownish-grey, loamy sand, lithosols. Uc 1.21. Acid soil reaction trend. Small areas of Dy 3.32 soils also may occur.	Broad-leaved ironbark, white mahogony, pink and/or white bloodwood, with scattered grey gum, gum-topped box, grass trees, and wattles, layered open forest.	Upper slopes and broad or flat ridge crests. 3-6% slope.	VI-VII d_{4-6}, m_6, r_5 e_{6-7}
3	25	Moderately deep to deep uniform coarse sands. Brownish-grey surface becoming light grey to bright yellow orange with depth. Uc 1.21, Uc 1.22. Neutral to acid soil reaction trend.	Narrow-leaved ironbark, rusty gum, and black she-oaks with scattered white mahogany, broad-leaved ironbark and wattles, open forest to layered open forest.	Lower slope positions. 3-6% slope.	IV-VI d_2, m_4, k_{2-3}, e_{4-6}
4	15	Moderately deep texture-contrast soils with brownish-black, loamy sand, A horizons over yellowish-brown clay subsoils. Dy 3.32, Dy 2.32, Dy 4.11. Neutral soil reaction trend.	Narrow-leaved ironbark with rusty gum, brush box, grey gum and scattered she-oaks, dogwood and wattles. Open forest.	Mid slope positions. 5-8% slope.	IV-VI d_{2-3}, m_4, k_{2-3}, e_{4-6}
5	4	Steep rock outcrops and scarps. Shallow loamy sand, lithosols occasionally occur. Uc 1.21. Acid soil reaction trend.	Broad-leaved ironbark, white mahogany, broad leaved stringybark, white bloodwood, black she-oak, with occasional narrow-leaved ironbark, pink bloodwoods and wattles. Open forest to layered open forest.	Upper slopes and scarps. 12 - 15% slope and steeper.	VIII d_6, m_6, t_{7-8} r_5, e_7
6	1	Moderately deep to deep, uniform, coarse sands (similar units 1 & 3) with some areas of texture-contrast soils with dark loamy sand A horizons over yellowish brown clays. Neutral to alkaline soil reaction trend.	Queensland blue gum, broad-leaved apple, grey gum with occasional gum topped box, native cherry and wattle. Open forest.	Minor drainage lines and lower slope positions. 1-3% slope.	II-III d_2, m_2, k_2, e_{2-3}

9. TARONG LAND SYSTEM (4847 HA)

Landform: Low hills to hilly terrain.
Geology: Sandstone and conglomerate of the Lower Tarong Beds. Rut.
Soils: Predominantly moderately deep, texture-contrast, soils with dark, loamy, A horizons over reddish-brown to yellowish-brown clays and areas of stony brownish-black and brownish-grey loamy lithosols.
Vegetation: Narrow-leaved ironbark open forest with areas of Moreton Bay ash, Queensland blue gum, gum-topped box, grey gum and broad-leaved ironbark and areas of dogwood and wattles. Extensively cleared or timber treated.

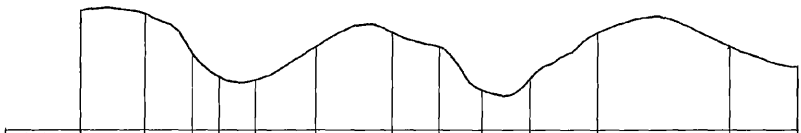


Land Unit and/or Land Systems	1	4	3	5	3	2	1	4	3	5	2	1	3
Described Site					107	108,69	67		68	65			99

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	30	Shallow to moderately deep texture - contrast soils. Dark brown, frequently stony, sandy loam to loam A horizon, bleached A_2 horizon, over reddish-brown or bright brown clays. Dy 3.31, Dr 3.31. Acid soil reaction trend.	Narrow-leaved ironbark open forest with scattered Moreton Bay ash, rusty gum, and black she-oak, dogwood and wattles.	Ridge crests and upper slope positions. 4-8% slope.	VI-VII d_3, m_{3-4}, k_{2-3}, e_{4-6}.
2	25	Moderately deep texture-contrast soils with brownish-black, sandy loam A horizons, bleached A_2 horizons (often stony or gravelly) over bright brown or orange clays. Dy 3.32, Dy 3.42, Dy 3.41. Neutral soil reaction trend.	Narrow-leaved ironbark and gum topped box open forest with scattered "scrub species".	Mid and upper slope positions. 6-10% slope.	VI-VII d_3, m_3, k_{2-3}, e_6
3	25	Moderately deep to deep texture-contrast soils with brownish-black, loamy, frequently stony, A horizons, bleached A_2 horizons, over yellowish-brown to bright yellowish-brown clays. Dy 3.42, Dy 3.32. Neutral soil reaction trend. Some areas of red gradational soils also occur.	Narrow-leaved ironbark open forest with scattered gum-topped box, Queensland blue gum and grey gums.	Mid to lower slope positions. 4-6% slope.	IV-VI d_{2-3}, m_3, k_{2-3} e_{4-6}
4	15	Steep rock outcrops and scarps with shallow, brownish-black, loamy or sandy loam lithosols. Uc 1,21, Um 6.12, Um 6.11. Neutral soil reaction trend.	Narrow-leaved ironbark with some grey gum, gum-topped box and broad-leaved ironbark, open forest. Understorey species of black she-oak, dogwood and wattles occur.	Steep scarps and rock outcrops on upper slope positions. 15-30% slope or greater.	VIII d_{4-6}, m_6, r_5, t_{7-8}, e_{7-8}.
5	5	Deep soils with brownish-black loams or light clays over yellowish-brown clays. Some minor linear gilgai may occur. Db 3.13, Ug 5.13, Ug 5.15, Ug 5.34. Alkaline soil reaction trend.	Gum-topped box, Queensland blue gum, grey gum, broad-leaved apple and narrow-leaved ironbark open forest.	Valley floors and minor drainage lines. 1-4% slope.	III d_2, m_2, s_2, e_{2-3}.

10. PALMS LAND SYSTEM (4010 HA)

Landform: Hills to deeply dissected terrain.
Geology: Shales, coal seams, sandstones and conglomerates of the Upper Tarong Beds. Rut.
Soils: Vary from shallow, stony, brownish-black lithosols to moderately deep, brown or yellowish-brown clays or texture-contrast soils with yellowish-brown clay subsoils.
Vegetation: Predominantly "scrub species: closed forest with areas of layered open forest of narrow-leaved ironbark, grey gum and gum-topped box with an understorey of lantana and "scrub species". Extensively cleared.

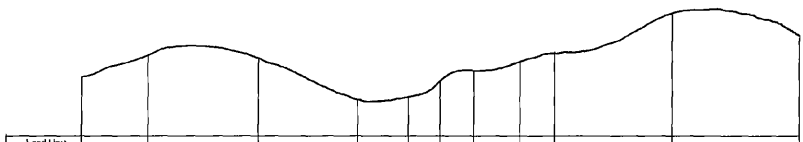


Land Unit and/or Land System	Upper Yarraman	3	4	6	4	1	2	3	6	2	1	5
Described Site					71	57						

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	30	Shallow to moderately deep soils. Brownish black, light to medium clays becoming yellowish-brown or bright brown at depth. Some stone occurs on the surface and in the profile. Ug 5.12, Ug 5.13. Neutral to acid soil reaction trend.	"Scrub species" closed forest often with lantana mixed throughout.	Ridge crests and upper slope positions. 5-8% slope.	VI- VII d_{4-6}, m_6, e_{6-7}.
2	20	Shallow to moderately deep soils. Brownish black, light to medium clays becoming yellowish-brown or bright brown at depth. (similar to land unit 1) Ug 5.12, Ug 5.13 Acid soil reaction trend.	"Scrub species" closed forest with scattered crow's ash and narrow-leaved ironbark. Lantana understorey frequently occurs.	Mid and upper slope positions. 12-20% or steeper slopes.	VII d_{4-6}, m_6, e_{6-7}.
3	20	Rock outcrops and very shallow, dark, stony, sandy loam lithosols. Uc 1.21, Um 1.21. Acid soil reaction trend.	"Scrub species" closed forest with crow's ash, wattles and narrow-leaved ironbark.	Steep mid and upper slopes. 15-35% slope or steeper.	VIII d_6, m_6, r_5, t_{7-8}, e_{6-7}.
4	15	Moderately deep texture-contrast soils with shallow, dark brown, sandy loam A horizons over yellowish-brown or brown clays. Dy 5.11, Dy 5.21, Gn 2.84. Some Um and Uc soils may occur. Acid soil reaction trend.	"Scrub species" closed forest with scattered narrow-leaved ironbark, gum-topped box, crow's ash, wattles and lantana.	Mid and lower slope positions. 6-12% slope.	VI-VII d_{3-4}, m_4, e_{4-6}
5	10	Moderately deep to deep texture-contrast soils with shallow, brownish-black or dark brown, sandy loam A horizons over yellowish-brown or bright brown clays. Dy 5.21, Dy 5.31, Dy 3.21, Dy 3.32. Acid soil reaction trend.	Narrow-leaved ironbark and gum-topped box with understorey of lantana and "scrub species", open forest to layered open forest.	Lower slope positions. Usually on fringe areas. 5-10% slope.	IV – VI d_{2-3}, m_4, e_{4-6}.
6	5	Moderately deep to deep soils. Dark clays becoming brown or reddish-brown with depth. Ug 5.32, Ug 5.37. Neutral to alkaline soil reaction trend.	Queensland blue gum, gum-topped box, broad-leaved apple and scattered "scrub species", open forest.	Valley floors and drainage lines. 1-5% slope.	III - IV d_{2-3}, m_3, e_3

11. COOYAR LAND SYSTEM (1749 HA)

Landform: Low hills to hilly terrain.
Geology: Granites and granodiorites of the Boondooma Igneous Complex, P-Rb, Woolshed Mountain Granodiorite, Puo, and undifferentiated intrusives. P-Mg.
Soils: Predominantly texture-contrast soils with shallow, sandy-textured A horizons over reddish-brown and yellowish-brown clay subsoils.
Vegetation: Silver-leaved ironbark or narrow-leaved ironbark open forest with areas of small-fruited grey gum, bloodwoods, white mahogany and stringybarks. Large proportion cleared or partially cleared.

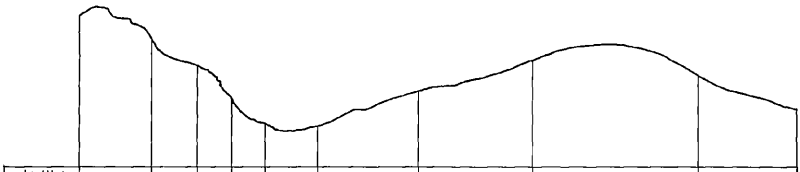


Land Unit and/or Land Systems	3	2	4	7	3	6	1	6	1	5
Described Site	14,15,16	45	48	13	94			27	24	

Land Units	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	25	Moderately deep to deep texture-contrast soils with brownish black to very dark brown, loamy sand, A horizons over reddish-brown to orange clays. Scattered rock outcrops occur. Db 4.21, Db 2.21. Acid soil reaction trend.	Narrow-leaved ironbark, white bloodwood, white mahogany open forest. Scattered dogwood and wattles.	Mid and upper slope positions. 4-8% slope.	VI - VII d_{2-3}, m_{2-3}, r_3 e_{4-6}
2	15	Moderately deep to deep texture-contrast soils with brownish-black, sandy clay loam. A horizons over bright brown clays becoming brown gritty clays. Scattered rock outcrops occur. Dy 3.12, Dy 3.13, Dy 3.22, Dy 2.22. Neutral soil reaction trend.	Silver-leaved ironbark open forest.	Broad ridge crests and upper slope positions. 3-6% slope.	IV - VI d_{2-3}, m_{2-3}, r_3 e_{4-6}
3	15	Moderately deep to deep texture-contrast soils with brownish-black to brownish-grey loamy sand to sandy loam A horizons over brownish-grey and greyish-yellow brown clay or gritty clay. Some rock outcrops may occur. Dy 5.11, Dy 5.31, Dy Dy 5.32. Acid to neutral soil reaction trend.	Narrow-leaved ironbark with scattered grey gum, silver - leaved ironbark and "scrub species", open forest.	Mid and lower slope positions. 2-5% slope.	III - IV d_{2-3}, m_{2-3}, r_3 e_{3-4}
4	15	Moderately deep soils with brownish-black fine sandy clay loams over dark reddish-brown and reddish-brown clays. Decomposing rock at depth. Scattered rock outcrops occur. Dr 3.12, Dr 3.22, Dr. 3.21. Neutral to acid soil reaction trend.	Silver-leaved ironbark open forest.	Mid and lower slope positions. 3-6% slope.	III-IV d_{2-3}, m_{2-3}, r_3 e_{3-4}
5	12	Shallow to moderately deep, brownish-black to brownish-grey, loamy lithosols to texture-contrast soils with brownish-grey or reddish-brown clay subsoils. Frequently rocky. Dy 3.12, Db 4.21, Db 2.21 and Uc 1.42, Uc 1.22. Acid soil reaction trend.	Broad-leaved ironbark, small fruited grey gum, white bloodwood, grey gum, forest she-oak, wattles and dogwood open forest to layered open forest.	Ridge crests and upper slope positions. 4-8% slope.	VI - VII d_{3-4}, m_{3-4}, r_4 e_{4-6}
6	10	Shallow loam to sandy clay loam, lithosols. Often loamy coarse sands. Large amounts of rock frequently occur. Uc 1.42, Uc 1.22. Acid soil reaction trend.	Narrow-leaved ironbark, broad leaved ironbark, small-fruited grey gum, white mahogany, white bloodwood, dogwood and wattles open forest to layered open forest.	Mid and upper slope positions, or rock outcrops. 8-20% slope.	VII-VIII d_{4-6}, m_6, t_6, r_5, e_{6-7}.
7	8	Moderately deep to deep soils with brownish-black gritty clay surface becoming yellowish-brown clays at depth. Ug 5.13 with some Um 6.14, Dy 3.12. Alkaline soil reaction trend.	Queensland blue gum, grey gum, broad-leaved apple and scattered narrow-leaved ironbark, open forest.	Valley floors and minor drainage lines. 1-3% slope.	II-III d_{2-3}, m_2, e_{2-3}

12. PIDNA LAND SYSTEM (6780 HA)

Landform: Low hills to hilly terrain.
Geology: Tonalite, diorite and adamellite of Taromeo Tonalite. P-Rt.
Soils: Predominantly texture-contrast soils with yellowish-grey and brown clay subsoils with areas of shallow uniform coarse textured soils and lithosols.
Vegetation: Narrow-leaved ironbark and/or silver-leaved ironbark, woodland to open forest with scattered Moreton Bay ash, Queensland blue gum and tumble down gum. Extensively cleared.



Land Unit and/or Land Systems	4	1	4	1	5	3	2	1	2
Described Site	83					82	78,80	85,75	84

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	35	Moderately deep to deep texture-contrast soils with brownish-black or dark-brown loamy sand to sandy clay loam A horizons over greyish-yellow brown and bright brown clays. Some rock outcrops may occur. Dy 5.12, Dy 5.13. Neutral to alkaline soil reaction trend.	Narrow-leaved ironbark, open forest with scattered Queensland blue gum, Moreton Bay ash and broad-leaved apple.	Ridge crests and mid and lower slopes. 5-8% slope or steeper in some areas.	IV-VI d_{2-3}, m_{2-3}, r_{3-4}, e_{4-6}
2	30	Moderately deep to deep soils with brownish-black or dark brown loams to light clays over brown, yellowish-brown or reddish-brown clays. Dy 2.12, Dr 3.22, Dy 5.32. Neutral soil reaction trend. Some rock outcrops occur.	Narrow-leaved ironbark, silver-leaved ironbark open forest with scattered Queensland blue gum and tumble down gum.	Mid and lower slope positions. 6-10% slope.	VI d_{2-3}, m_{2-} , r_{3}, e_{4-6}
3	15	Deep soils with dark brown sandy loam or clay loams over reddish-brown clays. Some rock outcrops occur. Dr 2.32, Dr 2.33. Neutral soil reaction trend.	Silver-leaved ironbark open forest with scattered Queensland blue gum and broad-leaved apple.	Lower slope positions. 3-6% slope and often up to 20%.	IV - VI d_2, m_2, r_{3-4}, e_{4-6}
4	15	Shallow brownish-black, loamy sands, lithosols or texture-contrast soils with reddish-brown or brown clay subsoils. Uc 1.22, Uc 1.23, Dr. 2.12. Neutral soil reaction trend.	Silver-leaved ironbark, narrow-leaved ironbark open forest with scattered Moreton Bay ash and "scrub species".	Rocky ridge crests and steep slopes. 10-20% slope or steeper.	VIII d_6, m_6, t_{6-7}, r_5, e_{6-8}
5	5	Deep texture-contrast soils with brownish-black or brown loam to light clay A horizons over yellowish-brown clays. Dy 2.12, Dy 5.12, Dy 5.13, Dy 3.2. Neutral soil reaction trend.	Queensland blue gum, tumble down gum, narrow-leaved ironbark open forest with scattered silver-leaved ironbark and broad-leaved apple.	Valley floors, minor drainage lines and lower slopes position. 1-3%	II-III d_2, m_2, e_2

13. GILLA LAND SYSTEM (4508 HA)

Landform: Hilly terrain.
Geology: Andesite, agglomerate and rhyolite of Gilla Andesite. Plg.
Soils: Predominantly loamy lithosols to shallow, loamy surfaced texture-contrast soils with yellowish-brown or reddish-brown clays.
Vegetation: Narrow-leaved ironbark, silver-leaved ironbark, small-fruited grey gum, grey gum, gum-topped box and rusty gum woodland to open forest with areas of closed forest of "scrub species" and brush box. Largely cleared or timber treated.

Land Unit and/or Land Systems	3	4	3	1	6	2	5	1	3	2	6	2	1	4
Described Site	77	103		79	89	87,88	76							

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	35	Moderately deep texture-contrast soils with brownish-black, often stony or gravelly, clay loams, bleached Ag horizons, over brown clays. Rock outcrops occur. Dy 2.42, Dy 2.32. Neutral soil reaction trend.	Gum topped box, narrow-leaved ironbark, open forest with scattered silver-leaved ironbark, grey gum, small-fruited grey gum and white mahogany.	Broad ridge crests and upper slope positions. 4-8% slope.	IV - VI d_{3-4}, m_4, r_{3-4}, e_4.
2	25	Moderately deep to deep texture-contrast soils with dark brown clay loam A horizons over dark reddish-brown clay. Some surface stone occurs. Dr 4.12, Dr 4.13. Neutral to alkaline soil reaction trend.	Silver-leaved ironbark woodland to open forest with scattered narrow-leaved ironbark and gum topped box.	Mid and lower slope positions. 6-10% slope.	VI-VII d_3, m_4, r_{3-4}, e_{4-6}.
3	20	Predominantly shallow, stony, greyish-yellow brown, loamy lithosols. Some brownish black lithosols and rock outcrops occur. Uf 1.21, Um 1.21. Neutral to acid soil reaction trend.	Narrow-leaved ironbark open forest and/or closed forest of "scrub species" and brush box.	Ridge crests and rock outcrops. 6-10% slope and steeper.	VIII d_5, m_6, r_5, e_{6-7}, t_6
4	12	Shallow to moderately deep texture-contrast soils with brownish-black loam A horizons over brownish-grey and dull yellowish brown clays. Some surface stone occurs. Dy 3.12, Dy 3.11. Neutral soil reaction trend.	Brush box with "scrub species" closed forest and scattered narrow-leaved ironbark and gum-topped box.	Mid and lower slope positions. 4-8% slope.	IV-VI d_{3-4}, m_4, r_{3-4}, e_{4-6}
5	5	Deep texture-contrast soils with brownish black or dark brown sandy clay loams over reddish-brown clays. Some rock outcrops may occur. Dr 3.42, Dr 3.41. Neutral soil reaction trend.	Gum topped box, rusty gum, open forest with scattered narrow-leaved ironbark and wattles.	Mid slope positions. 3-5% slope.	III - IV d_2, m_2, r_{3-4}, e_{2-3}
6	3	Moderately deep to deep texture-contrast soils with brownish-black to dark brown A horizons over brown or yellowish-brown clays. Dy 3.13, Dy 3.12. Alkaline soil reaction trend.	Queensland blue gum, grey gum open forest with scattered narrow-leaved ironbark.	Valley floors, minor drainage lines and lower slope positions. 1-3% slope.	III-IV d_{2-3}, m_2, e_{2-3}

14. BACK CREEK LAND SYSTEM (6716 HA)

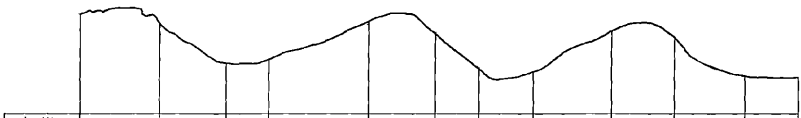
Landform: Hilly terrain.
Geology: Quartzite, mudstone, shale, greywacke of the Maronghi Creek Beds. Pzm.
Soils: Predominantly shallow, stony, lithosols and texture-contrast soils with reddish-brown, yellowish-brown or greyish-brown clay subsoils.
Vegetation: Narrow-leaved ironbark, grey gum, white mahogany and gun-topped box woodland to open forest with some silver-leaved ironbark, Queensland blue gum, fuzzy box and broad-leaved ironbark. Predominantly cleared or partially cleared.

Land Unit and/or Land Systems	4	2	3	5	4	1	3	1	3	6	2	1	3
Decribed Site		72	73,98		56,55	60	61	29,54			81	80	62

Land Unit	Est. % area.	Soils	Vegetation	Landform	Land Capability Class
1	30	Shallow, frequently stony, dark brown loams and gravelly loams. Um 1.43, Um 1.41 Neutral soil reaction trend. Small areas of texture-contrast soils occur. Dy 5.31, Dy 5.42.	Narrow-leaved ironbark open forest with scattered grey gum, white mahogany and broad leaved ironbark.	Rocky ridge crests and upper slopes. 8-10% slope.	VI-VII d_{4-6}, m_6, r_5, e_{6-7}
2	25	Moderately deep to deep texture-contrast soils with very dark brown to dark brown, loam or gravelly loams over brown or reddish-brown clays. Some surface stone may occur. Dy. 2.13, Dr 3.33. Alkaline soil reaction trend.	Broad-leaved ironbark, narrow leaved ironbark and gum-topped box open forest.	Broad ridge crests and upper slope positions. 4-8% slope.	IV d_{3-4}, m_4, r_{3-4}, e_{3-4}
3	20	Shallow to moderately deep soils. Brownish-black loams to light clays over rock and texture-contrast soils with yellowish-brown clay subsoils. Ug 1.41, Um 5.41, Dy 3.43. Alkaline soil reaction trend.	Narrow-leaved ironbark, gum topped box, silver-leaved ironbark and scattered Queensland blue gum woodland to open forest.	Mid and upper slope positions. 10-20% slope.	VII d_{4-6}, m_6, t_6, e_{4-6}
4	17	Moderately deep to deep texture-contrast soils with brownish-black sandy loam to loam surface, bleached A_2 horizons, over brown or olive brown clays. Dy 2.43, Dy 2.13. Alkaline soil reaction trend.	Narrow-leaved ironbark open forest. Scattered Queensland blue gum and grey gum.	Mid and lower slope positions. 5-7% slope.	IV d_{3-4}, m_4, e_{3-4}
5	8	Deep, texture-contrast soils with brownish-black loamy A horizons, over yellowish-brown clays or clays throughout. Dy 2.33, Dy 2.43, Uq 5.15. Alkaline soil reaction trend.	Queensland blue gun, grey gum, open forest with some fuzzy box and narrow-leaved ironbark.	Valley floors and minor drainage lines 1-4% slope.	III-IV d_2, m_2, e_{3-4}

15. ROCKY CREEK LAND SYSTEM (2480 HA)

Landform: Hilly terrain.
Geology: Quartzite, mudstone, shale, greywacke of the Maronghi Creek Beds. Some areas are weakly lateritized. Pzm.
Soils: Complex area with shallow, stony, lithosols, texture-contrast soils with bright reddish-brown and yellowish-brown clay subsoils and areas of red and brown clays.
Vegetation: "Scrub species" closed forest and layered open forest of "scrub species" narrow-leaved ironbark, broad-leaved ironbark, gum-topped box and fuzzy box and Queensland blue gum. Predominantly cleared.



Land Unit and/or Land Systems	3	4	6	2	1	3	6	5	1	2	6
Described Site		104			105						106

Land Unit	Est. % area	Soils	Vegetation	Landform	Land Capability Class
1	30	Moderately deep soils with brownish-black loams to light clays over dull yellowish-brown and dull reddish-brown clays. Um 5.41, Um 5.51, Dy 2,12. Neutral to alkaline soil reaction trend.	"Scrub species" closed forest with broad-leaved ironbark and gum-topped box.	Ridge crests and upper slope positions 4-8% slope.	IV-VI d_{3-4}, r_4, e_{4-6}
2	20	Shallow to moderately deep texture contrast soils with brown or brownish-black A horizons over bright brown and yellowish-brown clays. Dy 2.12, Dy 3.31, Dy 3.11. Acid soil reaction trend.	"Scrub species" closed forest with scattered narrow-leaved ironbark and gum-topped box.	Mid and upper slope positions. 3-6% slope and steeper slopes.	IV d_{3-4}, m_{3-4} e_3
3	20	Shallow, often stony, dark brown loams over rock. Um 1.43, Um 1.41. Neutral soil reaction trend. Small areas of texture-contrast (Dy 2.12, Dy 4.21) soils occur.	Narrow-leaved ironbark with "scrub species" layered closed forest.	Rocky ridge crests and steep slopes. 10-15% and steeper.	VII-VIII d_6, m_6, r_5 t_{6-7}, e_{6-7}
4	16	Moderately deep to deep texture-contrast soils with dark brown loamy A horizons over bright brown clays. Dy 2.11, Dy 2.21. Acid soil reaction trend.	"Scrub species" closed forest with scattered broad-leaved ironbark, narrow-leaved ironbark and gum-topped box.	Mid and upper slope positions. 6-10% slope.	IV-VI d_{3-4}, m_{3-4}, e_{4-6}
5	8	Moderately deep reddish-brown to bright brown light clays becoming heavier with depth. Uf 6.12, Um 5.41. Acid soil reaction trend. Some gradational soils also occur. Gn 2.11	"Scrub species" closed forest with scattered narrow-leaved ironbark.	Mid and upper slope positions. 6-10% or steeper slopes.	IV - VI d_{3-4}, m_{3-4}, e_{4-6}
6	6	Moderately deep to deep texture-contrast soils with brownish-black loamy A horizons over dull yellowish-brown clays. Dy 4.21, Dy 4.22 and some Ug 5.32. Neutral soil reaction trend.	Gum topped box, fuzzy box, narrow-leaved ironbark, and broad-leaved apple open forest with scattered Queensland blue gum and "scrub species".	Valley floors and minor drainage lines. 1-4% slope.	II - III d_2, m_2, e_{2-3}

APPENDIX II

GLOSSARY OF COMMON PLANT SPECIES

Botanical Name	Common Name
Acacia cunninghamii	Black wattle
A. harpophylla	Brigalow
A. implexa	Lightwood
A. irrorata	Green wattle
Acacia spp.	Wattles
Alphitonia excelsa	Red ash
Angophora subvelutina	Broad-leaved apple
Araucaria bidwillii	Bunya pine
A. cunninghamii	Hoop pine
Aristida spp.	Wire grass
Bothriochloa decipiens	Pitted blue grass
Brachychiton populneum	Kurrajong
B. rupestre	Bottle tree
Callitris columellaris	White cypress pine
C. endlicheri	Black cypress pine
Callistemon viminalis	Weeping bottle brush
Casuarina cristata	Belah
C. cunninghamii	River she-oak
C. littoralis	Black she-oak
C. torulosa	Forest she-oak
Cenchrus ciliaris	Buffel grass
Chloris gayana	Rhodes grass
Cynodon dactylon	Couch grass
Eucalyptus acmenoides	White mahogany
E. conica	Fuzzy box
E. crebra	Narrow-leaved ironbark
E. dealbata	Tumble down gum
E. eugenioides	White stringybark
E. intermedia	Pink bloodwood
E. major	Grey gum
E. melanophloia	Silver-leaved ironbark
E. microcorys	Tallowwood
E. moluccana	Gum-topped box
E. phaeotricha	White stringybark
E. pilularis	Blackbutt
E. propinqua	Small-fruited grey gum
E. punctata	Grey gum
E. saligna	Sydney blue gum
E. siderophloia	Broad-leaved ironbark
E. tereticornis	Queensland blue gum
E. tessellaris	Moreton Bay ash
E. trachyphloia	White bloodwood
E. umbra	White mahogany
Flindersia australis	Crow's ash
Jacksonia scoparia	Dogwood
Lantana spp.	Lantana
Macroptilium atropurpureum	Siratro
Medicago sativa	Lucerne
Panicum maximum var. trichoglume	Green panic
Pennisetum clandestinum	Kikuyu
Pinus patula	Patula pine
P. radiata	Monterey pine
Tristania conferta	Brush box
Xanthorrhoea spp.	Grass tree

APPENDIX III

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

LAND CAPABILITY CLASSIFICATION FOR AGRICULTURE (BASED ON MAINTENANCE OF LONG TERM AGRICULTURAL PRODUCTIVITY (JULY 1974)

TYPE OF LIMITATION	LIMITING FACTOR	DEGREE OF LIMITATION	SUB-CLASS
FACTORS LIMITING CHOICE OF CROPS OR CROP PRODUCTIVITY	Climatic limitation other than rainfall "C"	Slight restriction to choice of crops or slightly restricted production potential.	C2
		Moderate restriction to choice of crops or moderately restricted production potential.	C3
		Severely restricted choice of crops and severely reduced production potential.	C4
		Climatic limitation too severe to allow cropping.	C6
	Moisture availability for crop growth "m"	Occasional limitation to crop production; 7–8 crops possible in 10 years	m2
		Regular limitation to crop production; 5–7 crops possible in 10 years.	m3
		Occasional cropping possible. Less than 5 crops possible in 10 years.	m4
		Water availability too unreliable to allow cropping.	m6
	Effective soil depth "d"	Effective soil depth 60–100 cm	d2
		Effective soil depth 45–60 cm	d3
		Effective soil depth 25–45 cm	d4
		Effective soil depth < 25 cm	d6
	Soil physical factors affecting crop growth "p"	Degree of limitation imposed on crop production from soil physical factors affecting the growth of crop plants e.g. surface crusting, hard pans, cementation etc. Slight restriction.	p2
		Moderate restriction	p3
		Severe restriction.	p4
	Soil nutrient fertility "n"	Moderate deficiencies which may be economically corrected with careful management.	n2
		Severe deficiencies, difficult to correct and which require special management practices.	n3
		Very low fertility; continuous cultivation precluded by structural decline.	n4
	Soil salinity or sodicity "s"	Soil water availability slightly restricted or slight structure decay affecting crop production.	s2
		Soil water availability moderately restricted or moderate structural decay with some toxic effect on crops.	s3
		Soil water availability severely restricted or severe structural decay with moderate to severe toxicity.	s4
		Salinity or alkalinity too severe for crops. Tolerant improved species available.	s6
		Salinity or alkalinity too severe for pasture improvement; tolerant herbage available.	s7
		Bare salt pan; not practical to vegetate.	s8
	Topography "t"	Severe relief or major gullies preclude contour cultivation. Occasional cropping possible.	t4
		Slopes 15–20% or severe relief or gullying preventing cultivation.	t6
		Slopes 20–45% or extreme gullying but accessible to grazing animals.	t7
		Slopes on topography too severe for grazing animals.	t8
FACTORS LIMITING THE USE OF AGRICULTURAL MACHINERY	Soil workability "k"	Soil properties affecting machinery and thus reducing average production potential e.g. stiff clay, columnar structure, compaction, narrow moisture range for working. Slight restriction.	k2
		Moderate restriction	k3
		Severe restriction.	k4
	Rockiness or stoniness "r"	Tillage restricted with some types of machinery.	r2
		Tillage restricted with most types of machinery.	r3
		Tillage difficult with all machinery; occasional use possible.	r4
		Use of all machinery for cropping impractical.	r5
	Surface microrelief gilgai and gullying "g"	Tillage restricted with some types of machinery.	g2
		Tillage restricted with most types of machinery.	g3
		Tillage difficult with all machinery; occasional use possible.	g4
		Use of all machinery for cropping impractical.	g5
	Wetness "w"	Use of implements delayed occasionally and slightly reduced production potential.	w2
		Use of implements delayed regularly and moderately reduced production potential.	w3
		Use of implements very difficult and occasional crops only possible.	w4
		Permanently wet; use for cultivation impractical.	w5
FACTORS CONTROLLING LAND DETERIORATION	Susceptibility to water erosion "e"	Simple practices required to reduce water erosion under cultivation to the acceptable level.	e2
		Intensive practices required to reduce water erosion under cultivation to the acceptable level.	e3
		Requires inclusion of a pasture phase to reduce average water erosion losses to the acceptable level.	e4
		Continuous pasture required to reduce water erosion losses to the acceptable level.	e6
		Special practices or grazing restrictions required to reduce water erosion losses to the acceptable level.	e7
		Under grazing water erosion losses are in excess of the acceptable level.	e8
	Susceptibility to flooding "f"	Subject to occasional overflow flooding.	f2
		Subject to regular overflow flooding.	f3
		Subject to severe overflow flooding; permanent cultivation not possible	f4
		Flood frequency and/or severity precludes any cropping.	f5
	Susceptibility to wind erosion "a"	Slightly susceptible to wind erosion.	a2
		Moderately susceptible to wind erosion.	a3
		Severely susceptible to wind erosion.	a4
		Potential for wind erosion too severe to allow cropping.	a6–8

APPENDIX IV

ANALYTICAL METHODS

(a) Soil pH - 1:5 soil water suspension after 24 hours, with a glass electrode.

(b) Chloride - 1:5 soil water suspension with a specific ion electrode.

(c) Total Nitrogen - Kjeldahl digest.

(d) Available Phosphorus - acid extractable (N/100 H_2SO_4).

(e) Bicarbonate Extractable Phosphorus - Colwell (1963).

(f) Organic Carbon - Walkley and Black method.

(g) Particle Size Analysis - based on the international system of textural categories, with the Bouyoucos hydrometer.

(h) Replaceable Potassium - N/20 KCL extract.

(i) Cation Exchange Capacity - determination of NH^+_4 in the NH_4 saturated sample after leaching with NH_4CL at pH 7.

(j) Exchangeable Cations

(i) Soils with a pH $\geq$ 7.5 - extraction with alcoholic ammonium chloride (pH 8.4) after pre-washing with 60% ethanol.

(ii) Soils with a pH < 7.5 - extraction with aqueous, neutral ammonium chloride (exchangeable sodium figure corrected for soluble sodium by subtracting an amount equivalent to the soil chloride).

(I) Ca, Mg - atomic absorption spectrometer.

(II) Na, K - flame photometer.

(k) Total Soluble Salts - Electrical conductivity by 0.336 from 1:5 soil water suspension.

(l) Sodium chloride - chlorine values by 1.65.

APPENDIX V

SOIL CHEMICAL RATINGS

I. Nitrogen Categories (after Dawson, 1972)

N Category	Total N level (%)
Very high	> 0.50
High	0.25-0.49
Very fair	0.14-0.24
Fair	0.10-0.14
Low	0.05-0.09
Very low	< 0.05

II. Phosphorus Categories (Whitehouse, pers. comm.)

P Category	ppm P Bicarbonate extraction	ppm P Acid extraction	P Status
A		> 75	Very high
B	> 35	30-75	High
C	25-35	20-30	Medium
D	15-25	10-20	Low
E	< 15	< 10	Very Low

Fertilizer Recommendations

Category A - may not ever need P fertilizer.
Category B - normally no P fertilizer required particularly if both acid and bicarbonate extraction results are within range.
Category C - P fertilizer may give a response. Try application of phosphate fertilizer.
Category D - P fertilizer will give a response.

III. Potassium Ratings

m equiv. per 100 g	Rating
< 0.15	Very Low
0.15-0.20	Low
0.20-0.30	Fair
0.30-0.50	Very Fair
> 0.50	High

IV. Soil Salinity Categories (after Northcote and Skene, 1972)

Category 0 - Non-saline; no chloride salinity in either the surface soil or subsoil as defined for categories 1 and 2.

Category 1 - Surface salinity; soils containing in their A horizons, or in the surface 20 cm if either the

A and B horizons are undifferentiated or the A horizon is less than 10 cm thick, more than 0.1% sodium chloride in loams and coarse soils and more than 0.2% in clay loams and clays.

Category 2 - Subsoil salinity; soils lacking surface salinity but containing more than 0.3% sodium chloride in the B horizon, or below 20 cm if the A and B horizons are undifferentiated.

V. Soil Sodicity Categories (after Northcote and Skene, 1972) for the top metre of soil.

Category 0 - Non-sodic: ESP < 6.
Category 1 - Sodic: ESP 6-14.
Category 2 - Strongly sodic: ESP > 14.

VI. Soil Alkalinity Categories (after Northcote and Skene, 1972) for the top metre of soil.

Category 0 - Acid or insignificantly alkaline; pH< 8.0
Category 1 - Alkaline; pH 8.0 - 9.5.
Category 2 - Strongly alkaline; pH > 9.5

VII. Available Water Rating.

Available Water %	Rating
> 15	Very High
12.1-15	High
8.1-12	Medium
5.1- 8	Low
< 5	Very Low