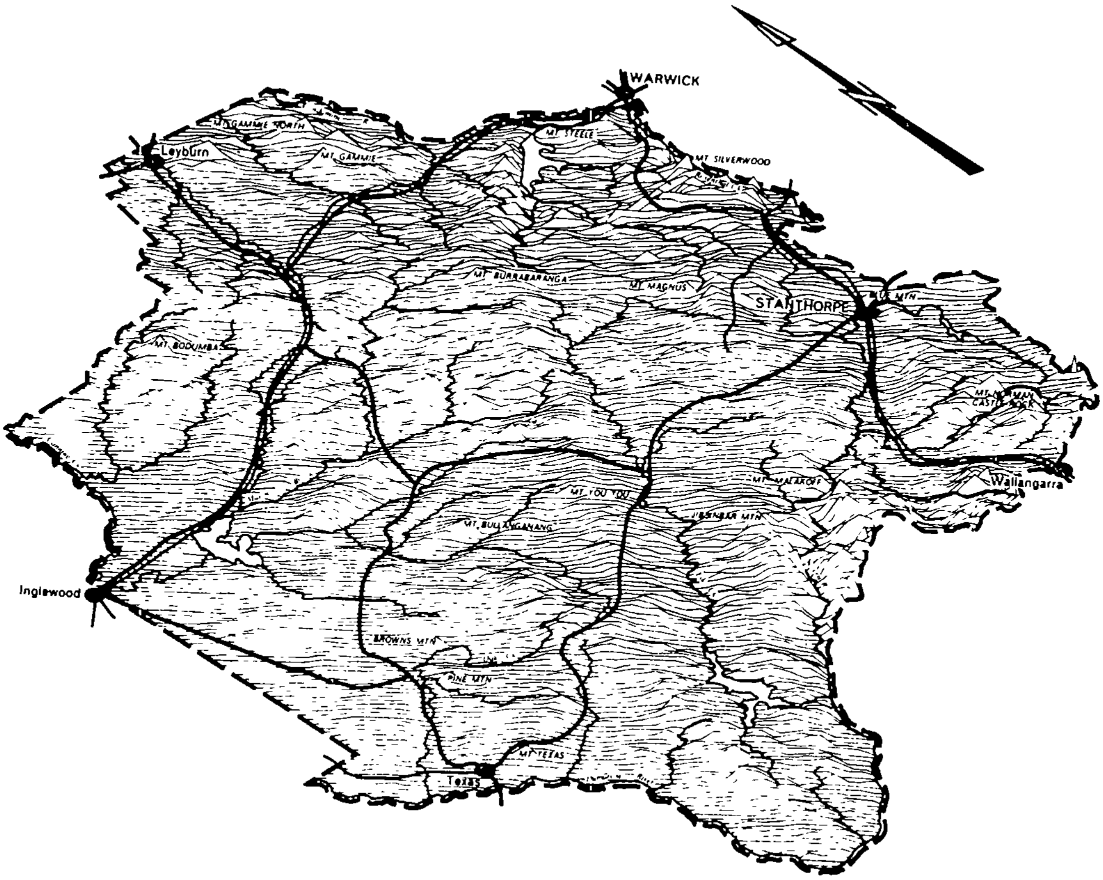
THE GRANITE AND TRAPROCK AREA OF SOUTH EAST QUEENSLAND

A LAND INVENTORY AND LAND UTILISATION STUDY

PART I – LAND INVENTORY

COMPILER AND MAIN AUTHOR A.K.WILLS



DIVISION OF LAND UTILISATION
TECHNICAL BULLETIN NO.13

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

April, 1976

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PART I

C O N T E N T S

PART II

LAND UTILISATION
(Note: separate Volume)

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COMMON ABBREVIATIONS AND TERMINOLOGY

QDPI	Queensland Department of Primary Industries
DLU	Division of Land Utilisation (in QDPI)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
LS (s)	Land System (s)

Traprock is a term of obscure origin which has acquired common usage and is used in this report to cover the Permian to Triassic volcanics and sediments, the Devonian to Carboniferous sediments and minor volcanics (the major unit) and the Silurian to Devonian sediments and pyroclastics. (See page 5-2.)

Granite, as used in 'The Granite and Traprock Area', refers to all areas of granitic rock in the study area, ranging in geological age from Lower Triassic, Ruby Creek Granite to Middle Permian, Dundee Adamellite - Porphyrite. (See page 5-2.)

The Granite and Traprock Area refers to the study area as defined in Section 1.1 and includes sandstone and alluvial geological units.

The Granite Belt is a term which is popularly used to describe the elevated land between Dalveen and Wallangarra where temperate zone fruit is grown. Where it is used in this report, it is meant to describe the large area of Permian-Triassic Granite included within the State Border and lying south of Hughey Creek and Dalveen (see MAP 4 - Geology).

1 INTRODUCTION

FIGURES

The Granite and Traprock Area of South-East Queensland - A Land Inventory and Land Utilisation Study, Division of Land Utilisation, Technical Bulletin No. 13, Queensland Department of Primary Industries, Brisbane, 1976.

THE GRANITE AND TRAPROCK AREA OF SOUTH EAST QUEENSLAND

A LAND INVENTORY AND LAND UTILISATION STUDY

1 INTRODUCTION

The Granite and Traprock area is a unique area of Queensland, lying wedged between the coastal plains on the east and the fringing plains of the Great Artesian Basin. In character, it is more akin to the lands of northern New England in New South Wales. Perhaps because of this transitional and 'alien' nature, the area has been overlooked to a great extent in regional studies.

This individuality means that only a limited amount of research results available in Queensland has application to the region. The realisation of this prompted the Eastern Graziers' Regional Development Committee to request that the Development Planning Branch of the Division of Land Utilisation carry out a survey of the area to form a basis for planning and development. The membership of the Committee comprises representatives from United Graziers' Association Branches at Warwick, Karara, Texas and Stanthorpe, a Warwick bank manager and officers of Queensland Department of Primary Industries.

More specifically, the factors causing anxiety in the area at the time of the request included unfavourable market trends for wool and fruit, and apprehension over the long term impact of the shift from sheep to beef cattle. It was recognized that some kind of regional overview was necessary so that problem areas in primary production could be identified and analysed in the overall context.

1.1 Location, Area and Aims of the Study

The area covers 8 650 square kilometres. It includes the shires of Rosenthal and Stanthorpe, and the major part of Inglewood Shire as far west as Canning Creek and the boundary of an earlier soils survey (Isbell 1957). It lies within latitudes 27°55' and 29°15' south and longitudes 151°00' and 152°15' east.

Lying just outside the study area boundary, the city of Warwick is the major urban centre for the area. It is followed in order of size by Stanthorpe, Inglewood and Texas. Other centres include Leyburn, Pratten, Karara, Dalveen and Wallangarra.

The aims of the study are:-

(a) to map and describe land systems, climate, geology, soils, vegetation, land use and land capability

(b) to investigate land use patterns and trends, and assess the impact on farms and the regional economy

(c) to suggest guidelines on land use planning for the future

(d) to publish a report.

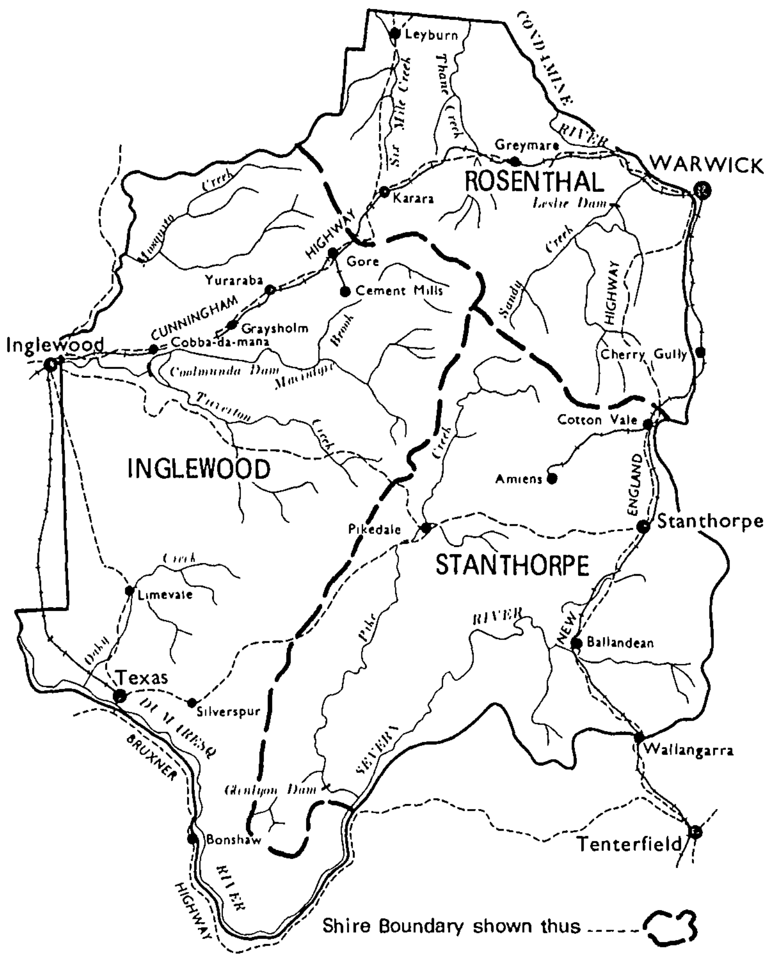

FIG. 1.1 - STUDY AREA, SHOWING LOCAL AUTHORITY AREA BOUNDARIES

1.2 Methodology and Organisation

Details of methodology are outlined for the separate sections, the general principle being to achieve maximum compatibility with similar earlier work. This entailed adherence to standardized forms of data collection, as laid down for land utilisation surveys carried out by Development Planning Branch, which in turn are designed to integrate with recording techniques used by other Branches in QDPI and by Divisions of CSIRO.

The report is presented in two main sections - land inventory and land utilisation. The principal author was assigned to initiate the land inventory work and to co-ordinate the efforts of other contributors to the project.

1.3 Acknowledgements

Twelve officers from DLU and over 30 from elsewhere in QDPI have contributed to the study. In addition, contributions and assistance have been received from the Queensland Departments of Mines, Forestry, Main Roads, Tourism, the Co-ordinator General, the Irrigation and Water Supply Commission, the Bureau of Meteorology and the Stanthorpe Shire Council. The co-operation of these official bodies has been very encouraging and their efforts have added much to the value of this publication.

The main author and compiler is grateful to Mr. W.F.Y. Mawson, who did the final editing of the report, the personnel of DLU's drafting section supervised by Mr. P.H. Scott, DLU's stenographers under the supervision of Miss G.P. Lally and particularly Mrs. L.M. O'Brien who typed the final text. Librarians of QDPI Central Library were also very helpful in obtaining reference material and their efforts are much appreciated.

Where practicable authors' names are given with their contributions. To other persons who have helped in some way and are un-named in the report, the main author expresses his sincere thanks and appreciation.

References

Isbell, R.F. (1957).- The soils of the Inglewood-Talwood-Tara-Glenmorgan region, Queensland. *Qd Bur. Invest. Tech. Bull.* No. 5.

2 SUMMARY DESCRIPTION OF THE PHYSICAL ENVIRONMENT OF THE GRANITE AND TRAPROCK AREA

The Granite and Traprock Area of South-East Queensland - A Land Inventory and Land Utilisation Study, Division of Land Utilisation, Technical Bulletin No. 13, Queensland Department of Primary Industries, Brisbane, 1976.

2 SUMMARY DESCRIPTION OF THE PHYSICAL ENVIRONMENT OF THE GRANITE AND TRAPROCK AREA

2.1 Climate

The study area is one of climatic transition and is classified as moist sub-humid around the Granite Belt and dry sub-humid in the remainder. It experiences both tropical and temperate weather influences and also airflows from maritime and continental sources.

Annual rainfall totals vary from 575 mm in the west to 850 mm in the east. Both winter and summer rainfall influences interact with terrain to produce a declining rainfall gradient from east to west. Winter rainfall is between 33 and 37 percent of the annual figure and small variations in this component can have a significant impact on the effective rainfall total. Rainfall variability is less of a problem than it is elsewhere in Queensland and this again appears to be related to the amount of winter rainfall received.

Centres in the study area frequently record the coolest temperatures in Queensland. Elevation seems to be the dominant control on temperature in both seasons. Heatwaves are normally expected in summer in the less elevated parts of the study area. In the eastern highlands, low extremes of temperature are expected in winter.

The degree of drought is a function of land use intensity and, despite obvious climatic differences over the area, droughts seem to affect the area uniformly. This is presumably because intensities of land use have built up to the climatic limits of each district. Compared to droughts, floods are not a major problem and have become of even less significance as the construction of major dams has progressed.

The main criterion used in climatic subdivision is moisture balance. This is the interaction of rainfall and temperature in a given wind/vegetation/soils environment. A combination of the Köppen (1931) and Thornthwaite (1955) approaches was used to subdivide the study area into three moisture status zones. These were then overlain by 24-hour rainfall intensity zones to produce seven climatic subdivisions as shown on Map 2.

2.2 Geology

The geology of the study area was already covered by Robertson (1972) before the current study was started. Rather than duplicate existing material, Section 5 on geology is in effect a summary of the earlier work, which cannot sensibly be summarized further in this section.

2.3 Geomorphology

The major geological subdivisions of the study area are (i) traprock (ii) the granitic intrusions (iii) the sandstone and (iv) the major alluvial tracts. These all display distinctive landforms, characteristic of the composition and structure of the parent material.

The main feature of the traprock is its resistance to erosion and the resultant hard ridges which are typical of much of this geological unit. The metamorphic aureoles formed at the margins of granitic intrusions are extreme examples of this hardness; while the incised meanders found throughout the streams of the area indicate a strong lithological or structural control on drainage patterns. The Severn Gorge is a distinctive and unusual example of intense downcutting and is considered to be the result of rapid uplift and possible faulting. Floodplains in the traprock country are generally narrow. Those associated with faulting display a number of abnormal microrelief features requiring further investigation. Numerous minor deposits of limestone in the traprock area are associated with limestone landform features such as terra rossa soils, solution caves and exposed reefs.

The granite country has produced a range of typical granite landforms, the most common being tors and balancing rocks. A few bornhardts are found in the National Park areas, but the dominance of boulder-strewn hills indicates that a finer network of rock jointing extended through the granite mass, than that conducive to bornhardt formation.

The widely separated sandstone units have experienced different landforming influences and display different characteristics depending on whether they are in the east or west of the study area. Much of the previous sandstone cover has been stripped by erosion and only shallow remnants are found towards the centre. The major unit increases in depth towards the north western boundary of the study area. Only south-west of Warwick is a substantial depth of sandstone found and this has been protected by surrounding traprock and possibly basalt cover.

The study area has been broken up into five landform subdivisions according to relative relief, slopes and elevation.

2.4 Soils

Soil parent material is a dominant factor determining the character and distribution of the soils of the survey area. There are four main geological provinces - the Devonian to Carboniferous undifferentiated sediments and minor volcanics (traprock), the Lower Jurassic Marburg sandstone, the Lower Triassic granites and the Pleistocene alluvium.

Associated with the traprock are a complex pattern of shallow loams, shallow earths and shallow texture contrast soils characterised by a high content of fragmented angular parent rock. The lower slopes and drainage lines are dominated by deeper texture contrast soils.

The Marburg Sandstone gives rise to a wide variety of soils. Red to brown texture contrast soils, brown cracking clays and massive red earths occur on the hills south and west of Warwick. North-west of the Coolmunda Dam and surrounding a basaltic residual; gilgaied clays and loamy-surfaced alkaline texture-contrast soils have developed over sandstone. Elsewhere sandstone has produced sandy, acid to neutral, texture contrast soils and siliceous sands on upper slopes with alkaline to neutral texture contrast soils on flats and depressions.

Gritty yellow and gleyed podzolics and siliceous sands are associated with the Lower Triassic granites between Dalveen and Wallangarra, but local areas north of Wallangarra, at Ballandean, Palgrave and Greymare have produced acid to alkaline texture contrast soils as well as siliceous sands.

Soils of alluvial origin vary with local geology. The Dumaresq River plain contains deep alkaline dark gradational soils (earths) and deep, alkaline, dark texture contrast soils while traprock alluvials develop deep, alkaline to neutral, yellow-brown to brown, texture contrast soils. By contrast, the Condamine River alluvials carry deep, dark, cracking clays, whereas alluvium surrounded by sandstone frequently contains red-brown gradational soils (earths) as well as texture contrast soils.

Soils of mixed origin occur south of Inglewood running off sandstone and traprock country. These are very gravelly texture contrast soils of variable pH and depth.

2.5 Vegetation

Because of geology and climate the vegetation of the traprock and granite area is unlike that of any other region of Queensland. The vegetation has been markedly affected by burning, clearing and grazing. The area is believed to have been originally covered by woodland, often layered, with small areas of open-forest in the wettest parts in the south east. Species of *Eucalyptus* and *Angophora* predominate in the tallest stratum, and fifteen communities have been defined depending on the occurrence frequency of about 16 species of *Eucalyptus* and *Angophora*. Either 'boxes' *(e. populnea, E. microcarpa, E. melliodora, E. pilligaensis, E. albens)* or 'ironbarks' *(E. crebra, E. melanophloia, E. caleyi)* predominate in the most widespread communities. There are problems in the identification and nomenclature of some eucalypts in the area. Natural grasslands do not occur.

The communities described are alliances, or in some cases where no logical classification of data could be made, formations. Some of the communities described have not been mapped seaparately either because they are intimately associated with other communities or because insufficient ground traverses were made to delimit them accurately.

The elevated granite of the south-east has distinctive vegetation with species of eucalypts not found elsewhere in Queensland and a high degree of endemism. It should be regarded as an extension of the New England Tableland. The high traprock area also has a distinctive vegetation, floristically poorer than the adjacent granite. The low granite area has vegetation similar to structurally and floristically simpler vegetation of the low traprock areas. There are well marked catenary sequences which vary a little between land systems in this area. The areas of sandstone and Cainozoic deposits are similar to areas farther inland.

2.6 Fauna

Thirty-four species of mammals, nine of them introduced, and 183 bird species, five introduced, have been recorded from the region. The majority are species common to the whole of subcoastal south Queensland, and are found in suitable habitat throughout the region. Several species, however, including six mammals and 24 birds are of restricted distribution. These include the introduced rabbit, which is excluded from the northern land systems and the fallow deer which occurs only in the Pikedale and two adjacent land systems.

The common wombat and the superb lyrebird occur only in the south-west corner of the region. For both species this represents practically the entire Queensland distribution.

Although a wide range of species of waterbirds occurs throughout the region, none is particularly abundant because of the paucity of surface water.

Some mammals and birds represent an occasional pest problem to graziers and orchardists. These include the larger macropod marsupials, the little red fruit bat, the silvereye and the eastern rosella.

3 LAND SYSTEMS OF THE GRANITE AND TRAPROCK AREA

by A.K. Wills, B. Powell and L. Pedley

FIGURES

MAPS

LAND SYSTEMS OF THE GRANITE AND TRAPROCK AREA

by A.K. Wills[1], B. Powell[2] and L. Pedley[3]

3.1 Introduction

3.1.1 Background to the Land System Concept

The term 'land system' was employed by Christian and Stewart (1953) to describe their reconnaissance level mapping units in post-war surveys of undeveloped northern Australia. It is defined as 'an area, or group of areas, throughout which there is a recurring pattern of topography, soils and vegetation' and was originally evolved 'in order that the developmental possibilities of the region might be assessed in a systematic way'.

CSIRO has since published over thirty reports in its Land Research Series, covering diverse areas of Australia and Papua/New Guinea, each of which has included a land systems map and descriptions. In addition, State and overseas bodies have either adopted, modified or independently evolved similar methods of mapping naturally complex areas of land (e.g. Gibbons and Downes 1964; Bawden and Stobbs 1963; Dawson 1972). Most users of the land systems concept have made adaptations and variations in emphasis, in accordance with their survey aims and participants' skills, for example the Victorian Soil Conservation Authority includes comments on land use and actual and potential water erosion (Sibley 1967). In CSIRO itself, the emphasis on quantification and standardisation over the years has produced increasing detail and precision in descriptions of land units which make up the land systems, while retaining the fundamental methodology and descriptive categories of the earlier surveys (Paijmans *et al.* 1971).

Also through time, the idea has steadily gained acceptance that land is a complex, which cannot be fully appreciated by separate assessment of each resource attribute (Christian and Stewart 1968). This is summed up in the statement by Christian (1964) that 'land must be considered as the whole vertical profile at a site on the land surface from the aerial environment down to the underlying geological horizons, and including the plant and animal populations, and past and present human activity associated with it'. This view of land as a combination of natural and social ecosystems is seen as a desirable comprehensive approach to land utilisation studies, particularly in less developed areas. While landforms, soils and vegetation remain dominant determinants in land systems mapping because of their importance for air photo-interpretation, it is desirable to consider fauna, climate and land use also, where specific area data are available or obtainable.

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1 Division of Land Utilisation, Department of Primary Industries.

2 Agricultural Chemistry Branch, Department of Primary Industries.

3 Botany Branch, Department of Primary Industries.

Since its inception the land system concept has been applied at different scales; with differing depths of detail; with variations of emphasis on the components and over a broad spectrum of landscape types. Its practical value and relationship to other forms of land classification are discussed below and, finally, an extended definition to apply in this study is presented.

3.1.2 The Land System Concept in Practice

Integrated surveys, resulting in land system maps of areas, are generally carried out by teams of specialists who combine their efforts to produce the end result. This multi-disciplinary approach and the comprehensive nature and volume of the finished document tend to overwhelm the average potential user, who is normally trained in one field and possibly attuned to assessing land in much smaller units. Thus a certain amount of extension and familiarisation activity is often necessary to ensure that a land system survey gains acceptance by the potential users at which it is aimed. Hopefully, this should become less of a need with the widening public awareness of environmental studies and their interdisciplinary nature.

The main advantage of a land system survey is that it delineates finite areas, distinctive in terms of a combination of resource factors, which can be used as planning units by development bodies.

Examples of this in Queensland include the use of CSIRO's Central Queensland surveys (Gunn *et al.* 1967; Story *et al.* 1967; Perry 1968) for detail farm planning in ballot blocks of the Fitzroy Basin Land Development Scheme (Turner 1975) and for an erosion survey of the Fairbairn Dam catchment (Skinner *et al.*1972). Plans to change land use in eroding sugar cane lands in the Bundaberg district also involved description of land systems and their use as a convenient means of disaggregation (Isis Land Use Study Committee, 1971; Gin Gin Land Use Study Committee, 1972).

In contrast, land systems of twelve CSIRO surveys in northern Australia have been used as sources for extrapolation to estimate a total area of land suitable for rain-grown crops in this part of the continent (Ladewig 1971).

The benefits of the land system approach need not be confined to agricultural pursuits. The comprehensive land inventory data presented may be used for urban or recreation land uses, selection of reserve or special purpose areas such as military training, waste disposal or for siting of civil engineering projects such as highways or dams. In the USA 'landscape units', defined as 'areas throughout which there is a characteristic pattern of landforms, soils and land use', were mapped to assist in determining an optimal route location for a new highway (Hamilton and Lacate 1971). The present wave of enthusiasm for decentralisation in Australia should hopefully see more use made of the integrated survey approach in siting, expansion and planning of regional centres according to natural determinants of land use.

3.1.3 Land Systems and Other Forms of Mapping Units

Land systems, unlike the smaller units which make them up (mapping units, land units, land components, land facets) are commonly published in map form. The smaller units are usually not mapped but are described in detail and their characteristic positions on modal landform diagrams indicated. Their relevance will be discussed in section 3.2.1 Format and Terminology.

Land systems maps are often accompanied by Soils, Landform, Vegetation maps. Although numerous points of similarity are often recognizable and should be expected, there need be no direct linkage between the mapped land systems and the mapping units of any single resource factor. This is simply because the depth of detail of the data, the grouping criteria and the map scale are often different.

A geographer would class all of the abovementioned types of map as being maps of geographic regions. The following quotation from Broek (1965) should help to clarify this statement.

> ' ... when we practise so-called regional geography we select certain features (topics) as criteria for marking out the region. After all, every spot on the earth is unique and full of diverse things. It is futile to think that one can master the totality of content of any area. To handle the areal complexity, to see the forest instead of the trees, we must ignore irrelevant details and grasp the dominant features that characterize the area. Inevitably, this means that one defines the region by some selected features. *A region, then, is an area homogeneous in terms of specific criteria chosen to delineate it from other regions.*'

It will be seen from this definition that land systems, land units and most mapping units may also be called geographic regions. The reason this synonymity is frequently not recognised is mainly because the lay usage of 'region' ascribes to it a certain order of magnitude such as Moreton Region, Burdekin Region, Department of Urban and Regional Development. Because of this loose convention regarding scale, the writer has tended to avoid the use of the term 'region', preferring the lack of implication in the term 'area'.

3.1.4 Definition

A land system, in the context of this study, is defined as an area, or group of areas, throughout which there is a characteristic pattern of landforms, soils and vegetation, combined with distinctive features of climate, fauna populations and land utilisation. The land system may be equated with a geographic sub-region defined in terms of its natural and social ecosystems.

3.2 The Land Systems

The following descriptions are intended to provide a broad spectrum picture of the land system areas, as shown on Map 1, to general readers of the report, and to those who require a general introduction to the study before pursuing more detailed avenues.

3.2.1 <u>Format and Terminology</u>

One page is allocated to each LS, with the LS name printed on the top-outer corner. For ease of reference an alphabetic index of LS names is found on the last page of PART I, related directly to page numbers.

The following notes explain the different items which appear in the LS description, in the order that they appear on each page from top to bottom:

(i) Block diagram - These diagrams are attempts to describe pictorially the landform configuration of the land units, as they make up the LS. The arrangement is modal and does not necessarily represent an actual block of land within the land system area. Vertical exaggeration and exaggeration of certain geomorphic features is used to highlight distinctive differences between land units. The circled numbers refer to the land unit number given in the table below each block diagram. Broad geological groupings are indicated on the vertical faces of each diagram and the key which applies is given below:

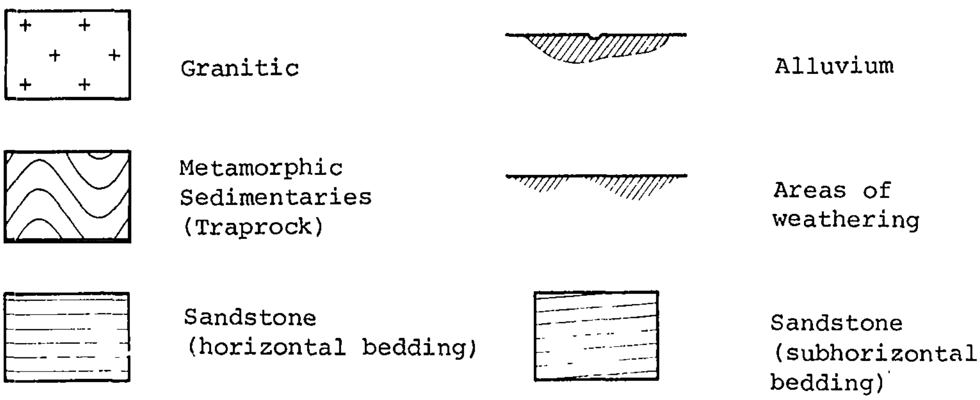


FIG. 3.1 - <u>LAND SYSTEM BLOCK DIAGRAMS - KEY TO BROAD GEOLOGICAL GROUPINGS</u>

(ii) Land system name - The LS name is positioned under each block diagram, followed by its area rounded off to the nearest 10 square kilometres. Below this is a brief geomorphic description.

(iii) Land unit descriptions - The land unit descriptions are in tabular form in the centre of each page. The three columns are from left to right the work of A.K. Wills (Development Planning Branch), B. Powell (Agricultural Chemistry Branch) and L. Pedley (Botany Branch) and descriptions in each column conform to standards applying in the respective branches as described below.

(iv) Left-hand column - This column combines a number of items of information. In the top left-hand column of each box is the land unit number in heavy type. In the top right-hand corner, in brackets, is the estimated percentage of proportion of the land system that the land unit represents.

The main item of information is the landform description which uses terminology as adopted by Development Planning Branch for standardised data recording. This is the Revised Landform Classification (24 March 1971) a copy of which forms Appendix 6.1. Information is also included on typical and limiting slope values, and land surface characteristics.

The final line, in brackets contains the land capability class (Land Class) and main limitations, derived as described in Section 11.3.1.

(v) Middle column - Soils - Land unit soil descriptions refer to dominant, co-dominant soil profile classes except where minor soil profile classes are indicated. Each soil profile class has been classified according to the factual key (Northcote 1974) either by complete key notation e.g. Dy 3.41, Gn 3.21 of described soil profiles or by generally summarising the soil profile class to subdivision level of the key e.g. Um, Dy.

(vi) Right-hand column - Vegetation - The structure of the plant communities has been described in terms of Specht's (1970) classification. Predominant species of the different strata recognised have been listed. Some indication of the degree of disturbance has been noted.

(vii) Climate - Information contained in this block is a condensation of the climatic analysis carried out in section 4 as it applies to the specific LS area. It is divided into three paragraphs covering moisture balance, rainfall and temperature characteristics.

(viii) Geology - This section lists the main stratigraphic units of the LS as described in section 5.

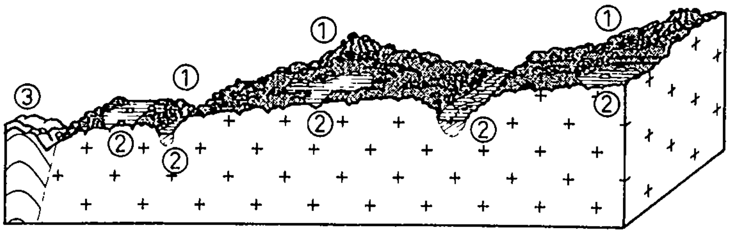
(ix) Geomorphology - A general landform description of the LS as a whole with an estimated modal value of relative relief given.

(x) Fauna - Readers will have to refer to section 9 for a full list of fauna which can be found in each LS. It would have been impractical to reproduce lists of the magnitude of Appendix 9A and only major departures from the norm are noted in the LS description.

(xi) Land Utilisation - This block is derived principally from the land use survey, field data collection and authors of section 12.

3.2.2 Land System Descriptions

See pages 3-7 to 3-29.



NORMAN LAND SYSTEM, 300 km^2

Two blocks of dissected, granitic highlands in a NW-SE trending mass divided by the Severn River .

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (80%) Deeply dissected hills, widespread tor outcrops and occasional inselberg formations; very stony surface. (VII–VIII d r e)	Shallow to deep, bleached, gritty, siliceous sands (Uc 2.21, Uc 2.23, Uc 2.34); shallow, gritty sands (Uc).	Layered woodland or open-forest of varied composition, *Eucalyptus andrewsii* and *E. caliginosa* the commonest species, on shallower soils *E. dealbata, E. laevopinea, E.* sp. aff. *E. bancroftii* also common – all with well developed, floristically complex shrubby understorey.
2 (18%) Valleys in major dissections and elevated areas of low relief; minor rock outcrops. (III–IV e)	Shallow to deep, bleached, gritty, siliceous sands (Uc 2.21); moderately deep, yellow and gleyed podzolics with loamy sand surface soil with a bleached or pale A2 horizon to 30 cm over grey and yellow, clay sub-soil (Dg 3.61).	Layered woodland of varied composition, mainly *E. andrewsii, E. caliginosa* and *E. deanei; Acacia filicifolia* prominent understorey tree, varied shrub layer.
3 (2%) Dissected metamorphic aureole intruded by minor Ruby Creek Granite. (VII–VIII d r e)	Shallow, gritty sands (Uc) on granite hills; shallow, gravelly loams (Um) and shallow, gravelly texture contrast soils (D) on traprock hills; minor: dark, acid, texture contrast soils (Dd 3.11) in swamps.	Woodland or open-forest of *E. crebra* and *E. dealbata* with lower tree layer, dense in places, of *Callitris endlicheri.*

Climate: The main unit experiences a moisture adequacy or surplus, over the average year, and the north-western unit a slight deficit. Moisture storage minima or deficits are usually experienced around April.

The mean annual rainfall ranges from 730 mm in the west to over 825 mm in the south-east. Comparable figures for the median are 715 mm to over 800 mm. 35% of the rainfall total falls in the winter months and the 24-hour rainfall intensity over the average year is quite low at 9 mm/rain day. In January only, this figure is as high as 13 mm/rain day and indicates a very low intensity winter component from southern sources.

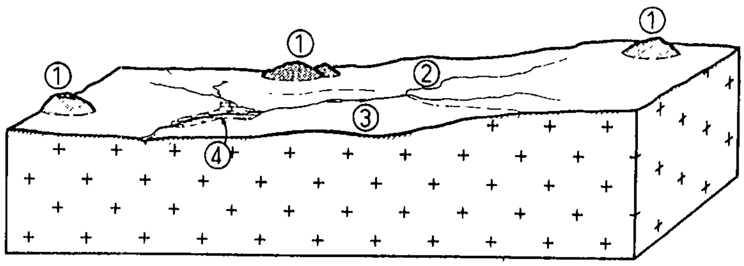
Mean January maximum temperatures are low compared to the rest of the study area, being 26°C in the larger unit and 27°C in the smaller. The mean July minimum is around 1°C.

Geology:- Stanthorpe Adamellite (Lower Triassic); minor undifferentiated sediments and minor volcanics (Devonian to Carboniferous) and outcrops of Ruby Creek Granite (Lower Triassic).

Geomorphology:- The highest portions of the extension of the New England Batholith in Queensland. Very dissected country with widespread tor development and part-formed inselbergs - Mt. Norman, The Pyramids and Bald Rock. The western unit is somewhat lower, with no inselbergs, and is bounded on its western edge by a steeply dissected metamorphic aureole intruded by minor occurrences of Ruby Creek Granite. Relative relief about 450 m.

Fauna:- Most A species, all B species except fallow deer, emu, corella, red-winged parrot and red kangaroo.

Land Utilisation:- Mainly National Park or rough grazing for beef cattle; minor orchards and improved pastures in narrow valleys and elevated low relief areas; some wool production in the western unit; mining around Ruby Creek intrusions.



SUMMIT LAND SYSTEM, 100 km^2

Elevated granite plateau of moderate relief.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (3%) Isolated rocky knolls, average slopes 15%. (VII d e)	Shallow to deep, bleached, gritty, siliceous sands (Uc); shallow, gritty sands (Uc); soils are similar to Unit 1 of Eukey L S	Layered woodland of *E. laevopinea* and *E. tereticornis*, often with dense lower tree layer of *Acacia neriifolia;* ground cover sparse.
2 (40%) Plains of moderate relief on Stanthorpe Adamellite average slopes 4%. (IV e)	Moderately deep to deep, bleached, gritty siliceous sands (Uc 2.22); moderately deep to deep, yellow and gleyed podzolics (Dy, Dg).	Cleared and often cultivated layered woodland of *E. laevopinea, E. andrewsii, E. caliginosa* and *Angophora floribunda* with patchy lower tree layer of *Banksia integrifolia* and *Callitris columellaris;* well developed shrub layer of *Cassinia quinquefaria, Heuchrysum diosmifolium, Dairesia mimosoides* and *Leucopogon melaleucoides;* ground cover low.
3 (45%) Plains of moderate relief on Ruby Creek Granite, average slopes 4%. (III e)	Moderately deep to deep, yellow and gleyed podzolics with loamy-sand to sandy loam surface soil with a bleached A2 horizon to 80 cm over bright-orange and grey, mottled, acid, clay sub-soil (Dy 5.41, Dg 4.41, Dg 4.81); moderately deep, bleached, yellow earths with sandy loam; surface soil with a bleached A2 horizon to 70 cm grading into bright orange and grey, mottled, acid, sandy-clay-loam to clay sub-soil (Gn 3.04).	Cleared and often cultivated layer of woodland of *E. andrewsii* and *Angophora floribunda* with *E. deanei* and *E. laevopinea* in places; lower tree layer of *Acacia neriifolia* and *A. implexa* and shrub layer of *Jacksonia scoparia;* ground cover low.
4 (12%) Colluvial slopes, average 2.5%; occasional tor outcrops. (III e)	Moderately deep to deep, yellow and gleyed podzolics (Dy, Dg); moderately deep to deep, gritty, siliceous sands (Uc 2.21).	Extensively cleared shrub woodland of *E. caliginosa, E. deanei* and *E. andrewsii*, small patches of *E. viminalis* and *E. seeana;* shrub layer of *Daviesia mimosoides, Sprengelia sprengelioides* and *Leucopogon melaleucoides;* sparse ground cover, mainly *Imperata cylindrica* var. *major.*

Climate:- This land system has adequate moisture throughout the average year with storage minima most likely in March or November.

The mean annual rainfall is around 800 mm with the median only slightly lower at about 790 mm. 37% of this is winter rain with markedly low annual and January 24-hour rainfall intensity figures of 8 mm and 11 mm/rain day, respectively. High elevation and low relief is probably the main reason for this.

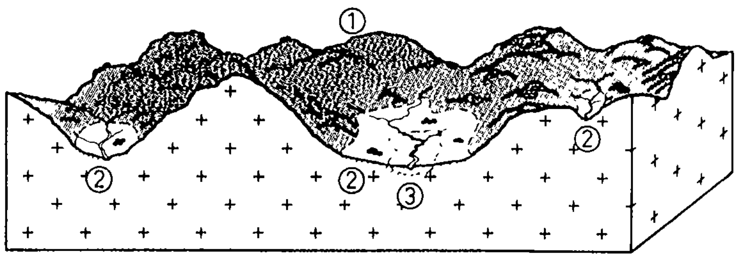
The mean January maximum temperature is 26°C and the July minimum mean is less than 1°C.

Geology:- Ruby Creek Granite and Stanthorpe Adamellite (Lower Triassic).

Geomorphology:- The highest granitic area of relatively gentle relief. The plateau surface is not conducive to concentration of run-off and drainage patterns are therefore poorly developed. Relative relief about 175 m.

Fauna:- Most A species and rabbits.

Land Utilisation:- Mainly orchards; some rough grazing.



MAGNUS LAND SYSTEM, 170 km^2

Steep ridges of resistant granite east, south east and south from Mt. Magnus.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (70%) Granitic hills, average slopes 13%; stony surface; tors and exposed rock common. (VII-VIII d r e)	Shallow to deep, bleached, gritty, siliceous sands (Uc 2.21); shallow, gritty sands (Uc); minor: yellow podzolics (Dy).	Layered woodland of *E. dealbata* and *E. laevopinea* with occasional *Angophora floribunda* and, near junction with 'traprock' *E. crebra*, patchy lower tree layer of *Callitris endlicheri* and usually well developed shrub layer of *Jacksonia scoparia*, *Cassinia quinquefaria* and *Acacia fimbriata*, open ground cover of *Danthonia racemosa*.
2 (25%) Colluvial lower hillslopes, 3 to 9%; stony surface; irregular microrelief and rock outcrops. (IV e)	Moderately deep, bleached, gritty, siliceous sands (Uc 2.12, Uc 2.21, Gn 1.36); minor: moderately deep, yellow and gleyed podzolics (Dy, Dg); moderately deep, texture contrast soils with yellow, alkaline, clay sub-soils (Dy 4.43).	Layered woodland of *E. dealbata* and *E. caliginosa* with patchy lower tree layer of *Callitris endlicheri* and *Acacia neriifolia* and shrub layer of *Jacksonia scoparia*, *Leptospermum arachnoides*, *Cassinia quinquefaria*, ground cover low.
3 (5%) Colluvial sopes, average 2.5%. (III e)	Moderately deep, texture contrast soils with yellow, alkaline, clay sub-soils (Dy); moderately deep, yellow and gleyed podzolics (Dy, Dg); soils are similar to Unit 3 of Severnlea L S	Woodland of *Angophora floribunda* and *E. tereticornis*, scattered lower *Banksia integrifolia*, rather dense ground cover of *Dichelachne micrantha*.

Climate:- Over the average year, most of the land system has adequate moisture levels but a slight deficit is experienced in the west. March is usually the critical month for moisture deficits.

Annual rainfall is around 780 mm for both the mean and the median, with 35.5% falling in the winter months 24-hour rainfall intensity figures are 9 mm/rain day for the average year and 13 mm/rain day for January.

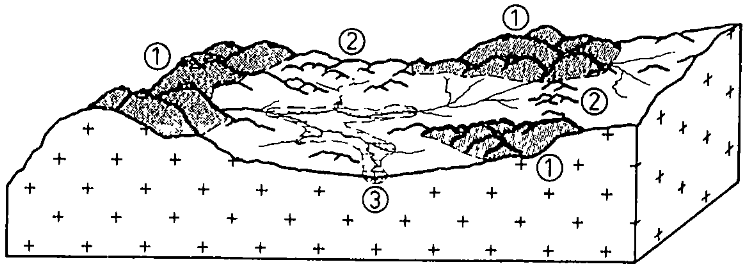
The mean January maximum temperature is around 26°C and the July minimum is less than 1°C.

Geology:- Ruby Creek Granite and Stanthorpe Adamellite (Lower Triassic).

Geomorphology:- Resistant granitic ridges associated with dissected, rapidly downwasting areas along the contact with the traprock at the western margin of the batholith. Relative relief about 250 m.

Fauna:- Most A species and rabbits.

Land Utilisation:- Main commercial use is forestry; some orchards and rough grazing, some wool production towards the west.



EUKEY LAND SYSTEM, 190 km^2

Elevated hills and irregular plains in two units, the major area being the lower catchment of Quart Pot Creek and the smaller area situated east of Dalveen.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (33%) Granitic hills, and minor low hills and plains of moderate relief; slopes 3 to 15%; stony surface and some large rock outcrops. (VI-VII d r e)	Shallow to deep, bleached, gritty, siliceous sands (Uc 2.12, Uc 2.22); shallow, gritty sands (Uc); minor: yellow and gleyed podzolics (Dy 5.41, Dg) – more common east of Dalveen.	Woodland of *E. andrewsii* and *E. tereticornis* or *E. blakelyi;* occasional *E. laevopinea, Angophora floribunda;* lower tree layer, moderately dense in places of *Acacia implexa, A. leucoclada* and *Choretrum candollei;* low to moderate ground cover of *Dichelachne, Cymbopogon refractus* and *Chloris acicularis.*
2 (55%) Plains of low and moderate relief; average slopes 3%, occasionally up to 9%. (III-IV d e)	Shallow to deep, yellow and gleyed podzolics with loamy-sand to light-sandy-clay-loam surface soil with a pale or bleached A2 horizon to 40-45 cm over yellow to grey, commonly mottled, acid, clay sub-soil (Db 4.21, Dy 4.81, Dy 5.41, Dg 3.81).	Extensively cleared woodland of *E. microcarpa* and occasional *E. bridgesiana* and *Angophora floribunda,* with *E. andrewsii* on steeper slopes; lower tree layer of *Acacia filicifolia* and on shallow soils shrub layer of *Jacksonia scoparia* and *Leptospermum* spp.
3 (12%) Plains of low relief, slopes 2 to 3%. (III e)	Deep, yellow and gleyed podzolics with loamy-sand to sandy-loam surface soil with a bleached A2 horizon to 30-80 cm over yellow and grey mottled, acid, clay-loam to clay sub-soil; (Dy 3.81, Dg 2.41); deep, gritty, siliceous sands (Uc 1.21, Uc 2.12, Uc 4.2).	Relict patches only of *E. nova-anglica;* ground cover greatly disturbed.

Climate:- The land system has a moisture adequacy or surplus over the average year, with April the most critical month for low storages.

The mean annual rainfall is around 815 mm, slightly higher in the northern unit, and the median for both units is above 790 mm, with 36.5% winter rainfall component. Low 24-hour rainfall intensity figures are also characteristic being 8 mm/rain day for the year and 11 mm/rain day for January.

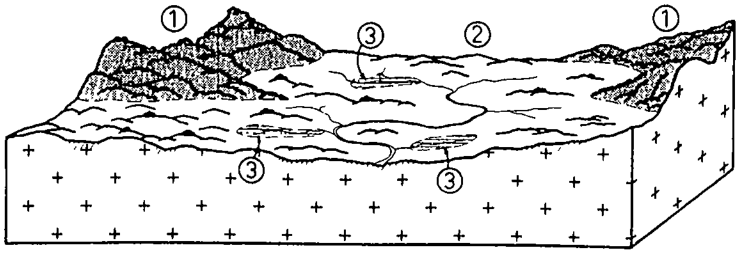
Mean temperatures in the main unit are low, being 26°C January maximum and below 1°C July minimum. Figures for the smaller northern unit are similar.

Geology:- Stanthorpe Adamellite and Ruby Creek Granite (Lower Triassic) and minor Pleistocene, stanniferous alluvium.

Geomorphology:- The main unit is an eroding granitic basin which has been supported by a resistant range of hills to the north-west. The area contained is generally of low, irregular relief with a few protrusions of knolls and spurs. The northern unit is of mixed relief and is supported by resistant traprock of the Ironpot LS. Relative relief about 275 m.

Fauna:- Most A species, all B species except fallow deer, emu, corella, red-winged parrot and red kangaroo.

Land Utilisation:- Mainly beef cattle grazing; a few sheep and some orchards. There is a pasture potential for fat lambs production in approximately half of the area.



SEVERNLEA LAND SYSTEM, 270 km²

Eroding granitic basin of the Upper Severn River.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (15%) Narrow ridges, spurs and knolls; slopes 15 to 25%; tors and exposed rock common. (VI-VII d r e)	Shallow to deep, bleached, gritty, siliceous sands; (Uc 2.12); shallow, gritty sands (Uc).	Woodland of *E. dealbata, E. laevopinea* and occasional *E. andrewsii* and *Angophora floribunda* with patches of *Callitris endlicheri;* well developed shrub layer, mainly *Leptospermum arachnoides* and *Jacksonia scoparia;* sparse ground cover.
2 (75%) Plains of moderate relief and some low hills; average slope 5%. (IV-VI e)	Moderately deep to deep, yellow and gleyed podzolics with loamy-sand to sandy-loam surface soil with a bleached A_2 horizon to 30-70 cm over grey or yellow, mottled, acid, clay sub-soil; (Dy 5.41, Dg 3.82, Dg 4.41); moderately deep to deep, bleached, gritty, siliceous sands (Uc 2.12, Uc 2.21); moderately deep to deep, bleached yellow earths with sandy-loam surface soil with a bleached A_2 horizon to 70-80 cm grading into yellow and grey, mottled, acid, gritty, clay-loam to clay sub-soil (Gn 3.84, Gn 3.04).	Extensively cleared layered woodland of *E. tereticornis* (or, in the southern quarter of the land system, *E. blakelyi*) *Angophora floribunda* and less commonly *E. caliginosa;* sporadic lower tree layer of *Callitris columellaris,* and *Acacia neriifolia;* patchy shrub layer mainly *Jacksonia scoparia;* moderate ground cover, mainly *Aristida ramosa, Eragrostis* spp. and *Dichelachne micrantha.*
3 (10%) Plains of low relief and alluvial flats associated with tributaries and above the usually incised main watercourses; slopes 0 to 3%. (III e)	Deep, texture contrast soils with loamy-sand surface soil to 10 cm over grey, alkaline, clay sub-soil (Dg 3.13); deep, bleached, gritty, siliceous sand (Uc 2.23); deep, gleyed podzolics with loamy-sand to sandy-loam surface soil with a bleached A_2 horizon to 60 cm over mottled, grey, acid, clay sub-soils (Dg 2.41, Dg 4.41).	Extensively cleared woodland of *E. caliginosa* and *E. tereticornis* (*E. blakelyi* in the southern part) with some *Angophora floribunda;* open lower tree layer of *Acacia neriifolia* and *A. implexa* and scattered shrubs sometimes present; ground cover moderate, mainly *Cymbopogon refractus, Dichelachne micrantha* and *Themeda australis.*

Climate:- There is neither a moisture surplus nor a deficit in this land system as a whole, over the average year. However, a gradient from the drier west to the moister east is evident. March is the critical month for storages.

Mean annual rainfall is around 780 mm with about 740 mm median, 35% falling in winter. Annual 24-hour rainfall intensity is quite low at 8 mm/rain day, and the figure for January is 13 mm/rain day.

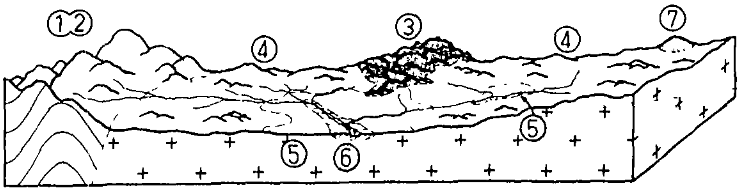
Mean temperatures are 27°C January maximum and around 1°C July minimum.

Geology:- Stanthorpe Adamellite and minor Ruby Creek Granite (Lower Triassic).

Geomorphology:- Very low undulating or irregular hills and plains of moderate relief, with peripheral spurs and scattered knolls. Relative relief about 375 m.

Fauna:- Most A species, all B species except fallow deer, emu, corella, red-winged parrot and red kangaroo.

Land Utilisation:- Mainly orchards; some rough grazing and wool production towards the west.



WASHPOOL LAND SYSTEM, 140 km^2

Eroded granitic basins cutting back into resistant Traprock hills.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (10%) Low traprock hills cutting back into higher hills and mountains, slopes average 6 to 10% going up to 20%. (VII d r e)	Shallow, gravelly loams (Um); shallow, gravelly, texture contrast soils (D); soils are similar to Unit 1 of Glenlyon L S.	Extensively cleared woodland of *E. crebra* (in the north) with dense patches of *Callitris endlicheri.*
2 (15%) Concave lower traprock hillslopes, 3 to 5%, with colluvial slopes 1 to 3%, along drainage lines; stony surface. (III-IV e)	Shallow to moderately deep, texture contrast soils with loamy-sand to loam surface soil usually with a pale or bleached A2 horizon to 20 - 45 cm over brown to bright-yellowish -brown, neutral to alkaline, clay sub-soils (Db 4.22, Dy 2.43, Db 1.13).	Extensively cleared woodland of *E. microcarpa* and *E. melliodora* and in the south, *E. conica* and some *E. blakelyi;* ground cover much disturbed.
3 (15%) Steep, granitic spurs and knolls protruding above the general erosion level, slopes 10 to 30%, stony surface with rock outcrops. (VII d r e)	Shallow to deep, gritty, siliceous sands (Uc 5.11); shallow, gritty sands (Gn 1.91).	Either (in the north) woodland of *E. crebra, E. maculata* and some *E. laevopinea* with scattered shrubs, especially *Daviesia* spp. and *Leucopogon* spp. or (in the south) woodland of *E. dealbata* and *E. laevopinea* with occasional *Angophora floribunda* and patches of *Callitris endlicheri* and well developed shrub layer mainly *Jacksonia scoparia,* both with low ground cover.
4 (35%) Plains of moderate relief on weathered adamellite, slopes 2 to 6%, stony surface common. (IV e)	Moderately deep to deep, texture contrast soils with sandy-loam surface soil with a bleached A2 horizon to 30-40 cm over dull-grey- brown, acid to neutral, clay sub-soil (Dy 3.41, Dy 3.42, Dy 4.41).	
5 (15%) Colluvial and lower footslopes on weathered adamellite, slopes 2 to 3%. (III e)	Moderately deep, texture contrast soils with loamy-sand surface soil with a bleached A2 horizon to 20-40 cm over grey, gritty, clay-loam or clay sub-soil (Dg 2.81, Dg 1.43); shallow to moderately deep, bleached, gritty, siliceous sands over a hard pan (Uc 2.33).	Largely cleared. In the north, woodland of *E. tereticornis* and *E. melliodora* with lower trees of *Acacia implexa* and occasional *Casuarina luehmannii,* in the south, woodland of *E. conica, E. microcarpa* and *E. blakelyi* with occasional lower *Casuarina luehmannii;* rather dense ground cover; much disturbed, predominantly *Dichelachne micrantha* and *Cymbopogon refractus.*
6 (10%) Alluvial flats in plains of weathered adamellite, slopes average 0.5% going up to 2% at the edges. (II-III d·f)	Deep, texture contrast soils with light-sandy-clay-loam surface soil with a bleached A2 horizon to 30-50 cm over brownish-grey to dull-yellow-orange, neutral to alkaline, clay sub-soil (Dy 2.42, Dy 2.43, Dy 3.43, Dy 4.43); minor; shallow, texture contrast soils with dark-brown, acid, clay sub-soil (Db 1.11).	
7 (< 1%) Isolated outcrops of granite, slopes 5 to 12%. (IV-VI d e)	Shallow to deep, gritty, siliceous sands (Uc 2); shallow, grittysands (Uc); minor; yellow and gleyed podzolics (Dy, Dg), soils are similar to Unit 1 of Magnus L S.	Woodland of *E. dealbata* and *E. laevopinea* with patches of *Casuarina luehmannii.*

Climate:- The land system remains marginally above a moisture deficit during an average year, with March usually the critical month.

The mean annual rainfall is around 780 mm and the median 760 mm. 35% of the rainfall total falls in the winter months and 24-hour rainfall intensity annually is 10 mm/rain day and, for January, 14 mm/rain day.

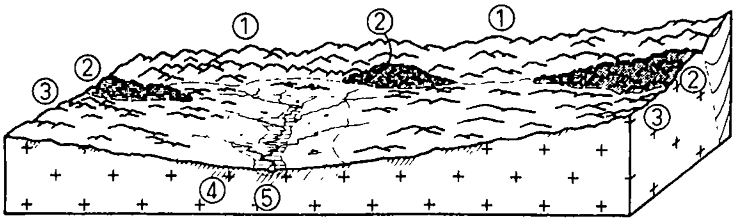
Mean January maxima are 26°C for both units, and around 1°C mean minima in July.

Geology:- Stanthorpe Adamellite (Lower Triassic); minor undifferentiated sediments and minor volcanics (Devonian to Carboniferous and Permian to Triassic), Ruby Creek Granite outcrops.

Geomorphology:- Eroded granitic basins between major traprock and granite units. Mainly very low hills and depositional surfaces with some steeper country in isolated spurs, knolls or on the fringes. Relative relief about 225 m.

Fauna:- Most A species, all B species except fallow deer, emu, corella, red-winged parrot and red kangaroo.

Land Utilisation:- Beef cattle and sheep grazing.



EVANDALE LAND SYSTEM, 100 km^2

Eroded granitic basin surrounded by Traprock hills.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (35%) Steep traprock hillslopes, mainly 10% go up to 30%; very stony surface and minor rock outcrops. (VII d r e)	Shallow, gravelly loams (Um).	Extensively cleared woodland of *E. dealbata* and *E. crebra*, sometimes small areas of *Callitris columellaris* and scattered shrubs; sparse ground cover, mainly *Bothriochloa decipiens* and *Aristida* spp.
2 (10%) Upper granodiorite slopes, average 5%; isolated outcrops and tors. (VI e)	Shallow to deep, gritty, siliceous sands (Uc 2.34); shallow, gritty sands (Uc).	
3 (20%) Lower granodiorite slopes, average 3%. (IV-VI e)	Moderately deep, texture contrast soils with a sandy-loam to light-sandy-clay-loam surface soil with a bleached A2 horizon to 20-40 cm over neutral to alkaline, grey to yellow-brown, clay sub-soil (Dy 3.42, Dy 5.43, Dg 2.42); moderately deep bleached, yellow massive earths (Gn 2.75).	Cleared woodland of *E. crebra* and *E. tereticornis*, sometimes scattered lower trees of *A. implexa;* moderate ground cover of *Cymbopogon refractus*, *Aristida* spp. and *Bothriochloa decipiens*.
4 (20%) Plains of low relief, average slope 1.5%; up to 20% rock outcrops. (III-IV e f)	Deep, texture contrast soils with sand to sandy-loam surface soil with a bleached A2 horizon to 40-60 cm over acid to neutral, yellow or grey, mottled, clay sub-soil (Dy 3.41, Dy 3.42, Dy 5.42, Dg 2.42); minor: alkaline, texture contrast soils (Dy 3.43).	Extensively cleared grassy woodland of *E. tereticornis* with some *E. microcarpa* and *E. melliodora*, moderate ground cover similar to that of Units 2 and 3.
5 (15%) Alluvial flats, average slope 0.5%. (II e f)	Moderately deep to deep, texture contrast soils with fine-sandy-loam or light-sandy-clay-loam surface soil with a bleached A2 horizon to 30-40 cm over brown or mottled yellow, clay sub-soil (Db 3.41, Db 3.42, Dy 3.43).	Cleared grassy woodland of *E. microcarpa* and/or *E. populnea* with some *E. tereticornis;* dense ground cover of *Chloris ventricosa*, *Themeda australis* and *Bothriochloa decipiens*.

Climate:- A moisture deficit is usually experienced in this land system during the average year, March being the most critical month.

The mean and median annual rainfall are both around 655 mm with 34% falling in the winter months. The 24-hour rainfall intensity is 10 mm/rain day annually and 15 mm/rain day in January.

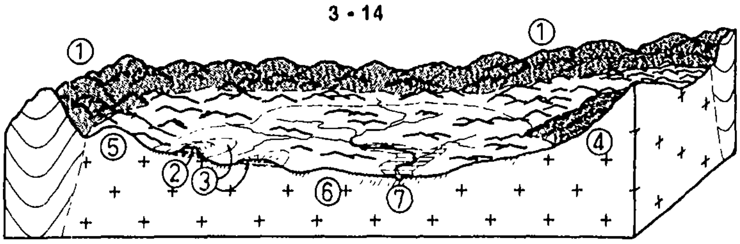
The mean January maximum temperature for the land system is 28^{o}C and the mean July minimum is about 2 ^{o}C.

Geology:- Greymare Granodiorite (Upper Permian to Lower Triassic) And undifferentiated metamorphosed sediments and minor volcanics (Devonian to Carboniferous).

Geomorphology:- A low lying eroded granitic basin surrounded to the west, south and east by a resistant metamorphic aureole in the Texas Beds or Traprock. Relative relief about 300 m.

Fauna:- Most A species.

Land Utilisation:- Mainly beef cattle grazing. Cultivation generally not recommented due to poor soil surface structures.



IRONPOT LAND SYSTEM, 500 km^2

Eroding granitic hills, some capped by residual sandstone layers, and granitic basins surrounded by traprock hills of intense relief.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetations
1 (30%) Steep traprock hills and incised valleys; average slope 20%, going up to 60%; stony surface common. (VII-VIII d r e)	Shallow, gravelly loams (Um); shallow to moderate deep,gravelly, texture contrast soils with loam to clay-loam surface soil with a bleached or pale A_2 horizon to 20-40 cm over acid, yellow-brown, clay sub-soil. (Dy 2.41, Dy 3.41, Dy 5.41, Db 2.41); minor; deep, brown, structured earths (Gn 3.21).	Partly cleared grassy woodland of *E. crebra* and occasional *E. dealbata, Angophora floribunda* and on lower slopes, *E. microcarpa* and *E. albens*, scattered lower trees of *Aca' leucoclada;* moderate ground cover of *Bothriochloa decipiens, Cymbopogon refractu* and *Aristida* spp. Small patches of softwood scrub with *Ficus platypoda, Alphitonia excelsu* and *Santalum lanceolatum* on steepest slopes.
2 (3%) Steep sandstone scarps and ridges,, average slopes 20%; some rock outcrops. (VII-VIII d r e)	Shallow, gravelly sands (Uc); shallow to moderately deep, acid, texture contrast soils (Dy 4.21, Dy 4.41).	Partly cleared woodland of *E. crebra* and *E. tereticornis* with sometimes dense lower tree layer of *Casuarina luehmannii* or in the south of the area of *E. andrewsii* and *E. tereticornis* with lower tree layer of *Acacia irrorata;* open ground cover of *Bothriochloa decipiens, Themeda australis* and *Imperata cylindrica* var. *major.*
3 (7%) Shallow sandstone layers, capping adamellite ridges; average slopes 3%, going up to 10 %. (VI r e)	Moderately deep, texture contrast soils with loamy-sand to sandy-loam surface soil with a bleached A_2 horizon to 25-35 cm over red to yellow, acid, clay sub-soil (Dr, Dy, Dg, Db); deep, red, massive earths (Gn 2.11); minor; deep, pale-brown, structured earths (Gn 3.94).	
4 (15%) Stony adamellite hills, average slope 30%. (VII e)	Shallow to deep, gritty, siliceous sands (Uc 2.34 , Uc 4.32); shallow, gritty sands (Uc 2.12)	Partly cleared shrub woodland of *E. crebra* and *E. dealbata*, scattered *Xanthorrhoea australis* on upper slopes; shrub layer, often dense, of *Jacksonia scoparia* and *Cassinia laevis*, ground cover of *Cymbopogon refractus Dichelachne micrantha* and *Themeda australis.*
5 (25%) Very low, stony adamellite hills, and plains of moderate relief; average slope 6%. (III-IV r e)	Deep, bleached, gritty, siliceous sands (Uc 2.12, Uc 2.21).	Extensively cleared woodland of *E. crebra* with *E. tereticornis* and *Angophora floribunda* on lower slopes, scattered lower trees of *Acacia leucoclada* and *A. implexa* and shrub layer, dense in places of *Cassinia laevis* and/ or *C. quinquefaria;* ground cover of *Bothriochloa decipiens, Cymbopogon refractus* and *Chloris* spp.
6 (10%) Pediment slopes, colluvial and alluvial plains of low relief; average slope 2.5%. (II-III e f)	Moderately deep, texture contrast soils with loamy-sand to clay-loam surface soil with pale or bleached A_2 horizon to 20 cm over neutral to alkaline, brown to pale-brown, clay sub-soil (Dy 2.23, Dy 3.23); deep, texture contrast soils with loamy sand to sandy loam surface soil with a mottled, bright-yellowish-brown, acid, clay sub-soil (Dy 5.21, Dy 3.42).	Cleared woodland of *E. tereticornis* and in places *E. microcarpa* or *E. caliginosa;* lower layers similar to Unit 5.
7 (10%) Eroding basins in minor granite intrusions; mainly low, irregular hills with minor colluvium and some incised areas of intense relief. (III-IV e)	Moderately deep, gritty, siliceous sands (Uc 2.12, Uc 2.21), on hills and upper slopes; moderately deep, texture contrast soils with loamy-sand surface soil with a bleached A_2 horizon to 30 cm over mottled, dull-brown or grey, acid to neutral, clay sub-soil (Dy 4.21) and moderately deep, yellow and gleyed podzolics (Dy, Dg), on lower slopes.	Cleared woodland of *E. crebra* and *E. tereticornis*, often with dense lower layer of *Casuarina luehmannii;* ground cover as for Units 2 and 3.

Climate:- A marked climatic gradient characterises this land system. From north-west to south-east it links the two contrasting climates of Evandale and Summit Land Systems. Thus in an average year, there is a distinct moisture deficit in the north-west and an increasing improvement towards the higher southerly parts of the land system. March is the critical month in the drier parts and November may see lower storages in the more favoured south.

Both mean and normal annual rainfall totals range from 670 mm in the north-west to 840 mm in the south-east. In the same order, 34% to 37% is the range for percentage winter rainfall. The annual 24-hour rainfall intensity is around 9 mm/rain day for the whole land system and 13 mm/rain day for January.

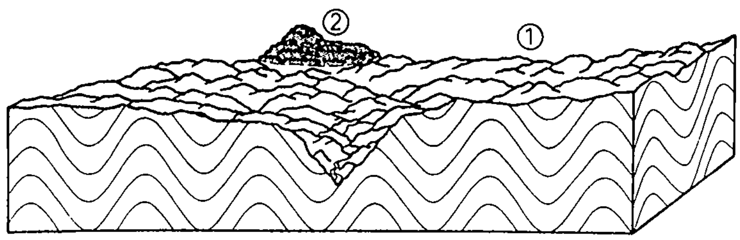
The overall mean January maximum temperature is around 26°C and July minimum 1°C.

Geology:- Herries Adamellite and Ruby Creek Granite (both Lower Triassic) overlain by Marburg Sandstone (Lower Jurassic) and intruding an undifferentiated mixed 'traprock' Palaeozoic mass.

Geomorphology:- An eroding granitic basin of mixed relief, draining mainly northwards towards Leslie Dam and surrounded by resistant metamorphic aureoles. In the north, relief is gentle within a narrow metamorphic ridge. To the south, the granitic relief becomes more intense and the metamorphics more extensive. The metamorphics in the east drop away sharply to Rosenthal Creek. Residual sandstone caps of varying thickness are found throughour the land system.Relative relief about 500 m.

Fauna:- Most A species, no rabbits.

Land Utilisation:- Mainly beef cattle, including stud farms; some wool production towards the west.



JIBBINBAR LAND SYSTEM, 240 km²

Deeply dissected traprock country downcut by the Severn River in its descent from the Granite Belt to the start of a floodplain at Mingoola.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (85%) Intensely dissected traprock mountains and deeply entrenched meanders of the Severn and tributaries; slopes up to vertical. (VIII d r e)	Shallow, gravelly loams (Um 1.23); shallow, gravelly earths (Gn); shallow, gravelly, texture contrast soils (D).	Woodland varying in composition locally and probably also from east to west. Prominent species: *E. caleyi, E. dealbata, E. crebra, E. melanophloia* (in western part), *E. sideroxylon, E. laevopinea* and *E. microcarpa*. Less common: *E. melliodora* and *E. albens, Callitris endlicheri, Acacia neriifolia* and *Casuarina luehmannii* most common lower trees. Shrub layer dense in places of *Cassinia laevis, Olearia elliptica* and *Dodonaea* spp. Ground cover low.
2 (15%) Granite outcrops: Jibbinbar Mountain is close to inselberg form and Red Rock is still partly overlain by traprock and forms a granitic depression east of the Severn. (VIII d r e)	Shallow to deep, gritty, siliceous sands (Uc); shallow, gritty sands (Uc); minor: yellow and gleyed podzolics (Dy, Dg). Soils are similar to unit 1 of Magnus L S	

Climate:- A slight tendency to a moisture deficit is seen in this land system for the average year, with March-April as the critical period.

Both the mean and median annual rainfall values are around 715 mm with a marked westwards declining gradient over the unit. 35% of total rainfall can be expected in the winter months. The 24-hour rainfall intensity is the highest for the study area with an annual figure of 13 mm/rain day and 17 mm/rain day in January.

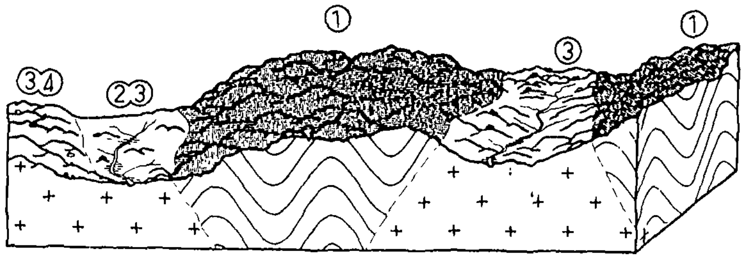
The mean January maximum temperature is around 27°C and the July minimum is 2°C.

Geology:- Undifferentiated sediments and minor volcanics (Devonian to Carboniferous); outcrops of Ruby Creek Granite.

Geomorphology:- Intensely dissected traprock mountains and knife-edge ridges around entrenched meanders of Severn River. Two outcrops of Ruby Creek Granite are found in the form of Jibbinbar Mtn., on the northern edge of the land system, and in the Red Rock depression east of the centre of the land system. Local relief about 750 m.

Fauna:- Most A species, rabbits and fallow deer.

Land Utilisation:- Rough grazing in accessible areas. Most of the area has little commercial value apart from various mines.



ROBERTS LAND SYSTEM, 110 km^2

A geologically complex highland area linking the granitic mass around Mt. Norman with the traprock mountains, south of Jibbinbar Mtn.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (50%) Traprock hills, average slope 14% going up to 25%; stony surface. (VII-VIII d r e)	Shallow, gravelly loams (Um); shallow, gravelly, texture contrast soils (D); soils are similar to Unit 1 of Glenlyon L S	Mixed eucalypt woodland, *E. dealbata* usually predominant, sometimes with dense understorey of *Acacia pubifolia* and *Leptospermum arachnoides*, ground cover low; on highest and wettest part in south small area of tall open forest of *E. radiata* and *E. dunnii* with understorey of *Hakea eriantha* and *Pteridium esculentum*.
2 (10%) Pediment and colluvial slopes, 1 to 3%. (IV e)	Moderately deep, texture contrast soils with a frequently gravelly surface soil over clay sub-soil (D); soils are similar to Unit 2 of Washpool L S	Woodland, extensively cleared of *E. microcarpa* and/or *E. conica*, patches of *Casuarina luehmannii*, sparse ground cover of *Aristida ramosa*, *Bothriochloa decipiens*, and *Stipa scabra*.
3 (15%) Minor eroding granitic basins; slopes mainly 0 to 5%, going up to 15%. (IV-VI e f)	Moderately deep, texture contrast soils with loam surface soil to 10-20 cm over alkaline, dark brown to yellowish-brown, mottled, clay sub-soil (Db 1.33, Db 4.23, Dy 3.13, Dy 3.43).	
4 (25%) Steep hills with rock outcrop and occasional tor formations, average slope 20%; minor depositional areas of low relief. (VII d r e)	Shallow to deep, bleached, gritty, siliceous sands (Uc 2); minor: moderately deep yellow and gleyed podzolics with loamy-sand surface soil with a bleached A2 horizon to 50-60 cm over acid, grey and yellow, gritty-clay sub-soil (Dg 4.81).	Layered woodland or open-forest of varied composition, *E. andrewsii* and *E. caliginosa* the commonest species, on shallower soils *E. dealbata*, *E. laevopinea*, *E.* sp. aff. *E. bancroftii* also common – all with well developed, floristically complex shrubby understorey.

Climate:- A slight moisture surplus is experienced in the average year, April being the critical month.

The mean annual rainfall is about 800 mm with a slightly lower median of about 780 mm. 34.5% of the rainfall total falls in the winter months. The annual 24-hour rainfall intensity figure is 11 mm/rain day and, for January, the figure is 15 mm/rain day.

This land system has a low mean January maximum temperature below 26°C. The mean July minimum is between 1° and 2°C.

Geology:- Mainly undifferentiated sediments and minor volcanics (Devonian to Carboniferous and Permian to Triassic) and Stanthorpe Adamellite (Lower Triassic); minor Bungulla Porphyritic Adamellite and Ruby Creek Granite (Lower Triassic) and Dundee Adamellite - Porphyrite (Middle Permian).

Geomorphology:- A complex area representing a meeting place for major influences to the south. The southern edge of the area is a watershed (and also the State border) and a particular feature of this is the steep scarp above Dorman's Flat. The land system is being actively cut back on its southern edge but is partly supported by highland to the north-east and north-west. Relative relief about 500 m.

Fauna:- Most A species, all B species except fallow deer, emu, corella, red-winged parrot and red kangaroo.

Land Utilisation:- Mainly low intensity beef cattle grazing. Developed pastures are suitable for fat lambs and breeding due to high winter rainfall.

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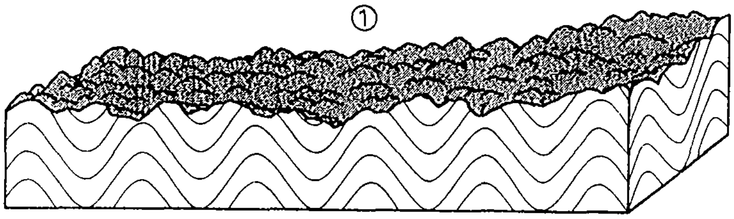


ARCOT LAND SYSTEM, 110 km^2

A deeply dissected Traprock hill block associated with the NNE - SSW aligned scarp extending from Mt. Burrabaranga.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (100%) Deeply dissected traprock hills, average slope 25% going up to 50%; stony surface. (VIII d r e)	Shallow, gravelly loams (Um 2.23); shallow, gravelly, texture contrast soils with loam surface soil with a bleached A2 horizon to 15–20 cm over yellowish-brown, acid, clay sub-soil (Dy 3.41).	Shrub woodland of *E. melanophloia*, *E. albens* and *E. dealbata*, shrub layer, often dense of *Acacia leiocalyx*, *Dodonaea attenuata* and *Cassinia laevis*, sparse ground cover of *Bothriochloa decipiens*.

Climate:- An area of marked moisture deficit in an average year, the most critical period being January through March.

Both the mean and the median annual rainfall is around 625 mm, with 37% being received in the winter months. The annual 24-hour rainfall intensity is 11 mm/rain day and, for January, is quite high at 16 mm/rain day.

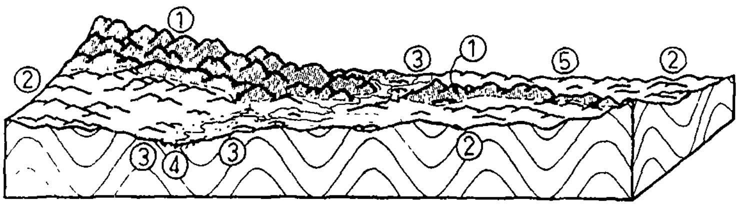
The mean January maximum temperature is 30°C and the July minimum is around 2.5°C.

Geology:- Undifferentiated sediments and minor volcanics (Devonian to Carboniferous).

Geomorphology:- A more resistant variety of traprock 100 - 200m. above the general level of traprock country; an isolated, major, north-trending, spur extending from the higher and probably more resistant traprock E of the scarp running SSE from Mt. Burrabaranga; the drainage pattern is intricate and down cuts sharply to produce very intense relief. Relative relief about 250 m.

Fauna:- Most A species and rabbits.

Land Utilisation:- Only rough grazing for wool production. Inaccessibility restricts any major development.



THANE LAND SYSTEM, 570 km^2

Traprock ridges and valleys, trending around NW/SE axis, transversely dissected by major drainage lines flowing north and north-eastwards to the Condamine River.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (55%) Traprock ridges, steep upper slopes and incised valleys; average slope 12% going up to 18%; minor rock outcrops and very stony surface common. (VII-VIII d r e)	Shallow, gravelly sands (Uc 1.21, Uc 1.23, Uc 4.21); shallow, gravelly loams (Um 2.12); shallow, gravelly, texture contrast soils with sandy-clay-loam surface soil with a bleached A2 horizon to 20-30 cm over red to yellow-brown, acid, clay sub-soil (Dr 2.41, Db 2.42, Dy 3.42).	Partly cleared open forest of *E. crebra* and *Angophora costata* or *E. maculata*, with patchy lower tree layer of *Casuarina luehmannii* and *Acacia* spp.; shrub layer of *Cassinia laevis, Olearia elliptica* and *Dodonaea* spp.; ground cover of *Aristida* spp. and *Ancistrachne ununulatum.*
2 (35%) Moderately steep slopes of lower traprock hills, 5 to 6%; minor rock outcrops. (VI d e)	Shallow, gravelly, texture contrast soils with loam to sandy-clay-loam surface soil with a bleached A2 horizon to 20-35 cm over red-brown to yellow, clay sub-soil (Db 1.41, Dy 2.43, Dy 3.42, Dy 5.43).	Extensively cleared woodland of *E. dealbata* and *E. crebra* with occasional *E. microcarpa;* shrub layer, sometimes dense of *Jacksonia scoparia* and *Acacia falcata;* sparse ground cover of *Aristida* spp., *Cymbopogon refractus* and *Themeda australis*.
3 (5%) Footslopes and areas of low relief, 3 to 4%. (VI r e)	Moderately deep to deep, gravelly, texture contrast soils with sandy-loam to sandy-clay-loam surface soil with a bleached A2 horizon to variable depth over neutral to alkaline, red, brown, or yellow, clay sub-soil (Dy 2.42, Db 1.43, Dd 1.43).	Partly cleared woodland of *E. microcarpa* and, occasionally, *E. crebra;* patchy shrub layer of *Myoporum deserti* and *Acacia* spp.; sparse ground cover of *Aristida* spp. and *Cymbopogon refractus*.
4 (5%) Narrow colluvial and alluvial flats, average slope 0.5%. (III e)	Deep, texture contrast soils with fine-sandy-loam to clay-loam surface soil with a pale or bleached A2 horizon to 30 cm over neutral to alkaline, yellow to brown, clay sub-soils (Dy 2.22), minor: deep, texture contrast soils, with dark, alkaline, clay sub-soil (Dd 1.43, Db 1.42).	Cleared woodland of *E. microcarpa, E. populnea* and occasional *E. melliodora* with scattered shrubs and moderate ground cover of *Aristida* spp., *Bothriochloa decipiens* and introduced species.
5 (< 1%) Minor low sandstone hills, relict from past sedimentary cover; average slope 3% going up to 5%. (VI r e)	Moderately deep, acid, texture contrast soils (D); soils similar to Unit 5 of Canal L S	Open forest or woodland of *E. crebra* and *Angophora costata* with scattered *Callitris columellaris* and *Casuarina luehmannii*.

Climate:- This land system experiences a marked moisture deficit in the average year, March being the most critical month.

The mean and median annual rainfall are both around 650 mm, of which 33.5% falls in the winter months. The annual 24-hour rainfall intensity is 12 mm/rain day and, for January, is 15 mm/rain day.

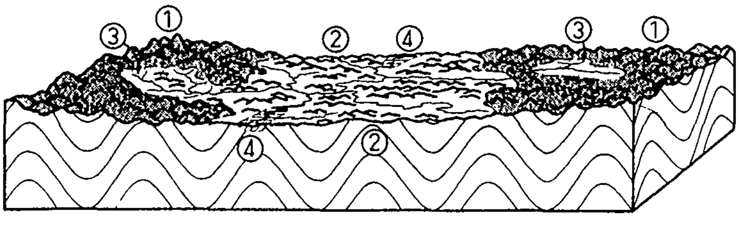
The mean January maximum temperature is around 29°C and the July minimum is 2.5°C.

Geology:- Undifferentiated Devonian to Carboniferous sediments and minor volcanics; Pleistocene alluvium in drainage lines.

Geomorphology:- Lower northern slopes of the main Traprock mass. Drainage pattern probably an antecedent from sedimentry cover of the Jurassic period. Relative relief about 250 m.

Fauna:- Most A species, B species include yellow robin, white-browed babbler, white face and emu in the north - west. No rabbits.

Land Utilisation:- Beef cattle and sheep grazing, mainly wethers, with timber reserves and State Forest in the most rugged areas.



GORE LAND SYSTEM, 1080 km²

Traprock ranges and scarps including much of the Herries Range and the upper catchments of Macintyre Brook and Bodumba Ck.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (70%) Steep traprock hills and scarps, average slope 10% going up to 20%; very stony surface. (VII d r e)	Shallow, gravelly loams (Um 1.23, Um 1.43, Um 2.12); shallow, gravelly, texture contrast soils (D).	Extensively cleared woodland of *E. crebra* and *E. dealbata* with clumps of *Callitris columellaris* and shrub layer, sometimes dense, of *Cassinia laevis;* open ground cover of *Bothriochloa decipiens* and *Aristida ramosa.*
2 (15%) Lower valley side slopes on major, down-cutting drainage lines; average slope 6% going up to 8%; very stony surface. (VII d r e)	Shallow, gravelly loams (Um 1.21, Um 5.21); shallow, gravelly, texture contrast soils (Db 1.43).	Cleared woodland of *E. microcarpa* and occasional *E. melliodora*, occasional patches of *Casuarina luehmannii* and *Acacia deanei;* low to moderate ground cover of *Aristida ramosa, Bothriochloa decipiens* and *Chloris* spp. (units 2, 3 and 4)
3 (10%) Lower valley side slopes on minor, elevated drainage lines; slopes 4 to 6%; slightly stony surface. (VI-VII d r e)	Shallow, gravelly, texture contrast soils with sandy-loam to clay-loam surface soil frequently with a bleached A2 horizon to 20-30 cm over red-brown to pale-brown, acid to neutral, clay sub-soil (Db 2.41, Db 3.13, Dy 2.11, Dy 2.41).	
4 (5%) Colluvial slopes, alluvial flats and minor pediment surfaces; slopes 0 to 3%. (III e f)	Moderately deep to deep, frequently gravelly, texture contrast soils with sandy-clay-loam surface with a thin (< 5 cm), A2 horizon to 10 cm over brown, alkaline, clay sub-soil (Db 3.53, Db 3.33).	

Climate:- A large land system covering areas of moderate to marked moisture deficits in the average year, March being the most critical month.

The mean and median annual rainfall are both around 640 mm. The winter rainfall percentage varies from 32% in the north of the unit to 37% in the south. Annual 24-hour rainfall intensity is 12 mm/rain day and the January figure is quite high at 16 mm/rain day.

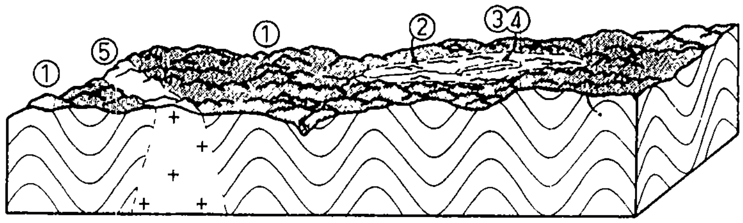
The mean January maximum temperature is around 29° to 30°C and the July minimum is between 1.5°C and 3.5°C, increasing north-westwards.

Geology:- Undifferentiated sediments and minor volcanics (Devonian to Carboniferous) and minor occurrence of Pleistocene alluvium.

Geomorphology:- A series of curved traprock strike ridges running W - E in the west to NW - SE in the east, where a scarp running NNE - SSW through Mt. Burrabaranga forms the edge of the land system. Main drainage lines, flowing to the south-west across the ridges, could be an antecedent pattern from sedimentary cover of the Jurassic period. Relative relief about 450 m.

Fauna:- Most A species. B species include rabbit, corella and red-winged parrot

Land Utilisation:- Predominantly sheep grazing.



PIKEDALE LAND SYSTEM, 1030 km^2

Traprock hills including much of the upper Pike Creek catchment and extending to Mt. Burrabarranga. The LS is bounded in the east by the edge of the New England batholith and in the west by the scarp running from Mt. Burrabarranga to the eastern limit of Arcot LS. A separate small extension of the LS is centred on the upper part of Middle Creek, north west of Dalveen.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 **(75%)** Low traprock hills; average slope 10%, going up to 20%; stony surface. (VII-VIII d r e)	Shallow, gravelly loams (Um 1.23, Um 2.12); shallow, gravelly, texture contrast soils with loam surface soil with a bleach to 30 cm over dull-yellowish, brown, acid, clay sub-soil (Dy 2.41, Dy 2.42); shallow to deep, gravelly, massive earths (Gn 2.11, K-Gn 2.41, Gn 2.82, Gn 2.94); an area west of Dalveen has shallow, gravelly, texture contrast soils with black, granular, sandy clay-loam to clay-loam surface soil to 10 cm over blocky, dark-brown to red, acid to neutral, clay sub-soil (Dr 2.12, Db 1.12, Dr 2.41).	Partly cleared woodland of *E. crebra, E. dealbata* and in places *E. sideroxylon, E. maculata* and *Angophora floribunda*, sometimes scattered lower trees of *Acacia neriifolia* and open shrub layer of *Daviesia* spp.; open ground layer of *Aristida* spp., *Enneapogon* spp., and *Danthonia linkii*.
2 **(10%)** Areas of moderate relief; slopes 4 to 5%; slightly stony surface. (VI d r e)	Shallow, gravelly loams (Um); shallow, gravelly sands (Uc 1.21); shallow, gravelly, texture contrast soils with sandy-clay-loam surface soil to 20-25 cm over yellow-brown, acid, clay sub-soil (Dy 2.11, Dy 2.21, Dy 3.41); minor; deep, texture contrast soils (Dy 3.12).	Extensively cleared woodland of *E. microcarpa, E. melliodora*, occasional *E. tereticornis* and *Angophora floribunda*, and, in the southern part of the land system, *E. albens*, and in the eastern area, *E. caliginosa;* trees and shrubs sporadic; moderate ground cover, mainly *Dichelachne micrantha, Bothriochloa decipiens, Danthonia linkii* and *Enneapogon* spp.
3 **(6%)** Lower pediment slopes, average 3%. (IV d r e)	Shallow, gravelly, texture contrast soils with loam to clay-loam surface soil frequently with a bleached A_2 horizon to 30 cm over red-brown to pale-yellow, acid to neutral, clay sub-soils (Dy 2.11, Dy 2.41, Dy 2.42, Db 1.12, Dg 3.41); minor; deep, acid to neutral, texture contrast soils (D); shallow, gravelly loams (K Um 2.12).	
4 **(3%)** Narrow colluvial and alluvial areas; slopes 0 to 2%. (III-IV e f)	Moderately deep to deep, gravelly, texture contrast soils with loam surface soil, frequently with a bleached A_2 horizon, over yellow-brown to brown, neutral to alkaline clay sub-soil (Dy 2.12, Db 2.43); shallow, gravelly, grey and brown, structured earths (Gn 3.21, Gn 3.94).	Extensively cleared grassy open-forest of *E. tereticornis* and *Angophora subvelutina*, ground cover mainly introduced *Paspalum dilatatum* with some *Cyperus* spp. and *Juncus* spp. in moist situations.
5 **(6%)** A linear granitic intrusion of low hills and a few small areas of low relief; average slope 12%. (VI-VII d e)	Shallow to moderately deep, gritty siliceous sands (Uc 4.21); shallow, gritty sands (Uc); minor; yellow and gleyed podzolics (Dy,Dg).	Probably woodland of *E. crebra*.

Climate:- The land system extends from areas of marginal moisture adequacy to areas of moderate deficits in average years. March is the critical month.

Both the mean and median annual rainfall figures, for the main unit, are around 700 mm, with 36% being received in winter. The small north-eastern unit's mean and median figures are 770 mm, with the same winter percentage. 24-hour rainfall intensity figures are 12 mm/rain day for the average year and a high figure for January of 17 mm/rain day.

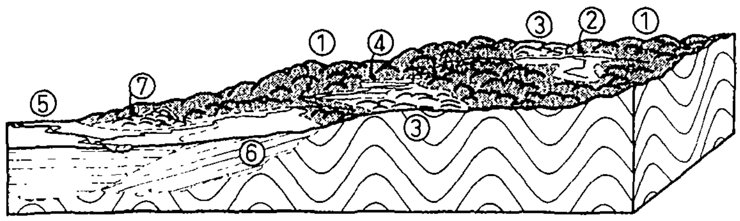
The mean January maximum temperature is around 28°C and the July minimum, between 1° and 2°C. Comparable figures for the smaller unit are below 26°C and below 1°C.

Geology:- Undifferentiated sediments and minor volcanics (Devonian to Carboniferous, minor Permian to Triassic) and minor Ruby Creek Granite (Lower Triassic).

Geomorphology:- Low hills with relatively gentle relief except close to the actively downcutting Pike Creek, where dissection around the deeply incised meanders is intense. A similar small area of intense relief is found where the LS impinges on the Severn River. Relative relief about 450 m.

Fauna:- Most A species, rabbits and fallow deer.

Land Utilisation:- Mainly sheep breeding and fat lambs, some beef cattle close to the higher land in the east.



TEXAS LAND SYSTEM, 530 km^2

Traprock hills forming the catchment of Oakey Ck. running into a segment of the Dumaresq floodplain.

Land Unit No. (% occurrence) Landfom Description (Land Class and Limitations)	Soils	Vegetation
1 (65%) Low traprock hills; average slope 8%, going up to 20%; stony surface. (VI-VII d r e)	Shallow, gravelly, loams (Um); shallow, gravelly, texture contrast soils (D); shallow, gravelly, massive earths (Gn 2.11).	Partly cleared woodland of *E. dealbata, E. melanophloia, E. crebra* and occasionally *E. sideroxylon*, lower tree layer of *Callitris columellaris* and shrub layer of *Acacia* spp. sometimes well developed; ground cover sparse, mainly *Aristida ramosa* and *Cymbopogon refractus*.
2 (6%) Elevated areas of low relief; pediment type land surface; slopes 2 to 6%. (IV-VI d)	Moderately deep, gravelly, texture contrast soils (D); deep, red-brown, alkaline, structured earths (terra rossa) on limestone (Gn 3.13).	Extensively cleared grassy woodland of *E. microcarpa* and *E. melliodora* usually with some *E. melanophloia* and occasionally with *E. populnea* or *E. albens* and occasional patches of *Acacia harpophylla;* ground cover sparse to dense, predominantly *Aristida ramosa, Bothriochloa decipiens, Cymbopogon refractus*, and *Chloris* spp. (units 2, 3 and 4)
3 (3%) Gently undulating foot-slopes; slopes 4 to 5%; stony surface common. (IV r e)	Moderately deep, gravelly, texture contrast soils (D); deep, red-brown, alkaline, structured earths (terra rossa) on limestone (Gn 3.13).	
4 (6%) Narrow colluvial and alluvial areas; slopes 0 to 1%. (II-III e f)	Moderately deep to deep, texture contrast soils with fine-sandy-loam to silty-clay-loam surface soil frequently with a bleached A2 horizon to 30-40 cm over brown to reddish-brown, neutral, clay sub-soil (Dr 2.42, Db 1.42, Db 1.52); minor; deep, brown, sandy-loams to clay-loams (Gn 2).	
5 (12%) Flat alluvial plains of the Dumaresq River; average slope 0.5%. (II-III e f)	Deep, structured earths with hardsetting, clay-loam surface soil frequently with a bleached A2 horizon grading into a dark-brown, neutral to alkaline, clay sub-soil (Gn 3.23,Gn 3.25); deep, texture contrast soil with hardsetting, loam to clay-loam surface soil with a bleached A2 horizon to 30-35 cm over greyish-yellow-brown, coarse-blocky or columnar, alkaline, clay sub-soil (Dy 2.42, Dd 1.43); minor: dark, loams to clay-loams (Um 1.43, Gn 2.43).	Cleared tall woodland of *E. tereticornis, Angophora subvelutina* and occasionally *E. populnea* and *E. pilligaensis;* ground cover disturbed, mostly introduced species.
6 (6%) Detrital slopes, 1 to 3%, around granitic and traprock outcrops. (III e)	Deep, grey and brown, cracking clays with self-mulching surface soil over alkaline sub-soil with gypsum and-or lime evident; commonly gilgaied (Ug 5.13, Ug 5.24); deep, texture contrast soils with sandy-loam to clay-loam surface soil frequently with a thin <5 cm bleached A2 horizon to 10-30 cm over a frequently gravelly, coarse-columnar or coarse-blocky, reddish-brown, alkaline, clay sub-soil commonly containing lime (Db 2.13, Db 4.43).	Cleared woodland of *E. populnea* and/or *E. pilligaenis* with small areas of open forest of *Acacia harpophylla* with under-storey of *Geijera parviflora;* ground cover moderate, *Stipa verticellata, Paspalidium* spp. and *Chloris* spp.
7 (2%) A catena of low relief, granite landforms, from tor clusters to depositional slopes, the latter dominating. (V r)	Moderately deep, texture contrast soils with gritty, sandy-loam to sandy-clay-loam surface soil with a bleached or pale A2 horizon to 30 cm over bright-reddish-brown to yellow-brown, alkaline, clay sub-soil (Dy 2.23, Dy 3.43); minor: moderately deep, texture contrast soils with acid to neutral, clay sub-soils (D); shallow, gritty, siliceous sands (Uc).	Cleared, probably woodland of *E. melanophloia* and/or *E. microcarpa* with scattered *Callitris columellaris*, ground cover similar to units 2,3 and 4.

Climate:- This land system experiences severe to moderate moisture deficits in the average year, the most critical month being January.

The mean annual rainfall is 625 mm and median 610 mm, 34% to 37% being received in winter. Annual 24-hour rainfall intensity is 11 mm/rain day and, for January is 14 mm/rain day.

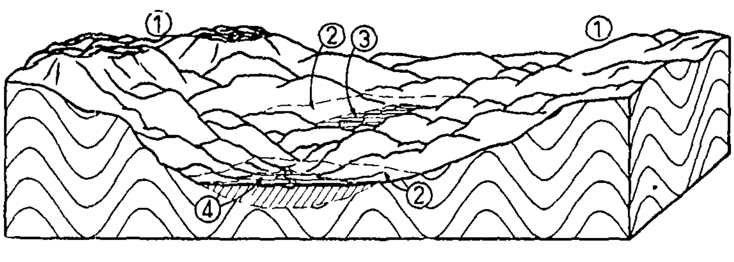
The mean January maximum temperature is over 30°C and the July minimum between 2.5° and 3 °C.

Geology:- Mainly undifferentiated sediments and minor volcanics (Devonian to Carboniferous and some Permian to Triassic) and Pleistocene alluvium; minor granite or granodiorite outcrops (Lower Triassic).

Geomorphology:- The upper catchment, as far as Limevale, comprises dissected traprock hills with some elevated areas of low relief and narrow alluvial flats. South of Limevale, the lower catchment comprises short streams in hills of lower relief including some granitic outcrops. The alluvium is divided into the Dumaresq floodplain and an older depositional area around the granitic outcrops. Relative relief about 350 m.

Fauna:- Most A species. B species include rabbit, emu, corella, red-winged parrot and red kangaroo in some years.

Land Utilisation:- Wool production in the timbered and open country; breeding and fat lambs, with some cropping, on the flats.



GLENLYON LAND SYSTEM, 610 km^2

Strongly dissected Traprock hills including the lower stretch of Pike Creek and the start of the Dumaresq/ Severn floodplain.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations	Soils	Vegetation
1 (88%) Traprock hills; average slope 11%, going up to 20%; stony surface common. (VI-VII d r e)	Shallow, gravelly loams (Um 3.12, Um 5.51); shallow, gravelly earths (Gn 2.22, Gn 3.22); shallow to moderately deep, gravelly, texture contrast soils (Dy 2.32, Dy 3.41).	Woodland of *E. melanophloia*, *E. dealbata* and *E. crebra* (on upper slopes) and *E. microcarpa* and *E. melliodora* (on lower slopes), some patches of *Callitris columellaris;* ground cover moderate, *Bothriochloa decipiens, Danthonia linkii, Cymbopogon refractus* and *Chloris* spp.
2 (5%) Short footslopes, usually fringing watercourses or floodplains; average slope 4%; slightly stony surface. (IV d r e)	Shallow to moderately deep, gravelly, texture contrast soils with light-sandy-clay-loam surface soil with a pale or bleached A2 horizon to 20-30 cm over brown, alkaline, clay sub-soil (Db 1.22, Db 1.42); shallow, gravelly, structured earths, with light-sandy-clay-loam surface soil with a pale or bleached A2 horizon to 20-30 cm grading into a brown, alkaline, clay sub-soil (Gn 3.26, Gn 3.06); minor: red and brown, cracking clays (Ug 5.3).	Extensively cleared grassy woodland of *E. microcarpa* and *E. melliodora;* moderately dense ground cover mainly *Bothriochloa decipiens, Aristida ramosa* and *Stipa ramosissima.* (units 2 and 3)
3 (2%) Narrow colluvial and alluvial areas; slopes 0 to 4%. (III-IV g f)	Moderately deep, gravelly, texture contrast soils with loam surface soil with a pale A2 horizon to 30 cm over brownish-grey, neutral to alkaline, clay sub-soil (Dy 5.22).	
4 (5%) Alluvial plains, slopes 0 to 1% (II-III e f)	Deep, dark-brown, massive earths with brownish-black, loam to clay loam surface soil grading into dark-brown or brown, alkaline, clay sub-soils (Gn 2.43); deep, dark-brown, texture contrast soils, with brownish-black, loam surface soil to 30 cm over dark-brown, alkaline, clay sub-soil (Db 1.53); deep, dark, alluvial soils - dark-brown, loams to clay-loams, frequently layered (Um 1.23, Um 5.52); minor: dark, hardsetting clays (Uf 6).	Cleared grassy woodland of *E. tereticornis.*

Climate:- A moderate moisture deficit is experienced in the average year and is usually most serious in the March - April period.

The mean and median annual rainfall totals are both around 640 mm, 36% of which falls in the winter months. 24-hour rainfall intensity figures are 12 mm/rain day for the year and 15 mm/rain day for January.

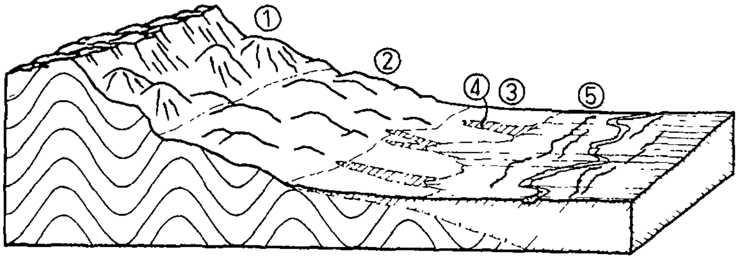
The mean January maximum temperature is around 29°C and the July minimum is between 2° and 3°C.

Geology:- Undifferentiated sediments and minor volcanics (Devonian to Carboniferous and some Permian to Triassic); minor Pleistocene alluvium.

Geomorphology:- Intensely dissected traprock ranges, trending NW-SE in the Pike Ck. catchment and N - S in the far south of the land system which drains directly to the Dumaresq; significant areas of the Dumaresq/Severn floodplain start just north of Mingoola; some elevated plateau like areas of relatively low relief form dip slopes to the scarp forming the eastern edge of Bonshaw LS. Relative relief about 375 m.

Fauna:- Most A species, rabbits and B species bats which occur in the Glenlyon Cave system.

Land Utilisation:- Mainly beef cattle with some sheep grazing; fodder crops on less steep units and on the flats with tobacco.



BONSHAW LAND SYSTEM, 380 km^2

Traprock scarps and foothills sloping west to the Dumaresq River.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (35%) Steep traprock hills and scarps; average slope 20%, going over 100%; stony surface. (VII-VIII d r e)	Shallow, gravelly loams (Um 5.21, Um 1.13); shallow, gravelly, texture contrast soils (D).	Woodland of *E. dealbata* and *E. melanophloia*, patches of *Callitris columellaris* and sometimes well developed shrub layer of *Geijera parviflora*, *Olearia elliptica* and *Notelaea microcarpa;* open ground cover of *Cymbopogon refractus* and *Danthonia linkii.*
2 (25%) Foothills and lower hillslopes; average slope 7%, going up to 12%; stony surface and minor rock outcrops. (VI-VII d r e)	Shallow, gravelly loams (Um 2.12); shallow, gravelly, texture contrast soils (D); minor: moderately deep, gravelly, red-brown, alkaline, structured earths (terra rossa) on limestone (Gc 2.22); brown, hardsetting clays (Uf 6.3).	As for unit 1, but *E. dealbata* is absent and *E. microcarpa* quite frequent; extensively cleared. (units 2 and 3)
3 (12%) Pediment slopes and some colluvial footslopes; average slope 3%. (III-IV r e)	Shallow to moderately deep, frequently gravelly, texture contrast soils with sandy-clay-loam surface soil to 10 cm over dark-brown, alkaline, clay sub-soil (Dd 1.13); minor: red brown, structured earths (terra rossa) on limestone (Gc, Uf).	
4 (3%) Narrow, colluvial and alluvial areas; average slope 1%. (III-IV e)	Deep, texture contrast soils with loamy-sand to silty-clay-loam surface soil with a bleached A2 horizon to 40-60 cm over brown or pale-brown, neutral, clay sub-soil (Dg 1.42, Db 3.42).	Extensively cleared woodland of *E. microcarpa, E. melliodora* and occasional *E. melanophloia* and *Angophora floribunda*, moderate to dense ground cover of *Stipa verticillata, Bothriochloa decipiens* and *Eragrostis* spp.
5 (25%) Flat plains of the Dumaresq River; average slope 0.5%, going up to 1%; some flood channels and other microrelief. (II-III e f)	Deep, texture contrast soils with clay-loam surface soil with a pale A2 horizon to 30 cm over dark-brown, alkaline, clay sub-soil (Dd 3.23); deep, dark-brown, alkaline, structured earths (Gn 3.23); medium-textured alluvial soils (Um); moderately deep, gravelly texture contrast soils with sandy-clay-loam surface soil with a bleached A2 horizon to 60 cm over yellowish-brown, clay sub-soil (Dy 3.41).	Extensively cleared woodland of *E. populnea* with occasional *E. melliodora* and *Angophora floribunda;* moderate ground cover of *Bothriochloa decipiens*, and *Chloris* spp.

Climate:- A marked moisture deficit is usual in this land system for the average year, with January as the most critical month.

The mean and median annual rainfall totals are both around 630 mm, with a winter component ranging from 35% in the south of the unit to 38% in the north. 24-hour rainfall intensity for the year is 10 mm/rain day, and for January is 14 mm/rain day.

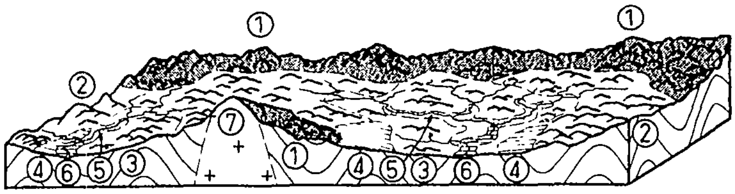
The mean January maximum temperature is around 30°C and the July minimum is around 2.5°C.

Geology:- Undifferentiated sediments and minor volcanics (Devonian to Carboniferous), some volcanics or sediments (Permian to Triassic) and alluvium (Pleistocene).

Geomorphology:- A series of short river valleys feed westwards into the Dumaresq River, in its northwards run towards Texas, cutting back into a west-facing scarp which is a southward extension of the scarp running SSW from Mt. Burrabaranga. Relative relief about 350 m.

Fauna:- Most A species and rabbits.

Land Utilisation:- Predominantly beef cattle grazing and various forms of cropping on the flats; some wool production.



WARROO LAND SYSTEM, 840 km^2

The basin of Bracker Creek and tributaries centred on Mt. Bullanganang.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (35%) Steep traprock hills and scarps; slopes 10 to 15%, going up to 25%; very stony surface. (VII d r)	Shallow, gravelly, loams (Um 1.23); shallow, gravelly, texture contrast soils (Dr 2.11).	
2 (30%) Traprock foothills; average slope 6%, going up to 12%; stony surface common. (VI-VII d r e)	Shallow, gravelly loams (Um); shallow, gravelly, texture contrast soils (Db 1.11, Dy 2.11).	
3 (8%) Lower valley side slopes and low divides; average slope 4%. (IV-VI e)	Shallow, gravelly loams (Um); shallow, gravelly sands (Uc 2.12); moderately deep, frequently gravelly, texture contrast soils with light-sandy-clay-loam to clay-loam surface soils commonly with a bleached A_2 horizon over yellow-brown to red-brown, clay sub-soil (Db 4.42, Dy 2.13, Db 2.11).	Extensively cleared woodland of *E. albens* and *E. crebra* with *E. dealbata* on upper slopes (occasional *E. caleyi* and *E. exserta* along boundary of Gore L S); occasional dense lower tree layer of *Callitris columellaris;* ground cover low to moderate, mainly *Aristida* spp., *Bothriochloa decipiens* and *Eragrostis* spp.
4 (7%) Short pediment slopes; average 2%. (VI d r e)	Shallow, gravelly, texture contrast soils with light-sandy-clay-loam to clay-loam surface soil commonly with a bleached A_2 horizon to 25 cm over yellow-brown, acid to neutral, clay sub-soil (Dy 2.11, Dy 3.42); shallow, gravelly loams (Um); shallow, gravelly sands (Uc 2.34).	
5 (7%) Narrow colluvial areas; average slope 0.5%. (III-IV e)	Shallow to deep, gravelly, texture contrast soils with sandy-loam to clay-loam surface soil with a bleached A_2 horizon to 20-60 cm over grey-brown to pale-brown, neutral, clay sub-soil (Dy 2.42, Dy 4.41).	Cleared woodland of *E. microcarpa, E. melliodora, E. pilligaenis* and occasional *E. tereticornis;* lower tree layer of *Casuarina luehmannii* and shrub layer of *Dodonaea* spp. and *Cassinia laevis* sometimes developed; open ground cover of *Bothriochloa decipiens, Aristida ramosa* and *Cymbopogon refractus.*
6 (10%) Narrow alluvial areas; slopes 0 to 0.5%. (II - III e f)	Moderately deep to deep, texture contrast soils with fine-sandy-loam to clay-loam surface soil with a pale or bleached A_2 horizon to 30-70 cm over yellowish-brown, neutral to alkaline, clay sub-soil (Db 1.22, Dy 2.34, Dy 3.42).	
7 (3%) Minor granitic intrusions of varying resistance and relief; Mt. Bullanganang is major unit with slopes up to 30%. (VII d e)	Shallow to deep, gritty, siliceous sands(Uc 2.31); shallow, gritty, sands (Uc); shallow, siliceous sands (Uc 2.12); shallow, texture contrast soils with sand surface soil with a bleached A_2 horizon over acid, clay-loam to clay-sub-soil (Dy 4.81).	Mainly shrub woodland of *E. dealbata, E. caleyi* and *Callitris columellaris* with lower layers of *Leptospermum arachnoides, Petalostigma pubescens* and *Acacia decora;* ground cover sparse.

Climate:- This land system experiences a marked moisture deficit in the average year, March being the most critical month.

Both the mean and median annual rainfall totals are around 640 mm, 34% to 36% of which usually falls in winter. Annual 24-hour rainfall intensity is 11 mm/rain day and, for January, 15 mm/rain day.

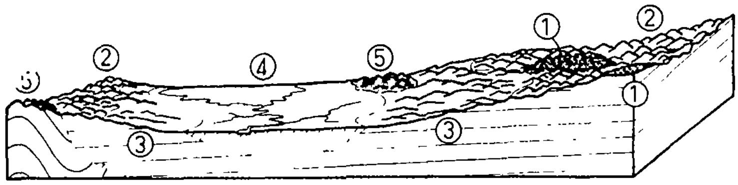
The mean January maximum temperature is around 30^oC and the July minimum about 2.5^oC.

Geology:- Undifferentiated sediments and minor volcanics (Devonian to Carboniferous) and minor undifferentiated volcanics or sediments (Permian to Triassic), intruded in two places by granite or granodiorite (Lower Triassic).

Geomorphology:- A dendritic drainage pattern of narrow alluvial flats flowing NW in low Traprock hills, bounded in the north and south by steep, dissected Traprock hills and, in the east, by an extension of the NNE-SSW aligned scarp starting in the Mt. Burrabaranga area. Mt. Bullanganang is a prominent resistant granitic feature in the centre of the land system. Relative relief about 400 m.

Fauna:- Most A species, B species include rabbit, emu and possibly fallow deer.

Land Utilisation:- Mainly beef cattle with sheep in the ridge country; fodder cropping and improved pastures in better areas.



LESLIE LAND SYSTEM, 160 km^2

Undulating sandstone hills and flat-topped ridges on either side of the Upper Condamine flats; minor Traprock protrusions.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (3%) Flat-topped sandstone ridges and scarps, slopes 0-15%. (VII e)	Shallow to moderately deep, texture contrast soils with sandy-loam to clay-loam surface soil, frequently with a bleached A2 horizon to 5-35 cm over reddish-brown, blocky, acid, clay sub-soil (Dr 2.11, Dr 4.41); minor: shallow, earthy sands with red-brown to brown, massive, neutral sub-soils (Gn 2.42); shallow, gravelly sands (Uc 1); shallow, texture contrast soils with grey to yellow, clay sub-soils (Dg, Dy).	Extensively cleared woodland of *E. crebra* with dense understorey of either 'softwood' *(Flindersia collina, Notelaea microcarpa, Heterodendrum diversifolium, Citriobatus spinescens* or 'heath' species *(Leptospermum flavescens, Dillwynia* spp., *Hakea* sp.) and *Acacia blakei* and *Triodia mitchellii.*
2 (40%) Undulating areas of moderate relief, slopes 2 to 6%. (IV-VI e)	Moderately deep to deep, texture contrast soils with loamy-sand to sandy-clay-loam surface soil, frequently with a bleached A2 horizon to 10-60 cm over reddish-brown to yellowish-brown, clay sub-soil (Dr 2.12, Dr 4.41, Db 2.42, Db 3.13, Dy 2.43); moderately deep to deep, red, massive earths with a frequently gravelly, sandy-clay-loam surface soil grading into a massive, dark-reddish-brown to brown, acid to neutral, sandy-clay sub-soil (Gn 2.11, Gn 2.12, Um 5.52); minor: grey, brown and dark, cracking clays (Ug 5.1, Ug 5.2).	Cleared woodland of *E. microcarpa* and *E. tereticornis*, dense ground cover of mostly introduced species such as *Paspalum dilatatum.* (units 2 and 3)
3 (25%) Flat plains and plains of low relief, slopes 0 to 2%. (III-IV e w)	Deep, texture contrast soils with loamy-sandy to sandy-clay-loam surface soil, frequently with a bleached A2 horizon to 10-40 cm over brown to yellowish-brown, neutral to alkaline, blocky or columnar, clay sub-soil, with lime or manganese concretions common in sub-soil (Db 2.33, Db 3.13, Dy 2.22, Dy 4.12, Db 2.33); minor: deep, grey, cracking clays (Ug 5.2).	
4 (30%) Condamine flat plains, mainly 0% slope but up to 2% locally, 1 to 2 km wide. (II w)	Deep, dark, cracking clays (Ug 5.17); minor: deep, dark, loams, to clay-loams of neutral pH (Um 5.52).	Woodland of *E. camaldulensis*, now cleared and usually cultivated.
5 (2%) Isolated traprock knolls, average slopes 5%. (VI d r e)	Shallow, gravelly loams (Um); shallow, gravelly texture contrast soils (D).	Extensively cleared woodland of *E. crebra* and *E. dealbata* with scattered patches of *Callitris columellaris;* open ground cover of *Aristida* spp. and *Bothriochloa decipiens.*

Climate:- A moderate moisture deficit is experienced in the average year, with March being the most critical month.

Both the mean and median annual rainfall totals are around 685 mm, with a winter component of about 34%. The annual 24-hour rainfall intensity is 10 mm/ rain day, and the January figure is 15 mm/ rain day.

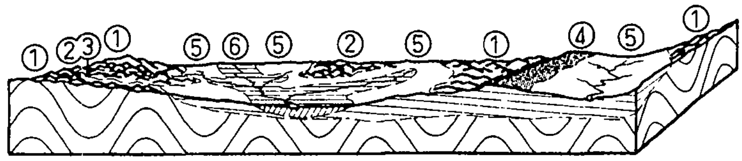
The mean January maximum temperature is around 27.5°C and the July minimum is around 1.5°C.

Geology:- Marburg sandstone (Lower Jurassic) and Pleistocene alluvium; minor undifferentiated Devonian to Carboniferous sediments and minor volcanics.

Geomorphology:- Undulating remnants of Lower Jurassic sediments displaying greater relief than in occurrences elsewhere and possible evidence of a basalt protective cover. Broad flood plains of the CondamineRiver divide the sandstone, and a few isolated traprock knolls protrude, Relative relief about 200 m.

Fauna:- Most A species. No rabbits.

Land Utilisation:- Predominantly beef cattle grazing with fodder and cash cropping on the flats; some horticulture and fruit growing near Warwick.



CANAL LAND SYSTEM, 310 km^2

Sandstone hills and alluvial flats of lower Canal Creek and its tributaries, with minor Traprock protrusions.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (15%) Upper traprock hill-slopes, ridges and incised valleys, slopes 3 to 10%, minor rock outcrops. (VI-VII d r e)	Shallow, gravelly loams (Um); shallow, gravelly, texture contrast soils (D).	Partly cleared woodland of *E. crebra* and *E. dealbata* with scattered *Callitris columellaris;* open ground cover of *Bothriochloa decipiens* and *Aristida* spp.
2 (4%) Lower traprock hill-slopes, 1 to 3%, slightly stony. (IV-VI r e)	Shallow, gravelly, reddish-brown to bright-brown, clay-loams and clays (Um 5.51, Uf 6.71); shallow, gravelly, texture contrast soils (D).	Extensively cleared woodland of *E. microcarpa,* occasionally with dense shrub layer of *Acacia ixiophylla,* moderate ground cover of *Cymbopogon refractus, Enneapogon* spp. and *Aristida* spp.
3 (1%) Minor colluvial units, slopes about 1%. (III-IV e)	Moderately deep to deep, neutral to alkaline, texture contrast soils (D).	
4 (5%) Steep scarps and narrow dip slopes and ridges, average slope about 15% up to 100%, rock outcrop. (VII-VIII d r e)	Shallow, gravelly sands (Uc); shallow, gravelly, texture contrast soils with loam surface soil with a sporadic bleached A_2 horizon at 20 cm over brownish-grey or dark-reddish-brown, blocky, acid, clay sub-soil (Dy 2.31); deep, bleached, siliceous sands (Uc 2.12, Uc 2.31).	Open forest of *E. siderophloia, E. crebra, E. dealbata* and *Angophora costata;* sometimes dense lower tree layer of *Callitris columellaris* and *Casuarina inophloia;* diverse shrub layer and very open ground cover.
5 (60%) Plains of low to moderate relief, slopes 1 to 3%. (IV-VI m e r)	Moderately deep to deep, frequently gravelly, texture contrast soils with a sand to sandy-clay-loam surface soil with a bleached A_2 horizon to 30-60 cm over greyish-brown to bright-brown, frequently mottled, clay sub-soil (Dy 5.41, Dy 3.41, Dy 4.41, Dy 5.43,Db 1.42); deep, bleached, siliceous sands (Uc 2.12).	Woodland of *E. crebra* and *Angophora costata* or *E. maculata* occasional *E. tereticornis* and *E. polycarpa,* with patchy lower tree layer of *Casuarina luehmannii* and/or *Callitris columellaris* and *Acacia crassa;* ground cover sparse, mainly *Cymbopogon refractus, Aristida* spp. and *Bothriochloa decipiens.*
6 (15%) Flat plains, 0.5 to 1 km wide. (II w e)	Deep, occasionally gravelly, texture contrast soils with sandy-loam to loam surface soil commonly with a bleached A_2 horizon to 15-50 cm over reddish brown to yellowish-brown, neutral to alkaline, clay sub-soil (Dr 2.23, Dr 2.32, Dr 2.41, Db 3.12, Dy 2.13, Dy 3.43); deep, structured earths with fine-sandy-loam surface soil with a bleached or pale A_2 horizon grading into reddish-brown, neutral to alkaline, clay sub-soil (Gn 3.16); minor: shallow, texture contrast soils with an acid, clay sub-soil (Dr 2.41); deep, brown, cracking clays (Ug 5.3).	Extensively cleared woodland of *E. microcarpa, E. populnea, E. tereticornis* and occasional *E. melliodora;* moderate ground cover, often of introduced species.

Climate:- This land system experiences moderate to severe moisture deficits in the average year, March being the most critical month.

The mean and normal annual rainfall totals are both around 640 mm, and 34% of this falls in the winter months Both the annual and January 24-hour rainfall intensity figures are high at 12 mm/rain day for the former and 16 mm/rain day for the latter.

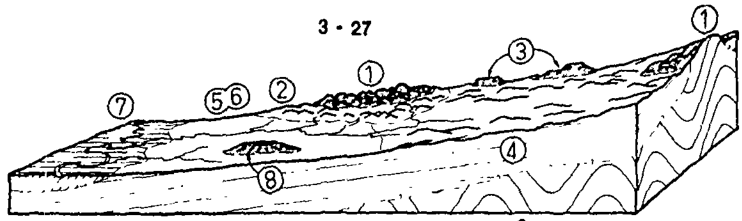
The mean January maximum temperature is around 29^o to 30^{o}C and the July minimum is around 3.5^{o}C.

Geology:- Marburg sandstone (Lower Jurassic) and Pleistocene alluvium; some undifferentiated Devonian to Carboniferous sediments and minor volcanics.

Geomorphology:- Western remnants of Lower Jurassic sediments, downwasting around resistant Traprock ridges, and associated with broad flood plains. Relative relief about 150 m.

Fauna:- Most A species and emus. No rabbits.

Land Utilisation:- Beef cattle and sheep rough grazing with forestry, in the hill units, and mainly beef cattle and some fodder cropping, on the flats.



DEVINE LAND SYSTEM, 600 km^2

Sandstone plains of low relief, with minor Traprock protrusions, sloping westwards towards Canning Creek and its confluence with Macintyre Brook. Similar smaller areas to the south.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (8%) Stony irregular, traprock slopes; average 8%, going up to 15%. (VI-VII d r)	Shallow, gravelly loams (Um 1.23, Um 5.21); shallow, gravelly, texture contrast soils (D); minor: shallow, gravelly clays (Uf 6.31).	Extensively cleared woodland of *E. crebra*, *E. dealbata*, occasional *E. albens* and on lower slopes, *E. pilligaensis* with clumps of *Callitris columellaris* and shrub layer, sometimes dense of *Olearia elliptica;* sparse ground cover of *Bothriochloa decipiens.* (units 1 and 2)
2 (4%) Lower traprock hill-slopes and areas of moderate relief; average slope 5%. (IV r e)	Moderately deep, texture contrast soils with sandy-loam to clay-loam surface soil with a bleached or pale A2 horizon to 10-30 cm over reddish-brown, alkaline, clay sub-soil with lime concretions (Db 4.23), or pale-brown, neutral, clay sub-soil (Dy 3.42).	
3 (1%) Scarps and narrow sandstone ridges: average slope 12%. (VII-VIII d r e)	Shallow, gravelly sands (Uc); shallow, gravelly, texture contrast soils (D).	Woodland of narrow-leaved ironbark *E. crebra*, rusty gum *Angophora costata* with occasional mountain gum *E. dealbata;* patchy lower tree layer of cypress pine *Callitris columellaris* and well developed shrub layer of *Acacia* spp., *Jacksonia scoparia* and *Leucopogon* spp. Sparse ground cover.
4 (50%) Irregular plains of low relief, slopes 2 to 3%. (VI d e)	Shallow to moderately deep, texture contrast soils with loamy-sand to sandy-clay-loam surface soil with a bleached A2 horizon to 30-50 cm over red to yellow-brown, acid, clay sub-soil (Dy, Db, Dr); moderately deep, bleached siliceous sands (Uc 2.22, Uc 2.34).	Layered woodland of *E. crebra*, *Angophora costata*, and occasional *E. exserta* and *E. tereticornis* with, often dense, lower tree layer of *Callitris columellaris* and *Casuarina luehmannii* and varied shrub layer of *Acacia* spp., *Daviesia squarrosa* and *Leucopogon* spp., extremely sparse ground cover. (units 4 and 5)
5 (20%) Flat plains and plains of low relief, slopes 1 to 2%. (III e)	Moderately deep to deep, texture contrast soils with loamy-sand to sandy-clay-loam surface soil with a bleached A2 horizon to 20-50 cm over columnar, reddish-brown to brown, alkaline, clay sub-soil (Dr 2.23, Db 2.43, Dy 2.42).	
6 (4%) Gilgai plains of low relief, slopes 1 to 2% (V g)	Deep, brown and grey, cracking clays, usually containing gypsum and/or lime (Ug 5.24, Ug 5.15); deep, texture contrast soils with loamy-sand to sandy-clay-loam surface soil, usually with a thin < 5 cm bleached A2 horizon at 15-30 cm over dark-brown to reddish-brown, alkaline, clay sub-soil containing lime nodules (Dd 1.13, Db 1.13, Dr 2.43).	Open-forest of belah *Casuarina cristata* and brigalow *Acacia harpophylla* with shrub layer of wilga *Geijera parviflora.* Moderately dense ground cover of brigalow grasses *Paspalidium* spp. and forbs *Enchylaena tomentosa, Rhagodia hastata, etc.)*
7 (13%) Flat alluvial plains, slopes 0 to 1%. (II f)	Deep, texture contrast soils with loam to silty-clay-loam surface soil usually with a bleached A2 horizon to 10-20 cm over red-brown dark-brown or yellow-brown, alkaline, clay sub-soil, frequently containing lime concretions (Dr 2.43, Db 1.13, Dy 4.13); deep, red-brown, alkaline, structured earths with loam-fine-sandy surface soil with a pale A2 horizon to 50 cm grading into red-brown, neutral to alkaline, clay sub-soil (Gn 3.16, Gn 3.55); minor : deep, texture contrast soils with loam-fine-sandy surface soil with a bleached A2 horizon to 40-60 cm over dull-reddish-brown to dull-yellow-orange, neutral, clay sub-soil (Dy 2.42, Dy 4.42); deep, grey and brown, cracking clays, commonly gilgaied (Ug 5.1, Ug 5.2).	Extensively cleared woodland of *E. populnea* and/or *E. pilligaensis* with occasional *E. melanophloia*, patches of *Callitris columellaris* sometimes scattered *Geijera parviflora;* open to dense ground cover of *Chloris* spp. and *Aristida* spp.; scattered areas of open forest of *Acacia harpophylla.*
8 (<1%) Residual basalt mesa, comprising a rocky cap and concave creep and pediment slopes from 15% to 2%. (VI-VII r to III k)	Stony, black, cracking clays (Ug 5.1).	Woodland of *E. melanophloia* with lower tree layer of *Callitris columellaris* and *Casuarina cristata;* moderate ground cover of *Dichanthium sericeum.*

Climate:- Severe moisture deficits are experienced in this land system in an average year, March being the most critical period.

The mean annual rainfall is 600 mm and the median 580 mm, 34% to 35% falling in winter. 24-hour rainfall intensity for the year is 10 mm/rain day and, for January, 14 mm/rain day.

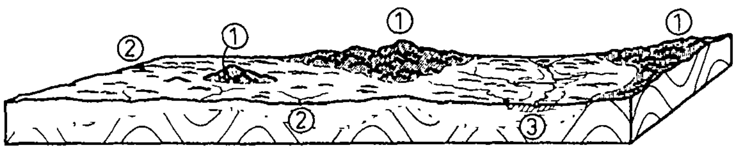
The mean January maximum temperature is 31°C, and the mean July minimum around 3.5°C.

Geology:- Marburg sandstone (Lower Jurassic) and Pleistocene alluvium; some undifferentiated Devonian to Carboniferous sediments and minor volcanics.

Geomorphology:- Low relief remnants of Lower Jurassic sediments, with Traprock protrusions mainly on the eastern edge. Other features include a residual basalt cap associated with gilgai plains and broad flood plains in the west. Relative relief about 180 m.

Fauna:- Most A species. B species include rabbit, emu, corella, red-winged parrot and red kangaroo in some years.

Land Utilisation:- Beef cattle grazing, fodder crops in the flood plains and low lying sandstone units, with some tobacco along Macintyre Brook; mainly forestry and some rough grazing in the rougher sandstone units; beef cattle and sheep in the main Traprock units.



BUNDELLA LAND SYSTEM, 190 km^2

Extensive areas of old alluvium with protruding traprock knolls and spurs.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (40%) Traprock spur or interfluve and associated knolls, aligned NW-SE, average slope 4% going up to 12%. (VII d r e)	Shallow, gravelly loams (Um 2, Um 5.21); shallow, gravelly, texture contrast soils (Dy 2.42).	Woodland of *E. crebra* and occasional *E. nubila* with patches of dense *Callitris columellaris* and *Acacia sparsiflora* and lower *A. semilunata;* very sparse ground cover.
2 (50%) Plains of low relief, coarse alluvium and detritus; irregular microrelief, including minor gilgai in the north; average slope 0.5%, going up to 2%. (IV r e)	Moderately deep, gravelly, texture contrast soils with fine-sandy-loam to sandy-clay-loam surface soil with a bleached or pale A2 horizon to 20-40 cm over red, dull-brown to yellow-brown, clay sub-soil (Dd, Dr, Db, Dy).	Shrub woodland of *E. crebra* and occasional *E. microcarpa* with scattered lower trees of *Casuarina luehmanii* and *Callitris columellaris;* moderate to dense shrub layer of *Acacia ixiophylla* and *A. semilunata;* extremely sparse ground cover; small areas of open forest of *Acacia harpophylla* and *Casuarina cristata.*
3 (10%) Floodplains of Brush and Catfish Creeks; slopes 0 to 0.5%. (III e f)	Shallow to deep, texture contrast soils with loam-fine-sandy to clay-loam surface soil with a pale or bleached A2 horizon to 30 cm over yellowjsh-brown, neutral to alkaline, clay sub-soil (Dy 2.23, Dy 2.42).	Similar to Unit 4 of Magee L S

Climate:- This land system experiences severe moisture deficits in an average year, its most critical period being in March.

Both mean and median annual rainfall totals are around 620 mm, of which 35% is received in the winter months. The annual 24-hour rainfall intensity is 10 mm/rain day, and the January figure is 13 mm/rain day.

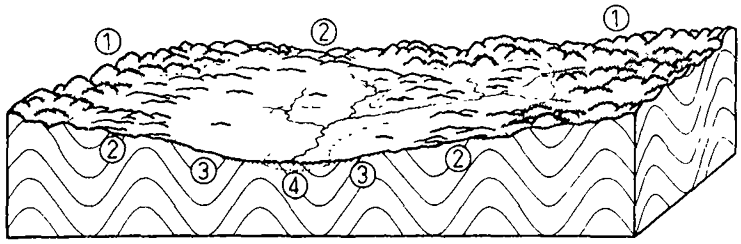
The mean January maximum temperature is around 31°C and the July minimum around 3°C.

Geology:- Pleistocene alluvium and undifferentiated sediments and minor volcanics (Devonian to Carboniferous).

Geomorphology:- Plains of low relief - old alluvium and detritus with irregular microrelief - drained by Catfish and Brush Creeks in narrow alluvial strips. A NW-SE trending traprock interfluve with peripheral knolls protrudes above the general level. Relative relief about 100 m.

Fauna:- Most A species. B species include rabbit, emu, corella, red-winged parrot and red kangaroo in some years.

Land Utilisation:- Mainly timber and rough grazing of beef cattle.



MAGEE LAND SYSTEM, 130 km^2

Low lying traprock hills draining to the western edge of the traprock geologic unit.

Land Unit No. (% occurrence) Landform Description (Land Class and Limitations)	Soils	Vegetation
1 (30%) Low traprock hills and irregular footslopes, average slope 10%. (VII-VIII d r e)	Shallow, gravelly loams (Um 5.21); shallow, gravelly, texture contrast soils (D); soils are similar to Unit 1 of Bundella L S	Woodland of *E. crebra* and occasionally *E. panda;* lower tree layer of *Callitris columellaris, Acacia sparsiflora;* moderate varied shrub layer and sparse ground cover.
2 (35%) Lower traprock hillslopes, 3 to 5%. (VI d e)	Shallow, gravelly loams (Um); shallow, gravelly, texture contrast soils (D); soils are similar to Unit 1 of Bundella L S	Layered woodland of *E. crebra* and occasional *Angophora costata;* dense lower tree layer of *Casuarina luehmannii;* dense shrub layer, mainly *Acacia semilunata;* extremely sparse ground layer.
3 (25%) Colluvial slopes, average 1%. (IV-VI e)	Moderately deep to deep, texture contrast soils with loamy-sand to loam surface soil with a bleached A2 horizon, frequently gravelly to 20-35 cm over brown or brownish-yellow, columnar, alkaline, clay sub-soil (Db 1.43, Db 3.43, Dy 2.43).	Layered woodland of *E. pilligaensis* and *E. crebra;* lower strata similar to that of Unit 2.
4 (10%) Alluvial flats, slopes 0 to 0.5%, going up to 2.5% in minor areas of microrelief. (III e)	Deep, texture contrast soils with loam to clay-loam surface soils with a bleached A2 horizon to 30 cm over brown to yellow-brown, alkaline clay sub-soil (Dy 2.43); deep, brown, alkaline earths (Gn).	Woodland of *E. microcarpa* and/or *E. pilligaensis* with occasional *E. populnea* and *E. melliodora;* rarely moderate shrub layer of *Eremophila mitchellii,* ground cover of *Aristida* spp. and *Bothriochloa decipiens.*

Climate:- Severe moisture deficits are experienced in this land system in an average year, the most critical period being January through March.

The mean annual rainfall total is around 625 mm, and the median 610 mm with a 35% winter component. Annual 24-hour rainfall intensity is 10 mm/rain day and, for January, is 14 mm/rain day.

The mean January maximum temperature approaches 31 °C and the July minimum is between 2.5 °and 3 °C.

Geology:- Undifferentiated sediments and minor volcanics (Devonian to Carboniferous) and Pleistocene alluvium, (unclassified sandstone occurrances).

Geomorphology:- Plains of moderate relief with occasional low hills draining westwards, out of the study area, to extensive alluvial plains. This is the farthest west extension of the traprock country and is considerably down-wasted. Relative relief about 150 m.

Fauna:- Most A species. B species include rabbit, emu, corella, red-winged parrot and red kangaroo in some years.

Land Utilisation:- Extensive beef cattle and sheep grazing with some cropping; forestry.

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4 CLIMATE OF THE GRANITE AND TRAPROCK AREA

by A.K. Wills

Page

The Granite and Traprock Area of South-East Queensland - A Land Inventory and Land Utilisation Study, Division of Land Utilisation, Technical Bulletin No. 13, Queensland Department of Primary Industries, Brisbane, 1976.

TABLES

FIGURES

MAPS

4 CLIMATE OF THE GRANITE AND TRAPROCK AREA

by A.K. Wills*

The study area experiences a sub-humid climate. It is an area of climatic transition and the elevated region of the Granite Belt with its periphery, may be termed moist sub-humid, and the remainder of the area dry sub-humid.

Rainfall is greater in the warmer half of the year although the winter proportion is significant. Both tropical and southern weather systems interact with topographic features, in and near the study area, to produce short term variability in areal distribution of rainfall. There is a westward decline in rainfall incidence from the eastern highlands to a band of lower country running north-south from Mosquito Creek, through Coolmunda Dam to Silverspur, although rainfall tends to increase again west of Inglewood and Texas. Both summer and winter temperatures broadly reflect elevation. Heat waves occur regularly in the western part of the study area in summer, while spells of moderate to severe frosts are common throughout the area in winter. Droughts can affect the study area, but due to the southerly influence and high winter rainfall component, the moisture status of the area is often out of phase with much of Queensland. Major flooding is experienced only on the Condamine and Dumaresq floodplains. On the smaller streams, flash floods are more common but generally have little impact.

Previous climatic studies of the area have concentrated on presentation of statistics related to specific centres (e.g. Wheatley 1969). The aim of this section is to delineate climatic subdivisions and to describe and explain climatic variation throughout the area.

4.1 Climatic Classification

Thornthwaite's revised moisture budget classification (1955), which is discussed later (section 4.5.1), divides the study area into moist sub-humid and dry sub-humid categories.

Application of Köppen's (1931) revised classification of climates also produces a similar subdivision of the area, the bulk of the area being classed as 'Cfa', i.e. 'rainy climates with mild winters, no marked dry season and hot summers (average temperature of the warmest month exceeds 22^{o} C); and the Granite Belt as 'Cfb' or 'rainy climates with mild winters, no marked dry season and cool summers (average temperature of the warmest month below 22^{o} C, but with at least four months above 10^{o} C). (James 1951.)

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* Division of Land Utilisation, Queensland Department of Primary Industries.

Finally the Koppen classification has been used in a climatic year analysis for Queensland (Dick 1964) which portrays a marked division in the study area along the lines described previously. The Granite Belt and its periphery are shown to experience humid climatic years, as distinct from semi-arid or arid, in over 90 per cent of years; while most of the rest of the area experiences only 65 to 80 per cent of humid years.

4.2 Meteorological Controls

The study area includes the most southern part of Queensland, and it is thus less under tropical influences and more under the cool influences of the south than any other part of the State. However the natural variability of weather systems ensures that significant effects from both sources are felt in most years. In addition, sub-coastal location means that the region experiences both continental and maritime influences.

In common with most of Australia, the area's weather reflects the west to east passage of alternate depressions and anticyclones. The centres of the depressions are usually too far south to have a direct effect but the associated cold fronts may extend through the area, especially in the cool season. However the changes of wind associated with the passage of the southern systems produce fairly predictable and characteristic changes in the weather. Other features which can affect the weather of the region include tropical cyclones in their decaying phases, upper-air low-pressure areas and the extension of the central Queensland trough, which is a semi-permanent summertime phenomenon.

Highland areas exert a major modifying influence on all air masses traversing the study area. The Granite Belt and, to a lesser extent, the Herries Range have a noticeable effect on climate variations within the region.

4.3 Rainfall

Six rainfall maps are included in Map 3 which folds out at the end of this section. Map 3.1 is of mean annual rainfall and Map 3.2 shows median annual rainfall. The median, or 50 percentile figure, is considered to be a more realistic rainfall expectation for a given period than the average, or arithmetic mean, for the same period.

Maps 3.3 and 3.4 are of mean summer (October to March) and mean winter (April to September) rainfall totals.

Maps 3.5 and 3.5 show median November and June rainfall totals and indicate normal rainfall expectations in those months; which tend to be at the start and finish of the annual moisture deficit period for the study area.

The maps are all drawn from long period average data supplied by the Australian Bureau of Meteorology, Brisbane. Histograms of rainfall probabilities on Map 2, are drawn from published data (Australian Bureau of Meteorology 1968).

4.3.1 Seasonal Distribution

Map 2 located at the end of this section shows the climatic subdivisions of the study area and rainfall and temperature histograms for climatic recording stations applicable to the area. The histograms of monthly rainfall percentiles show clearly that the highest rainfall can be expected in December/January while a secondary peak is normal in June/July. The secondary peak is reliable, as evidenced at the 90 percentile level on the histograms.

During summer, the dominant rain-producing influence is the north-easterly to south-easterly airflow which introduces moist maritime air from the Pacific Ocean or the Tasman Sea. These airflows produce high rainfall totals on the coast itself but the natural trend of rainfall declining with distance inland is arrested, because of instability renewed by the topographic barriers of the southern border ranges and the scarps around Cunningham's Gap.

Other summer rainfall influences are essentially random in their occurrence, for example thunderstorms in the spatial sense, and tropical cyclones in the temporal sense.

In winter, the northward movement of the weather systems produces airflows predominantly from the south-west to south-east quadrant. Winter rainfall totals are less because the cooler air is incapable of holding as much water as in summer and also because a greater proportion of winter airflows have a greater overland traverse and are thus relatively dry. Nevertheless the rainfall which is received in the cool season seems to have a greater impact than its relatively low figures would indicate. The lower temperatures result in a greater proportion of effective rainfall and a loose correlation is detected between Thornthwaite's moisture index values and the percentage of winter rainfall.

Overall, winter rainfall, makes up 33 to 37 per cent of the annual total. The highest winter rainfall component over 37 per cent, is around Silverspur in the south-west of the study area, with a secondary area around Dalveen and Thulimbah The lowest winter rainfall component, less than 33 per cent is centered on the Karara area. An approximate delineation of these areas is given on the next page (Fig. 4.1).

4.3.2 Spatial Distribution

Both annual rainfall maps (3.1 and 3.2) indicate a decline in rainfall totals towards the west with a particularly steep gradient between Dalveen and Warwick. This is the usual trend found from the coast towards the inland, compounded by the effect of elevation in the eastern highlands and local orographic effects of scarps at points on the State border.

The distinctive features of both annual rainfall maps are the peaks in rainfall, around Dalveen and on the south-eastern fringes of the study area, and the low rainfall centres near Coolmunda Dam and Silverspur, with secondary lows at Maidenhead and Karara. Between these, lies an area of apparently steady transition. It is clear that these areal differences are closely related to the land surface characteristics of elevation and irregularity; the low rainfall areas being low lying and in the lee of one or more of the main rain-producing airflows. The high rainfall areas coincide with topographic obstacles in the paths of the same airflows.

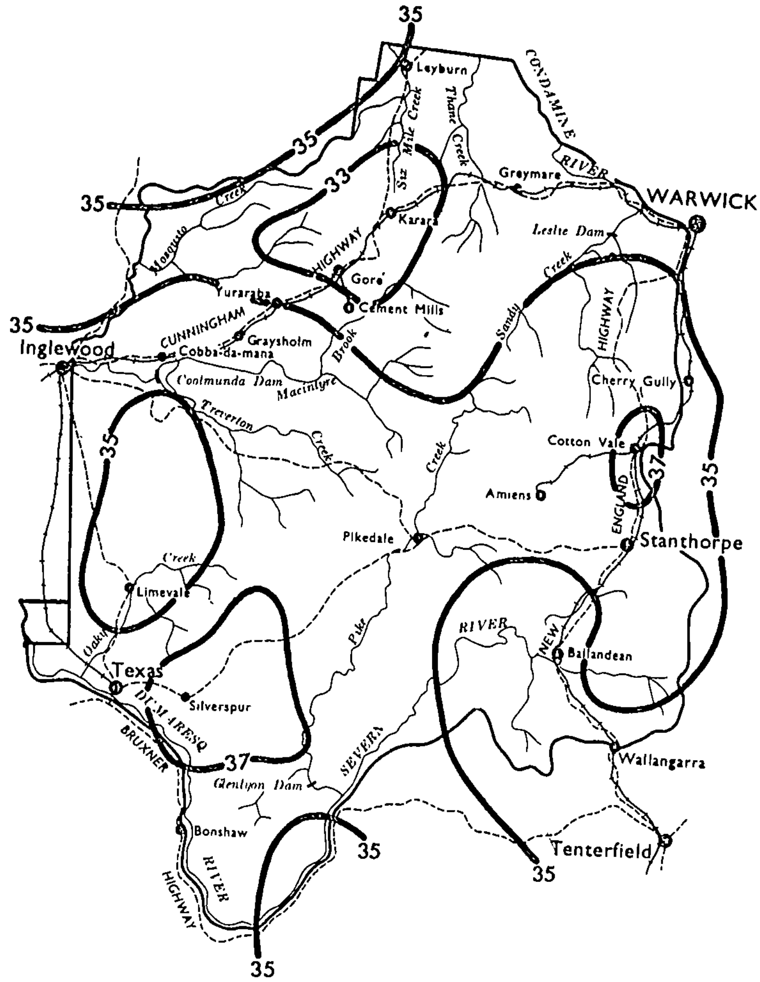

FIG. 4.1 - WINTER (APR-SEP) RAINFALL COMPONENT - PERCENTAGE

The summer isohyets display a westward decline (Map 3.3), similar to the annual pattern. A distinctive feature of the summer rainfall map is the longitudinal band of lowest rainfall, running from Silverspur northwards through Graysholm. This is repeated in Map 3.5, showing median rainfall for November. Irregular isohyetal patterns on the summer rainfall map indicate the importance of topographic features in influencing local rainfall distribution. In particular the rain-shadows south-west of the ridges in Thane LS, those in the lee of the Herries Range beyond Yuraraba, and the alignment of the high summer rainfall area at Dalveen indicate a dominant topographic influence, with a northerly component in the rain-producing easterlies, reflected in the westerly to south-westerly gradients. The steepest gradient in summer is noted on both maps between the south-western edge of the Granite Belt and the low summer rainfall area around Silverspur and Raleigh.

The winter rainfall pattern is closely related to elevation, with the exception of the isolated, slightly higher rainfall area around Inglewood. The wettest parts of the study area in winter are the eastern half of the Granite Belt and the highlands of the Roberts Range. The rainfall gradient tends to decline north-westwards, indicating a dominant rain-producing influence from the south-east.

Map 3.6, showing median rainfall for June, presents a less clear picture. Most of the study area lies between 30 and 40 mm, the middle isohyet, 35 mm, indicating a north-westerly declining gradient throughout most of its length; but it is interrupted by a positive anomaly of over 40 mm centered around Graysholm. A similar area of higher June rainfall is located along the Dumaresq River from Eversley to Maidenhead. For June, these latter areas receive similar rainfall totals to the eastern Granite Belt. During this short period the longitudinal band of low rainfall country, referred to above experiences a reversed situation.

One possible explanation for this lies in the characteristics of winter airflows which affect the study area. As the winter weather systems pass eastwards over the continent, the study area experiences both northerly and southerly airflows. The former are usually warm north-westerlies which are relatively dry, and these give way to south-westerlies which eventually back to south-easterly. The south-easterlies carry the most moisture and release it orographically over the ranges and scarps of the State border. This influence is the major contributor to winter rainfall and the results are seen, on Maps 3.4 and 3.6, around Dalveen, east of Eukey and on the Roberts Range. It is suggested that the secondary higher June rainfall areas result from southerly and south-westerly airflows which produce the winter rainfall peak. Although these are drier than the south-easterlies, having travelled over more land; they are also colder, closer to their dew point and more likely to respond to an orographic stimulus. The two areas highlighted coincide with areas of high ground, aligned across the path of southerly airflows. A more detailed rain gauge network could be expected to reveal similar areas of higher and lower rainfall related to topographic features.

4.3.3 Rainfall Variability

Northern Australia and most of Queensland experience high rainfall variability. This is due to the high summer rainfall component, much of which is convective and highly localised. Sporadic occurrence of tropical cyclones also adds to the variability of rainfall.

Primary producers are heavily dependent on rainfall for successful plant and animal production. Competent management decisions should be related to expected rainfall incidence. These decisions can now be based on objective data available from the Australian Bureau of Meteorology. From past climatic records, the chances of receiving certain amounts of rainfall are assigned probabilities. Some of these data have been published, for individual months and runs of months at selected Queensland stations, and cover the 20 per cent, 50 per cent and 80 per cent probability levels (Robinson and Mawson 1975).

The rainfall value with a 50 per cent probability of attainment is known as the median. This is the middle value of an array of values, ranked from lowest to highest, and is considered to be a more realistic expectation than the simple average or arithmetic mean. For most Queensland stations, the mean is significantly higher than the median. The shorter the period considered, the greater this divergence is likely to be. This is due to the occasional extreme values of rainfall, which are received from tropical cyclones and storms and are included in the arithmetic calculation of the mean, but are concentrated at one end of the ranked array of values used in determining the median.

By Queensland standards, the study area is not subject to a wide range of variability. The maps of median and mean annual rainfall (Map 3.1 and 3.2) do not differ markedly. This can be attributed partly to the area's southerly location which is responsible for the higher winter rainfall component. The second major influence is its position in the lee of the Great Dividing Range which is an effective barrier to the coastal, cyclonic influences which frequently bring high summer falls to other areas.

4.3.4 Rainfall Intensity

Rainfall intensity is a measure of the rate at which rain is received. It has a direct bearing on problems of soil erosion, runoff and flooding. However for these purposes, detailed data relating to short time periods are essential. In this section, 24-hour rainfall intensity is the parameter used (Australian Bureau of Meteorology 1966a and 1966b). This is derived by dividing the mean rainfall (mm) by the number of rain days, a rain day being one on which at least 0.25 mm of rain is received.

The 24-hour rainfall intensity varies significantly within the study area (see Fig. 4.2) and has been used for climatic subdivision. A high rainfall intensity area (greater than 12 mm/rain day (annual) and greater than 15 mm/rain day (January)) extends in a band through Gore and Pikedale and connects the Canal and Jibbinbar Land Systems. In contrast, a low rainfall intensity area (less than 8.5 mm/rain day (annual) and less than 11.5 mm/rain day (January)) is centered on the Dalveen-Stanthorpe-Eukey area. The remainder of the study area lies between the limits quoted before.

It is suggested that the reason for the eastern low intensity area is the plateau-like nature which produces a mild orographic effect on low stratus cloud traversing the area, resulting in a drizzle on days when there is little or no rain elsewhere in the study area. This would mean a significant jump in the number of rain days in the year but only a slight change to the rainfall total, and therefore a low 24-hour rainfall intensity figure.

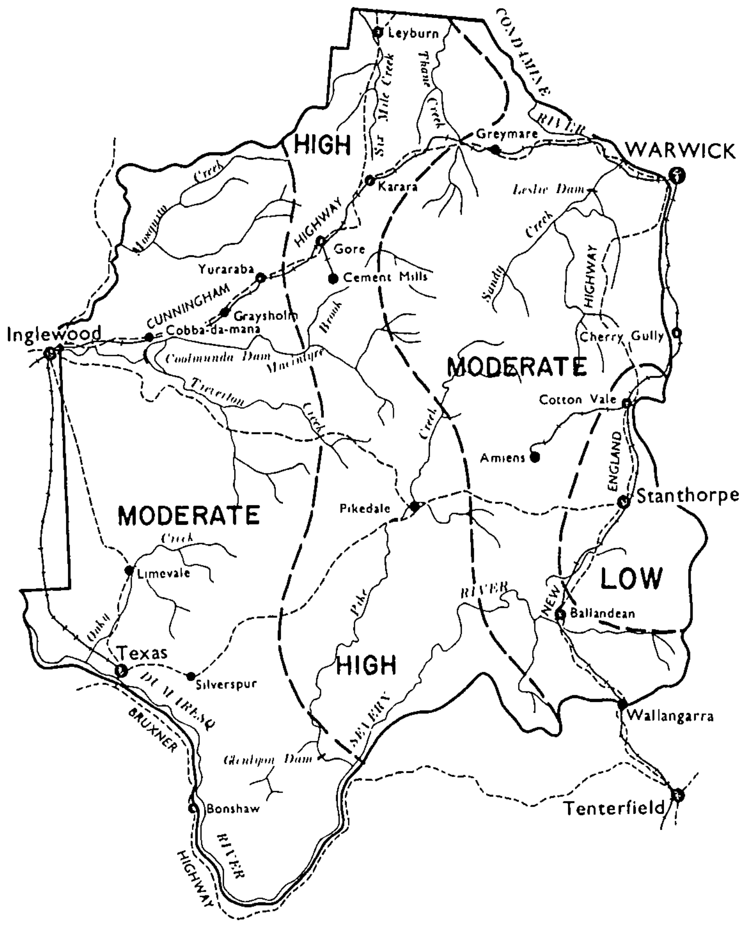

FIG. 4.2 - <u>24 HOUR RAINFALL INTENSITY</u>

The central band of high rainfall intensity lies on the eastern edge of the longitudinal band of lowest rainfall, running from Graysholm to Silverspur. Because high intensity rainfall is usually related to summer storm activity, it is considered that the band of high rainfall intensity is a meridional zone where frontal, or trough-associated, cumulus cloud moving east, reacts to the added impetus of the rising topography. It is postulated that most developing thunderstorms would cross this zone in their early maturity phase which is characterised by compactness, severe turbulence and highly localized heavy showers. Under these conditions, rainfall recording stations would record fewer rain days but would have fairly high rainfall totals over the long term as a result of the heavy showers they did receive. East of this zone, the storms in their more mature and decaying phases would tend to produce a more even spread of rainfall, of lower intensity.

4.3.5 Thunderstorms and Hail

Thunderstorms may form when cold fronts pass through the area, as previously described. They may also form over the Border Ranges to the east of the study area and migrate west as they develop, or they can form in situ as a result of intense diurnal heating during humid summer conditions. Interpolation from an analysis of the sources of Queensland's rainfall attributes approximately one-third of the rainfall of the area, to thunderstorms, half of this falling in the four months December to March (Rimmer *et al.* 1939). Stanthorpe is reported as experiencing 50 to 60 thunderstorms per year and Warwick 40 thunderstorms (Wheatley 1969) per year. The frequency declines to only 15 per year at Goondiwindi so that much of the study area can expect a frequency lower than the two largest centres.

Hail is associated with many of the thunderstorms experienced in the area. Its frequency of occurrence and severity are difficult to assess as records are few, can be very subjective, and even with the best records, there is little chance that all hail falls have been observed and reported. The Bureau of Meteorology has provided approximate information on hail frequency from press reports over the period 1935 to 1953.

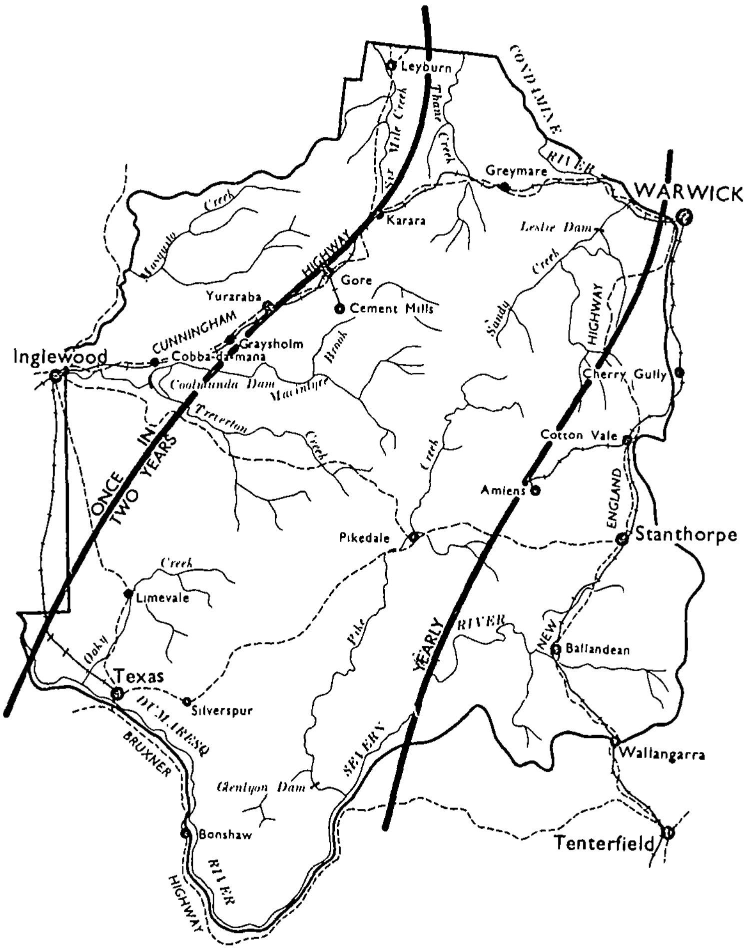

FIG. 4.3 - APPROXIMATE FREQUENCY OF HAIL, BASED ON PRESS REPORTS 1935-1953

4.4 Temperature

Maps 3.7 and 3.8 indicate, respectively, isotherms of mean January maximum temperatures and mean July minima and have been drawn by the Australian Bureau of Meteorology, Brisbane. Mean temperatures for stations in or near the study area are shown graphically on Map 2 and have been drawn from published data (Australian Bureau of Meteorology 1969) or from data supplied by the Australian Bureau of Meteorology, Brisbane. The exception is Inglewood, the data for which were taken directly from the Whetstone field station's records for the last 15 years. The histograms of temperature extremes are drawn from data supplied by the Australian Bureau of Meteorology, covering period from 6 to 18 years, again with the exception of Inglewood. Average frequencies have been rounded to the nearest single day and proportionately adjusted for incomplete segments of the record.

The isotherm maps are necessarily generalized due to the paucity of temperature recording stations. Means of average daily temperatures have not been mapped as temperature extremes are usually of most interest.

4.4.1 Summer Temperatures

Map 3.7, showing mean January maximum temperatures, indicates broadly that elevation is the dominant control on temperature during the warm season.

Reference to the Map 2 temperature graphs and histograms shows quite clearly that the highest temperatures are experienced in the west at Inglewood and Texas, with the expectation of 3 to 4 days per average year with maxima of 38^{o} C or more. In the north-east, Warwick and Hermitage expect an average of 4 or 5 days per year with maxima of 35^{o} C or more; while the coolest summers are experienced on the Granite Belt, Applethorpe, Stanthorpe and Wallangarra expecting only between 1 and 6 days per year with maxima 32^{o} C or more.

Heat waves have been empirically defined as a succession of days on which the maximum temperature exceeded 38^{o} C (Skerman 1953). Although defined specifically for its effect on grain sorghum growing, this limit is equivalent to 100^{o} F, or 'the century', and has been widely recognized as a measure of heat wave conditions.

Skerman has quoted the following heat wave statistics for Warwick (see over).

TABLE 4.1 - HEAT WAVE DATA, WARWICK, 1926-50

Consecutive days with maximum temperatures over -		November	December	January
38° C (100° F)	2	1	5	8
	3	1	-	6
	5	-	-	1
41° C (105° F)	2	-	-	2
	3	-	-	1

Further data on heat waves and their effects on primary industries are found in Section 13.

4.4.2 Winter Temperatures

Map 3.8 of July minimum temperatures again indicates that elevation is a dominant factor affecting winter temperatures.

The similarity ofthe graphs of the annual mean temperature regime shown on Map 2, with variations solely due to elevation, is to be expected in stations so close together. The histograms of cold extremes are more informative and confirm that this area is the coldest in Queensland.

Temperature extremes of -1° C or lower can be expected at all stations in the five months May to September. In an average year, temperature extremes of 5° C or less can be expected between April and November. Overall, Applethorpe is seen to be the coldest of the temperature recording stations, with lower mean temperatures, more temperature extremes in winter and few summer extremes.

It is interesting to note the seasonal extremes at Inglewood and Texas, where the seasonal changeover months of April and October may experience extremes of either heat or cold. Within seasons extreme temperatures are experienced on a significant number of days.

Dates of the beginning and end of the period of frost-risk are presented on the opposite page in graphical form (Fig. 4.4) for five stations in or near the study area. The diagram is drawn from data tabulated in the Queensland Graingrowers' Association Handbook (2nd edition, April 1975) and originally supplied by the Australian Bureau of Meteorology.

4.5 Moisture Balance

Discussions of rainfall alone or of temperature alone do not provide adequate data for primary production considerations. Rather the interaction of rainfall and temperature constitutes the dominant climatic control on the natural environment and on human adaptation to this environment.

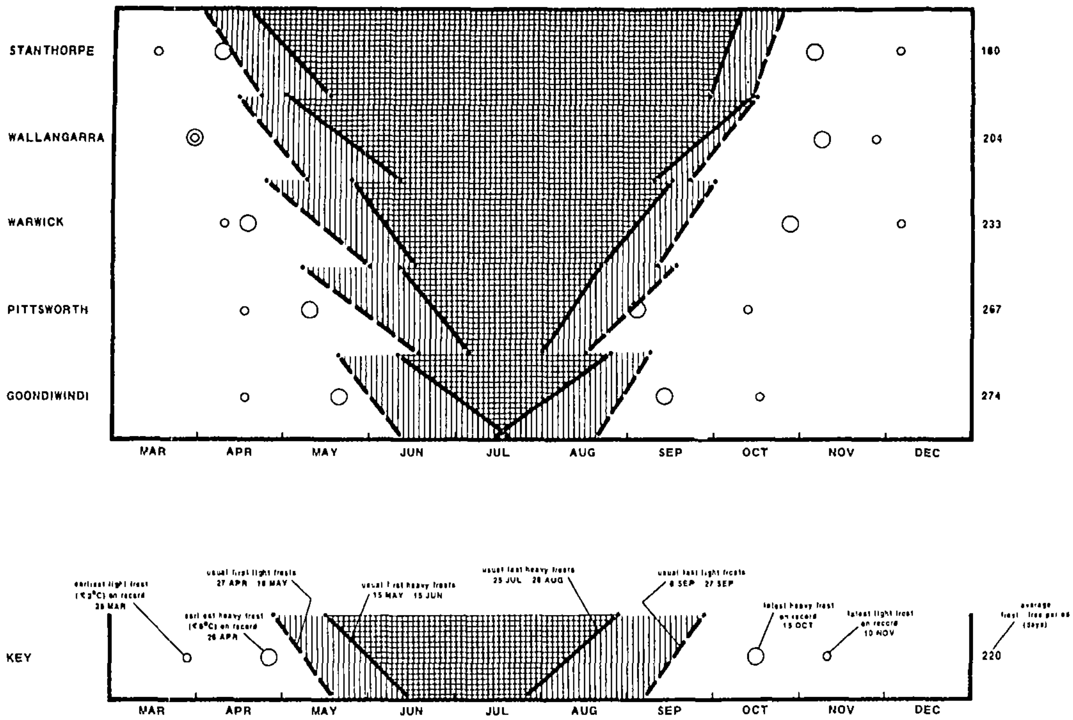

FIG. 4.4 - <u>DATES OF START AND FINISH OF PERIOD OF FROST-RISK</u>

Rain which reaches the ground may return to the atmosphere directly by evaporation, indirectly via the surface soil and plant systems, that is by transpiration, or very indirectly by penetrating to the ground water reserve and emerging in streams or lakes to evaporate either on the way to, or as part of, the ocean. This latter process - complex, unpredictable and long term - is not considered in meso-scale moisture balance studies. But the former two processes, collectively known as evapotranspiration, have been subject to much consideration and study ever since man perceived that his survival depends, directly and indirectly, on a certain minimum rate of effective rainfall receipts.

The dominant determinants of evapotranspiration are, first of all, the level of rainfall receipts, which sets the absolute limit on water loss; and then the air mass temperature which has an exponential relationship to evapotranspiration, that is as temperature increases, evapotranspiration increases at a greater rate. Other important factors are wind, the density, composition and structure of the vegetation layer and the porosity and moisture retention characteristics of the near surface soil layers.

The latter factors vary appreciably on the microscale and become important in microclimatological studies related to specific crops or specific sites. For purposes of climatic subdivision, one reverts to the main broad-scale factors of rainfall and temperature and their interaction, in a hypothetical fixed wind/vegetation/soils environment.

The moisture balance classifications used to analyse the climate of the study area, the expected variations in evapotranspiration losses and the further variations that can be expected from the response of different representative soil types found in the area are now discussed.

4.5.1 Moisture Balance Classification

The two most well known climatic classifications (Koppen 1931; Thornthwaite 1955) were used as an initial means of subdividing the study area climatically. Another was briefly examined for its relevance (Papadakis 1961) but was considered to be too complex for mapping purposes.

The Koppen classification is based on monthly and annual means of temperature and rainfall. It distinguishes between dry and humid climates, the moisture status depending not only on rainfall totals but also on air temperature and seasonal distribution of rainfall. This distinction is based on a comparison of rainfall figures for the summer and winter half years and is therefore relatively crude.

The Thornthwaite classification is similar in principle but considers temperatures and rainfall receipts on a monthly basis. Evapotranspiration losses are derived from temperature and day-length data, net monthly changes in moisture being incorporated in a hypothetical land surface having a water holding capacity of 100 mm. Despite this refinement, the classification may be criticised as being over complex when considered in relation to the relatively crude inputs of monthly rainfall and temperature data. However there is advantage in the fact that these types of data are more widely available than more refined data. From the mapping point of view, a large number of relative values is more important for spatial differentiation than a few accurately determined absolute figures.

Not unexpectedly, since the raw data are the same, both classifications display similar patterns of moisture status variation. How they have been used to subdivide the area climatically is described in section 4.8.1.

4.5.2 Evapotranspiration

The determinants of evapotranspiration have been mentioned before. The broad scale factors are well catered for in the final climatic subdivision (section 4.8.2) but, in applying this information, it is necessary to consider the microclimatological factors which can critically modify any extrapolation of detailed agroclimatological data from one place to another:

(a) Aspect is very important as this controls the angle at which the sun's radiation meets the land surface. The more acute the angle, the less heat will be absorbed; and thus air in the immediate area will become less heated, inducing lower evapotranspiration rates. Aspect also modifies the impact of wind on evapotranspiration.

In the study area an easterly to south-easterly aspect would favour a moister status as it would present a more acute angle to the sun's rays, face the direction of the moist easterly and south-easterly airflows and be sheltered from the hot, northerly winds of summer and the relatively dry winter south-westerlies.

(b) Relief is another factor often associated with aspect. In general the higher a site is in a landscape, the more it will be exposed to drying influences. Therefore moisture status will vary inversely with a site's elevation relative to its surrounds.

(c) Vegetation plays a complex role in the water balance equation.

Initially it intercepts rainwater and may increase evaporation losses by preventing a proportion of water from being absorbed at the soil surface. This type of loss will increase with overall density of plant cover and the layered structure of the plant community. Interception is not considered to be a major cause of water loss in the study area due to much of the land being cleared and the natural open canopy of the remaining vegetation.

By contrast the stems, rooting systems and organic soil surface layers assist in percolation of water to soil depths where evaporation rates are reduced. This is important as many of the traprock soils, in the disturbed state, have hardsetting surfaces with low infiltration rates.

Vegetation also constitutes a shelter mechanism which reduces evaporation by wind. Such gains, however, are offset to some extent by an increase in transpiration as the wind energy is absorbed by the plant foliage. Both positive and negative effects would vary with the volume of above-ground plant material, and the losses would be affected by the transpiration characteristics of each species, their phases of growth, rooting depths and the pre-existing moisture status.

4.5.3 Effects of Soil Type

The soils of the study area are quite varied with regard to their characteristics of absorption, retention and release of water. There are significant areas of extremely shallow, loamy lithosols; deep sands; various alluvial clays and texture contrast soils with A horizons of varying depth and texture.

Leeper (1961) indicates that the relative merits of different soils and their horizons depend on the type of rain received. A greater proportion of heavy or steady rain will be retained in a heavier soil (although surface sealing or a pre-existing cracking condition may change this generalisation), while a greater proportion of light showers may add significantly to storage in sandy soils.

The release of water to plants is another factor which must be considered. The heavier textured soils generally make a greater proportion of their stored water unavailable for plant absorption; but their field capacity is usually so much higher that they still release a greater absolute amount than a lighter textured soil.

The complexity evident in this phase of the hydrological cycle suggests that moisture status investigations at the micro-scale in the study area will have to take into consideration a number of soil profile characteristics, and any extrapolation of results will be restricted to a range of comparable profiles.

4.6 Drought

Drought is a concept related to land and water use and infers a marked deficiency from expected rainfall. Although meteorological or hydrological droughts can be defined according to arbitary levels of natural phenomena such as rainfall and surface or ground water storages, their gravity is assessed in economic terms. The impact varies according to the financial losses involved and the numbers of people affected.

Thus a given natural situation of water availability may be adequate in one set of land and water use conditions but may result in a drought under a more intense pattern of land and water use. The risk of drought in a given area therefore increases with the area and water requirements of the types of crops and the numbers of livestock located therein.

Ideally, farming and grazing systems should be flexible enough to accommodate natural meteorological fluctuations but this is rarely practicable. It is hoped that comprehensive land inventories such as this report will indicate the limits of wise land use and provide data on which sound management decisions can be based.

Experience in the study area indicates a loose correlation between land use intensity and drought incidence. Fig. 4.5 below shows that, for the three local authority areas, timing of drought declarations has been fairly well synchronised despite marked differences in land use intensity and probably in relative levels of moisture status. In other words, land tends to be used up to a certain limit of its recognised capacity.

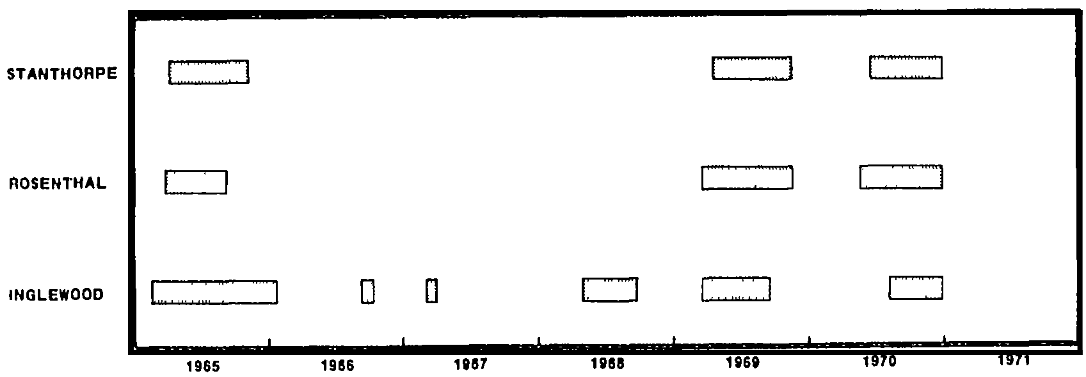

FIG. 4.5 - PERIODS OF DROUGHT DECLARATIONS

During the relatively dry phase from 1965 to 1970, Inglewood Shire appears to have been more severely affected than the other two. This is probably more the result of higher temperatures and different soil types than anything to do with intensity of land use.

4.7 Flooding

Floods occur, on the average, over once per year on the Dumaresq floodplain at Texas. The worst periods are October to February and, surprisingly, the June-July period, which probably results from a combination of abnormal rains, low evaporation rates and enhanced runoff due to sparse winter ground cover. Inglewood experiences floods only once in four or five years and this figure is probably negligible following the completion of the Coolmunda Dam.

Small-scale flash flooding is a characteristic of much of the study area as a result of the narrow, minor floodplains which often have substantial catchments in country of intense relief and shallow soils supporting a rather sparse vegetataive cover. Flash flooding is a major limitation to intensive use of these alluvial soils.

4.8 Climatic Subdivisions

4.8.1 Criteria for Subdivision

As mentioned above, the two factors which vary most significantly over the study area are moisture status - the interplay of rainfall and temperature variations - and rainfall intensity, which suggests a zone of storm development dividing the areas of reliable and unreliable rainfall.

The Thornthwaite and Koppen representations of moisture status were merged to divide the study area into three regions, one line being the combination of the Köppen Cfa/Cfb boundary and Thornthwaite's line of moisture balance (i.e. a moisture index of zero), the second line being the combination of Thornthwaite's minus 20 moisture index and a line of 2.2 mm rainfall in excess of Koppen's semi-arid (BS) limit.

The rainfall intensity map (Fig. 4.2) was then superimposed to produce seven subdivisions based on moisture status and 24-hour rainfall intensity.

Finally, the boundaries were slightly adjusted to more nearly parallel major topographic features as it became obvious that topography played a major role in the climate of the study area.

The result (Map 2) is considered to be a reasonable attempt at subdivision based on readily available data. It should be used with circumspection especially with regard to microclimatological matters (see section 4.5.2) and to sites on or near subdivision boundaries. Such sites would be best considered as experiencing significant proportions of the climatic characteristics on each side of the line, unless a user's local knowledge indicates otherwise.

4.8.2 The Subdivisions

(1) The Western Subdivision - This area lies approximately west of the 151° 30' E meridian and includes all or most of the following land systems - Devine, Bundella, Waroo, Magee, Texas, Arcot, Bonshaw.

A moisture deficit, that is when evapotranspiration exceeds rainfall plus moisture storage, is experienced for about seven months of the year, November to May inclusive, and is due mainly to higher summer temperatures of the lower elevations, the average January temperature at Inglewood Research Station being 25.6° C.

The mean and median annual rainfall values for the area are 625 and 600 mm respectively with around 36 per cent of this total falling in the winter months. Rainfall intensity is moderate for the study area, being 10.2 mm per rain day for the year and, for the month of January, 13.2 mm per rain day.

(2) The Northern Subdivision - In terms of moisture availability this is the least climatically favoured part of the study area. It includes Canal LS, the north-western half of Thane LS and north-western quarter of Gore LS.

Moisture deficits are typically of eight to nine months' duration that is from September or October to May. This is again due to high temperatures, estimated at 24° C average for January, because of lower elevation and latitude. However the deficits are probably aggravated by the noticeably higher rainfall intensity in this area causing increased runoff losses, the annual intensity being 13.0 mm per rain day and for January, 17.7 mm per rain day.

The mean and median annual rainfall are both around 650 mm with 33 per cent of this received during the winter months.

(3) The North-Eastern Subdivision - This subdivision takes in the land systems of Leslie and Evandale, the south-east half of Thane, much of Ironpot and parts of Gore, Pikedale and Washpool (northern unit).

The average duration of moisture deficit is seven months per year, from November to May, mainly due to high temperatures, the average January temperature at Warwick being 23.7° C.

The mean and median annual rainfall figures for the area are around 675 mm. The winter rainfall component is around 35 per cent.

Rainfall intensity is moderate, 10.4 mm per rain day for the year; but tending to above average intensity in January at 14.5 mm per rain day.

(4) The Far South Subdivision - Available data indicate that the southern subdivision is closely similar to the north-eastern subdivision; but this is on the basis of lengthy extrapolation of moisture status over the year and on rainfall intensity, derived from climatic stations located outside the subdivision.

There are no stations sufficiently close to give representative climatic statistics, the data given in the previous section being most representative, with the exception of winter rainfall percentage which is about 1 per cent higher.

The subdivision coincides approximately with the Glenlyon LS.

(5) The Central Subdivision - This area covers mainly the southern half of Gore LS and the southern two-thirds of Pikedale. Fringe portions of other land systems are also included.

Moisture deficits exist, on the average, for about six months from December to May. No temperature data are available but the area is estimated to have a similar regime to that of Warwick. Thus the improved moisture status appears due to the higher winter rainfall component which is around 36 per cent.

Rainfall intensity is higher here than elsewhere in the study area but this anomaly seems to be concentrated in the summer peak rainfall period. For the year, average intensity is 11.9 mm per rain day, while the January average is 17.5 mm per rain day.

The mean annual rainfall for the area is around 700 mm, with a median value of 650 mm, indicating some unreliability.

(6) The Eastern Subdivision - The subdivision includes the land systems of Norman, Eukey, Severnlea, Magnus and Summit with fringes of Pikedale, Washpool (northern unit) and Ironpot. It is characterised by adequate moisture or a surplus throughout the average year and a lower rainfall intensity than elsewhere in the study area.

Moisture surplus may be experienced for an average of three months, anytime from June to October, and is due to two main factors:

(i) the higher elevation which means lower temperatures, notably 21.6^{o} C January average for Stanthorpe, and

(ii) the eastern border scarps and ridges which induce orographic rainfall from moist easterly airflows.

The mean annual rainfall for the area is 800 mm with the median value about 13 mm below that figure. Rainfall intensity for the year is only 7.9 mm per rain day and 11.2 mm per rain day in January.

(7) The South-Eastern Subdivision - Covering most of the land systems of Jibbinbar, Washpool (southern unit) and Roberts, elevation and relief of the area again favour a positive moisture status.

An average of four months moisture surplus is experienced from July to October and during the rest of the year adequate moisture is available. The mean January temperature at Wallangarra is 20.7° C.

The annual rainfall mean is 775 mm with a median of 700-775 mm. A moderate to high rainfall intensity of 11.4 mm per rain day for the year, and 15.0 mm per rain day for January is experienced.

4.9 Acknowledgements

The author wishes to thank the Australian Bureau of Meteorology for providing data used in this section and for commenting on early drafts of the text.

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5 GEOLOGY OF THE GRANITE AND TRAPROCK AREA

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TABLES

MAPS

The Granite and Traprock Area of South-East Queensland - A Land Inventory and Land Utilisation Study, Division of Land Utilisation, Technical Bulletin No. 13, Queensland Department of Primary Industries, Brisbane, 1976.

TABLE 5.1 - STRATIGRAPHIC SUCCESSION

ERA	AGE	ROCK UNIT	LITHOLOGY	THICKNESS in METRES	STRUCTURE
	HOLOCENE		Soil Cover	variable	
QUATER-NARY	PLEISTOCENE to HOLOCENE	STANNIFEROUS ALLUVIUM	Sand, silt, mud, gravel	1 to 10	
		CONDAMINE ALLUVIUM	Sandy alluvium with vertebrate fossils overlain by Recent muds	up to 20	
TERTIARY	UPPER OLIGOCENE to LOWER MIOCENE	MAIN RANGE VOLCANICS	Alkali olivine basalts, trachytes, minor tuffs, sediments	30 1000	Low angle dips on flows, minor plugs associated
			Quartzose sandstone conglomerate silicified and ferruginized	up to 100	Sandstone cross-bedded gently depositional dips
MESOZOIC	MIDDLE JURASSIC to LOWER CRETACEOUS	"KUVBARILLA BEDS"	Mainly fresh water sandstone, siltstone, mudstone, some conglomerate	up to 700	Horizontal to gently dipping, steepening toward west
	MIDDLE TO LOWER JURASSIC	WALLOON COAL MEASURES	Fine grained labile to sublabile sandstone, mudstone siltstone, and coal, calcareous in part	120 - 500	Mainly gentle to moderate dips, folded in part, locally steep dips associated with faulting
	LOWER JURASSIC	MARBURG SANDSTONE	Feldspathic sublabile sands, mudstone siltstone and coal, calcareous in part	120 - 500	Gentle to moderate dip, folded in part and locally steep dipping adjacent to faults
			UNCONFORMITY		UNCONFORMITY
	PERMIAN to TRIASSIC	NEW ENGLAND BATHOLITH	Granite, adamellite, granodiorite with minor diorite and gabbro, quartz feldspar porphyry dykes associated	unknown	Intrusive
PALAEOZOIC	LOWER to UPPER PERMIAN	CONDAMINE BEDS	Mudstone, poorly sorted sandstone conglomerate, minor tuffs	1950 -	Faulted against Connolly Volcanics unconformably overlain by Marburg Sandstone
		DRAKE VOLCANICS (Equivalents)	Rhyolite and rhyodacite flows and tuffs	300 - 450	Dip as low as 10 degrees on flows Intruded by granite
	LOWER PERMIAN	RHYOLITE RANGE BEDS	Acid volcanics overlying conglomerate, lithic sandstone, calcareous siltstone and mudstone	1200	Dips variable-moderate to steep Faulted against Silverwood Group and intruded by granite
		EIGHT MILE CREEK BEDS	Acid volcanics, agglomerate, breccia and tuff overlying conglomerate pebbly sandstone, siltstone and mudstone	900	Faulted against Silverwood Group, intruded by rhyolite and quartz-feldspar porphyry
		EURYDESMA and WALLABY BEDS	Conglomerate, sandstone, siltstone, limestone	200+ and 150+	Dip moderate to steep, downfaulted into Silverwood Group
		UNNAMED - six small areas of outcrop in Texas Beds	Conglomerate, pebbly sandstone lithic sandstone, pebbly mudstone siltstone minor limestone and acid volcanics	up to 900	Dips moderate to steep unconformable on and faulted against Texas Beds
			UNCONFORMITY		UNCONFORMITY
	UPPER DEVONIAN to UPPER CARBONIFEROUS	TEXAS BEDS	Interbedded lithic sandstone and mudstone, intraformational conglomerate, schist, jasper, intermediate volcanics and limestone	unknown but great	Dip moderate to steep, strongly deformed and folded Probably unconformable on Silverwood Group, intruded by granite
			? UNCONFORMITY ?		? UNCONFORMITY ?
	SILURIAN ? to LOWER DEVONIAN	SILVERWOOD GROUP including Rosenthal Creek Formation Connolly Volcanics and Risdon Stud Formation	Sandstone, mudstone, chert, conglomerate, limestone, pyroclastics and tuff	4,400	Dips moderate to steep, intruded by granite and diorite

5 GEOLOGY OF THE GRANITE AND TRAPROCK AREA

by A.D. Robertson*

Reference to the structure and lithology in this report is based upon information in Exon *et al.* (1969), Olgers and Flood (1970), Exon *et al.* (1972), Robertson (1972), Olgers, Flood and Robertson (1974) and from unpublished data of the Geological Survey of Queensland.

The Palaeozoic (traprock) sediments of the Warwick-Stanthorpe-Texas area form the northern part of the New England Fold Belt. These sediments are eugeosynclinal, highly deformed interbedded sandstone and mudstone with minor chert jasper, intraformational conglomerate, intermediate volcanics and limestone, ranging in age from Ordovician ? to Permian. Faulting during the Permian resulted in Permian volcanics, mudstone, sandstone and conglomerate being downfaulted into Lower Devonian strata to the south and south-east of Warwick. Permian to Lower Triassic granitic rocks intrude the strata of the New England Fold Belt.

This fold belt is flanked in the north-west, north and north-east by relatively undisturbed rocks of the Great Artesian and Clarence-Moreton Basins. The Mesozoic sequence is essentially conformable, with Continental sediments onlapping the Texas High. These sediments comprise sandstone, mudstone and arkose, and include deposits of coal. Faulting and minor folding developed in the Cretaceous and early Tertiary. During the Miocene outpourings of basaltic lava accompanied by pyroclastics and acid volcanics formed the Main Range Volcanics. Widespread erosion followed and was accompanied by the deposition of Pliocene and Pleistocene sands containing vertebrate fossils.

The stratigraphic succession is summarized in Table 5.1 opposite. Map 4 portrays simplified geology after the Stanthorpe Special sheet (Robertson, 1972).

5.1 Geological History

The oldest rocks in the area crop out south of Warwick. These rocks belong to the Silverwood Group, deposition of which may have commenced in Silurian times and continued through the Lower Devonian. The Silverwood Group was deposited under eugeosynclinal shallow water marine conditions and represents part of the widespread volcanism associated with Lower Devonian times. Approximately 4 400 m of volcanics and interbedded sediments were deposited.

Fossiliferous limestone lenses are found towards the top of the Silverwood Group in the Connolly Volcanics and in the Rosenthal Creek Formation. The Silverwood Group has been correlated with the Tamworth Group, and is considered to be younger than the Rocksberg Greenstones and the Bunya Phyllite in the Brisbane region. In the Middle Devonian, deposition was interrupted by the Tabberabberan Orogeny, which affected the strata of the Silverwood Group.

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* Geological Survey of Queensland, Department of Mines.

In Carboniferous time, great thicknesses of eugeosynclinal volcanolithic sediment (Texas Beds) were deposited unconformably on the Lower Devonian Strata. The Texas Beds comprise a thick sequence of sandstone, mudstone, jasper, chert, intraformational conglomerate, limestone and andesitic volcanics. Deposition of the Texas Beds was terminated by the Kanimblan Orogeny (Late Carboniferous) which severely deformed the strata.

Permian sedimentation comprised a great thickness of volcanolithic sediments accompanied by widespread volcanism. This material was deposited unconformably on the deformed Carboniferous and older strata. Epeirogenic movements towards the middle of the Permian resulted in a cessation of sedimentation, a beginning of batholithic granitic intrusion and a commencement of the emergence of the Texas High. Granitic emplacement continued through to the early Triassic.

Permian strata in the Silverwood area were downfaulted into Devonian material. To the west of Stanthorpe, at Alum Rock, Terrica, Silver Spur, Ashford and Glenmore, the Permian rocks are confined to small faulted outliers resting unconformably on Lower Carboniferous Texas Beds. In the vicinity of the Maryland River, 11 km north-east of Stanthorpe, Permian rocks crop out in a small irregularly shaped inlier. Rhyolitic volcanics north of Wallangarra have been equated to the Permian Drake Volcanics 40 km to the east.

Folding movements occurred at the close of the Permian and the New England Fold Belt (Texas High) was uplifted. Triassic sediments derived from the erosion of the high were deposited in flanking basins. As sedimentation continued the material lapped further onto the Texas High. Epeirogenic movement occurred again at the end of the Triassic, resulting in an increase in the rate of erosion and deposition. Fluviatile arkosic sandstone (Marburg Sandstone), with a basal conglomerate, resulted. With decreasing sedimentation rate, swamps and lakes developed by Middle Jurassic time.

These swamps and lakes became the sites of depositions of the Walloon Coal Measures. A large proportion of andesitic volcanic debris and the presence of bentonite associated with the Walloon Coal Measures suggest contemporaneous volcanism. In excess of 2 000 m has been recorded for the thickness of the Mesozoic strata.

Following the Jurassic a long period of steady erosion occurred. This was interrupted by tectonic activity during which major structures developed to the east of the Warwick-Stanthorpe-Texas area. Minor folding and faulting disrupted the Mesozoic succession in the report area.

In the early Miocene, outpourings of predominantly basaltic lava formed a sheet over a thousand metres thick over a large part of the area to the east of Warwick. A profusion of sills, dykes and plugs were intruded accompanied by doming of the Mesozoic sequence.

Since the Miocene, erosion has removed several thousand metres of volcanics and Mesozoic sediments in the more actively eroding areas. In Pliocene and Pleistocene times sands containing vertrebrate fossils were deposited along major stream courses.

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6 GEOMOHPHOLOGY OF THE GRANITE AND TRAPROCK AREA

by A.K. Wills

The Granite and Traprock Area of South-East Queensland - A Land Inventory and Land Utilisation Study, Division of Land Utilisation, Technical Bulletin No. 13, Queensland Department of Primary Industries, Brisbane, 1976.

APPENDICES

FIGURES

6 GEOMORPHOLOGY OF THE GRANITE AND TRAPROCK AREA

by A.K. Wills*

Geomorphology is the science of landforms. Based in geology, it is concerned mainly with land surface characteristics resulting from:

(i) the varying resistance to erosion processes, of an area's rock types,

(ii) movements of the earth's crust,

(iii) climatic influences.

It is of use in broad scale land classification, as similar landforms or slopes often reflect similar land use characteristics, particularly with regard to soil types.

6.1 Geology, Topography and Drainage

Geology is covered in the foregoing section. It is sufficient here to point out the major geological subdivisions:

(i) the traprock

(ii) the granitic intrusions

(iii) the sandstone country, and

(iv) the major alluvial tracts

These all display distinctive landform types which are characteristic of the composition and structure of the parent materials.

The topography of the study area is best appreciated by referring to Figure 6.1 (over) which shows a number of cross-sections of the area. The location of each cross-section is to be found in Figure 6.2 , the map of landform subdivisions.

The main broad scale topographic characteristics are the 'steps' from the highest country in the south-east to the lowlands of the west. This is almost completely due to the granitic intrusions which themselves form the highest levels and are broken up into land systems, mainly according to the amount of dissection which has taken place. Adjacent to the intrusive level is high level traprock which, because of the batholith's proximity having caused enhanced metamorphosis, has been more resistant to downwearing than the bulk of the traprock which forms the lower traprock 'step'. Below these, are the depositional lowlands composed of residual down-worn sandstone or transported granitic and traprock sediments from the east.

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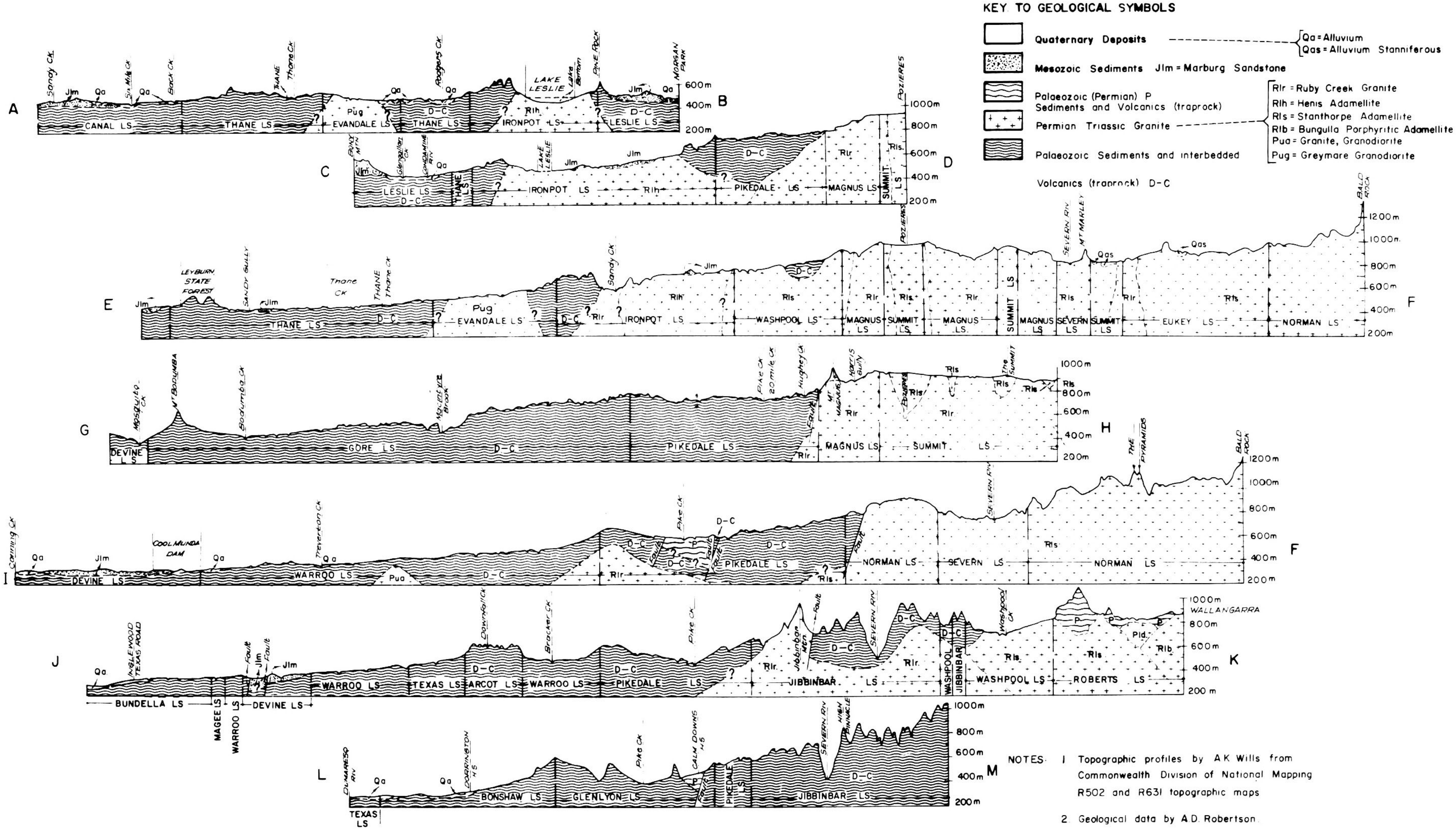
* Division of Land Utilisation, Department of Primary Industries.

FIG. 6.1 - CROSS SECTIONS THROUGH THE GRANITE AND TRAPROCK AREA.



NOTES:
1. Topographic profiles by A.K. Wills from Commonwealth Division of National Mapping R502 and R631 topographic maps
2. Geological data by A.D. Robertson.
3. Vertical Scale exaggeration ten fold.
4. Location of cross sections is found on Fig 6.3 - LANDFORM SUBDIVISIONS.

The main watersheds in the study area are the Herries Range and the scarp between Mt. Burrabaranga and Fish Hole Mountain which extends south through Cox's Sugarloaf to Maidenhead on the Dumaresq River.

North of the Herries Range, drainage is directly northwards or north-easterly to the Condamine River. Thane Creek and Canal Creek (also known as Six Mile Creek) are substantially unaffected in their direction by the differing lithologies and discordant structures which they drain. However Greymare Creek and the streams feeding Lake Leslie have strongly influenced the topography of their granitic basins.

South and east of Mt. Magnus, the Severn and its tributaries drain most of the Granite Belt. It then downcuts deeply into the high traprock (see cross-sections J-K and L-M) to meet up with Pike Creek and the Mole River at Mingoola.

Pike Creek drains an elongated catchment from the Herries Range southwards, between the edge of the batholith and the west-facing scarps which divide the higher traprock country from the lower.

Westward drainage is equally divided between the Macintyre Brook/Bracker Creek dendritic complex flowing into Coolmunda Dam and the short streams which feed directly to Canning Creek, north of the dam, or to the Dumaresq River as it turns north-west past Texas.

6.2 Landform Features of the Area

6.2.1 The Traprock

First impressions of the traprock country are of a monotonous repetition of hard ridges and little else. On closer inspection however, a number of features stand out which call for investigation.

(a) Metamorphic Aureoles - These resistant rings of traprock around granitic areas are caused by metamorphism due to close proximity to the magma at time of intrusion. When eventually exposed to weathering and erosion, the metamorphosed rock typically displays more resistance than its granitic inlier; and the final result is a down-worn granitic basin with a surrounding steep, hard, traprock ridge. The best examples of this are around Leslie Dam and Greymare Creek (see cross-sections A-B and C-D) but these pronounced effects of metamorphism can be found along most major granitic limits.

(b) Incised Meanders, Gorges and River Profiles - Entrenched meanders are common on Pike Creek, Macintyre Brook north of its confluence with Branch Creek, and on the Severn River. Extreme examples are found on Pike Creek, south of 'Melva' homestead and a number of smaller entrenched meanders are found, on Macintyre Brook, in the area north of 'Burrabaranga' homestead. Although these meandering forms could have been inherited from an antecedent pattern, it is likely that more recent influences have been lithological or structural. This is particularly the case with the Severn River, between Fletcher and Mt. Malakoff, which is controlled in its course by resistant granite blocks and traprock strike ridges.

Between Mt. Malakoff and Mingoola, the course of the Severn is remarkably direct for such a violently downcutting stream and it is thought that it is influenced by an, as yet undefined, faulting system (Robertson *pers. comm.*).

This last mentioned feature is known as the Severn Gorge (see cross-sections J-K and L-M) and is evidence that uplift occurred in this area in comparatively recent times. This is seen at the smaller scale along most of the streams mentioned previously. In addition to the incised meanders, most stream banks and many beds are of bedrock exposed by the downcutting. In these areas, the only zones of deposition are at minor nick points where mainly gravel and loose rock is banked up against more resistant bands of traprock lying across the course of the stream.

River profiles were examined for the main rivers in the study area. Due to the relatively coarse contour data available, only extreme features were noted. A stepped and mainly convex profile segment along Middle Creek stands out where it crosses an intense series of dykes north-west of Dalveen. The only other significant irregularities relate to the stretch on the Severn River from above Accommodation Creek to near the 520 m level. This segment corresponds approximately to that between Fletcher and Mt. Malakoff referred to previously and spotlights it as a zone requiring intensive study for evidence of faulting.

(c) Floodplain Characteristics - The possibility that drainage patterns in the study area are partly antecedent was mentioned previously. This appears to be particularly so in regard to the northward flowing Thane Creek and Canal Creek (Six Mile Creek). It is suggested that these creeks formed when the cover of Mesozoic sandstones was thicker and more widespread. With subsequent stripping of this sedimentary cover, due probably to uplift as well as normal erosion processes, the steeply dipping traprock ridges which, in this area, trend mainly NW-SE were cut through by the major streams which succeeded in maintaining their original courses.

The result has been two distinct floodplain types related to the lithology and characteristics of the materials traversed by the streams. The resistance of the traprock is reflected in the relative narrowness of the floodplains which average 600 m in width; while, in the softer sandstone, the average width of the floodplain is about 1 600 m.

Other floodplain phenomena relate to specific areas of:

(i) Mosquito Creek, between 'Lonsdale' and 'Paisley' homesteads,

(ii) Lickhole Creek, north of Pikedale, and

(iii) lower Tea Tree Creek, as it meets the Severn River north of Mingoola.

Each of these is associated with nearby faulting, but there are no further unusual characteristics common to all three.

The first two are comparable in that there is a confused and discordant microrelief, both on the floodplain and around the margins. Mosquito Creek's floodplain seems to be cutting back and forming a new level from its contact with the sandstone. Its footslopes are irregularly undulating and one auger hole there revealed two duplex soil profiles, the upper having a neutral soil reaction trend and the lower an alkaline trend, with a 10 cm layer of quartzite and traprock gravel on the surface. Presumably this area experienced two phases of deposition and horizonation, the latter a particularly wet one; and now, due to a drop in local base level, is being cut down under semi-arid/dry sub-humid climatic conditions. Lickhole Creek's floodplain appears to be more stable than Mosquito Creek's although its fringing topography is similarly complex. On the eastern fringes, the foothills come down to a low, hummocky landscape of unknown origin; while on the west, a bluff of low, truncated spurs coincides with a geological fault.

A similar series of truncated spurs, but more spectacular, is seen from 'Hillside' homestead northwards along Tea Tree Creek. According to the geological map, this is not a fault line, although it is in a faulted area.

The above descriptions of unusual features in minor floodplains pose questions rather than provide answers, and the sites mentioned warrant detailed follow-up work.

(d) Limestone Features - Numerous small deposits of limestone are found throughout the traprock (Robertson 1972; Siemon 1973). The main economic deposits at Cement Mills and Limevale have weathered to produce long pediment slopes of reddish brown terra rossa (or similar) soils - very unlike any traprock slope form.

Between 'Viator' and 'Riversdale' homesteads are the Texas Caves. Compared to other cave systems in Australia and overseas, they are relatively insignificant; but the scarcity of such formations in Queensland gives them local importance. The landscape of this area has been described as 'karst' and there are sporadic sinkholes (or dolinas), entries into cavern roofs and a reported underground stream. The main characteristic of a karst area is a predominantly vertical and underground drainage, resulting in the absence of surface streams (Sweeting 1968). This area therefore comes into the karst category, only marginally - if at all. The valley in which the caves are found is rather atypical for the traprock area, in that it is roughly U-shaped and its meanders are ingrown rather than entrenched; but there are no indications of the broader scale karst features which characterise well-known karst regions of the world.

The Pinnacle is a small peak which has been preserved by its limestone capping, while the main scarp, from Cox's Sugarloaf south, retreated eastwards from the Dumaresq River. Nearby, to the north is another limestone outcrop at about the same level and which was probably contiguous with the Pinnacle at some time in the past. The limestone, which has been weathered and transported from this source, has produced pediment type footslopes and terra rossa soils similar to those found between Texas and Limevale.

6.2.2 The Granite

Granite landforms constitute a more discrete field of study than most specialist areas of geomorphology. Unlike the traprock, a considerable body of directly comparable work has been done on granite, both overseas and elsewhere in Australia. A broad spectrum of the better-known granite landforms are found in the intrusive parts of the study area. These are listed below and discussed in a roughly ascending order of size.

(a) Tors and Tor Clusters - Tors are rounded granite boulders which were originally core stones in the area of deep weathering and have since been exposed through the erosion and disappearance of the weathered material. Apart from the Girraween National Park, where most granite landform features are to be found, good examples of tors are found in the Passchendaele-Donnelly's Castle area.

(b) Balancing Rocks - These are similar to tors but are usually found singly, poised in situ on a fragment of weathered granite, after stripping of the weathered material. A tor is a granite boulder which has settled or fallen into a position of stability while a balancing rock is a boulder in a position of conditional stability which can easily be upset. Balancing rocks are found near Passchendaele, the Pyramids and South Bald Rock.

(c) Weather Pits (or Gnammas) - These circular depressions are found on bare granite surfaces such as the upper slopes of bornhardts (see below) or near flat, exposed platforms at or near drainage lines. In the study area they are generally small and not so well developed as those found in South Australia for instance (Twidale 1968). However shallow gnammas or pans are found on the bare rock exposed near Bald Rock Creek at the Girraween National Park barbecue area; and small armchair shaped gnammas are found on South Bald Rock, Castle Rock and the Pyramids.

(d) Tafoni - Tafoni are weathered depressions found on bare rock surfaces. They are similar to gnammas but are found on the sides or bases of rock outcrops and boulders. Minor examples of side tafoni are common and a good example of basal tafoni can be seen in Passchendaele State Forest.

(e) Erosion Channels (Granitrillen) - As with the previous two features, these erosion channels are bare rock phenomena. Their occurrence appears to be related to subtle differences in the resistance of the surface layers of granite. A case in point is the Pyramids, the southern peak of which is wearing down by exfoliation of thick rock sheets and the northern peak of which appears, from a distance to be smooth, but is in fact interlaced by shallow 'granitrillen'. The surface of South Bald Rock is similarly indented by a shallow channel network. Most of these channels are sinusoidal in cross-section but a few straight channels have developed which tend to have a rectangular or square cross-section. These do not appear to be related to jointing patterns although it is hard to see any other cause for this anomalous channel form.

(f) Bornhardts - This term is used here to describe granitic hills, with domed summits, steep sides and mainly bare surfaces. They are residual rock masses that were resistant to chemical weathering and have been exhumed as the surrounding weathered material was eroded away in an erosion cycle following that in which the deep weathering occurred (Thornbury, 1969). Best examples are found in Girraween National Park - The Pyramids and Castle Rock, and on the State Border - Bald Rock and South Bald Rock. At South Bald Rock, an additional feature is noted in the form of a basal rock platform or bench, only 30 to 50 cm above the level of Racecourse Creek flat.

(g) Rectilinear Drainage - Although the right angled bends expected of streams developed on granite are not apparent in great numbers in the study area, a linear pattern is evident on the large scale, where streams coincide with major joints. The main unit of Norman LS contains four such major linear depressions, radiating from an east-west alignment at Horan's Gorge to north-south at Racecourse Creek. These depressions are typically flat and meet the adjacent valley sides quite abruptly, with only a narrow detrital slope if any. The moisture status of this land unit is normally above average due to the contrasting factors of rapid and high runoff from the steep bare rock surfaces and the high absorption potential of the flat valley of deep, coarse sand and gravel. It is likely that these are areas of deep weathering and, in a future pluvial phase, would be denuded to produce a bornhardt landscape of greater relief.

6.2.3 The Sandstone

The sediments laid down over the Texas structural high (Hill and Denmead 1960) have been largely worn-down and are disappearing towards the edges of the study area limits. The units are quite widely separated and consequently have different characteristics due to different landform controls.

(a) The Hills South and West of Warwick - This area has more relief than the other sandstone areas and two reasons are postulated for this difference:

(i) the surrounding traprock country is very resistant and has supported the sedimentary rock around much of its margins (see cross-section A-B, Leslie LS)

(ii) the basalt extrusions of the Dividing Range probably extended to this area and provided protection which the western sandstone areas did not receive. The reddish brown soil colour and accordance of summit level of the residual flat topped ridges together with vegetational changes indicate a basaltic influence

(b) Cuestas - The main units of the Canal LS and Devine LS contain the last remnants of an anticline breached by the Texas structural high. The major clue lies south-west of Leyburn in the form of a shallow, but resistant, cuesta (scarp) running north of and parallel to Sandy Creek. Other fragments of cuestas are found south of there and in the area north and west of Graysholm. These all face south-east.

(c) Gilgai - Patches of gilgai microrelief are found in flat country in the sandstone geological unit, between the MacIntyre Brook and Canning Creek alluvia. This is not considered to be a typically sandstone landform but is probably more a product of past basaltic influence evidenced by the minor residual north-east of Coolmunda siding.

6.3 Landform Evolution

6.3.1 Tectonic History and Present Processes

(a) The Granitic Intrusions - These are documented in detail by Robertson (1972). The interrelationships between the intrusions vary according to place and geological time, and have resulted in a complex land surface which is only partly explained in the disaggregation into land systems.

The last emplacement namely the Ruby Creek Granite, appears to be the most resistant to erosion, relative to the major intrusive unit - the Stanthorpe Adamellite. This has resulted in the rugged ridges which surround the Broadwater basin and support the plateau country around the Summit. Deep incisions, massive tor clusters and extensive areas of exposed rock are common in this area.

The most widespread intrusion, the Stanthorpe Adamellite, shows evidence of extensive downwasting. It can however be broken up into areas of varying resistance and the land systems reflect this. Relief varies from the dissected highlands of the south-east, with widespread tor-strewn ridges, narrow swampy valleys and emerging bornhardts, to the low relief basins of Washpool Creek and The Broadwater. Intermediate cases are represented in the upper Severn and Quart Pot Creek basins.

To the north, the Herries Adamellite has eroded considerably but its basin is modified by the more recent intrusions, dykes in the middle portion of the unit and to a lesser extent by the Marburg Sandstone layers which once covered it. Remnants of the sandstone cap some of the ridges but are now too shallow to have much effect in protecting the underlying granite,although fragmentary remains of a hard sandstone layer may be seen close to the New England Highway near the Pikedale turnoff 18 km from Warwick. The Herries Adamellite north of Dalveen is similar to the southern part of the main unit, probably because of a more substantial sandstone capping and its position between two particularly resistant areas of traprock.

The Greymare Granodiorite has eroded considerably to become a simple basin unit draining to the north-east and surrounded by an aureole of traprock hills.

Other intrusions in the study area are of minor importance and are dealt with in the appropriate land system description.

(b) The Traprock - These Paleozoic sediments occupy most of the study area and their geological complexity has deterred detailed disaggregative mapping until comparatively recently (Lucas 1960; Robertson, 1972; Olgers, Flood and Robertson 1974)

Lucas' work in particular with its numerous queried and smoothed boundaries, serves to emphasize the problems faced by all kinds of land resource surveyors in the traprock area. The heavy folding and overfolding at the end of the Carboniferous is the reason for the contorted and faulted plan distribution of the sediments.

The main characteristics of the Paleozoic beds are their steeply dipping nature and the resistance of the parent material. This has resulted in a ridged landscape of intense relief which, since the Carboniferous, has been subjected to phases of erosion, sedimentation and uplift, yet has probably changed little in character. It is essentially an old landscape of rocks which cannot change much more than they have already done, unless a long enough stillstand occurs which allows the area to be reduced to a peneplain.

The main broad scale landforming process in the traprock is scarp retreat or wearing back, going on from the south-west. This is particularly apparent in the land systems of Warroo and Bonshaw, and to some extent in Texas and Glenlyon. These constitute Landform Subdivision No. 3 - The South Western Scarps and Foothills.

The ridges of the traprock country are best seen in Thane LS where Mt. Gammie and Mt. Gammie North produce extremes of relief. In Gore LS, lower relief but a greater repetition of the ridge pattern is evident. In both these land systems, the general north-west to south-east trend, found in much of the study area, tends towards an east-west alignment further northwards.

The Pikedale LS and Jibbinbar LS seem to have resisted downwearing most effectively. This is probably due to underlying granite which has reinforced and silicified the parent rock. Although the north-west to south-east pattern of ridges and valleys is seen in Pikedale LS, it is more subtle and at the broad scale, the area, is quite plateau-like. Jibbinbar LS would be similar but for the dominant influence of the downcutting Severn River, produced by the uplift of the adjoining batholith and the additional orographic component in the rainfall due to elevation.

A small area of Silurian to Devonian sediments is found in the east of the Ironpot LS. This is the oldest rock type in the study area and has produced the most intense relief in the area's northern half. The intensity of relief is surpassed only by the Severn Gorge and this is probably a product of the resistant parent material and recent uplift, as indicated by complex faulting east of Rosenthal Creek.

(c) The Sandstone - This parent material is of minor occurrence in the study area and its landform processes are discussed in section 6.2.3.

6.3.2 Climatic Change

Studies in climatic change have been carried out for regions fringing the study area (Jessup 1961; Paton 1965; Sparrow 1964). Other work relates to Queensland or Australia as a whole (Whitehouse 1940; Gentilli 1961). It is safe to assume that the study area has also been affected by climatic fluctuations, both in the short term of the Holocene (or Recent) epoch and farther back in geological time.

Unfortunately, clues to climatic change can also be confused with the effects of tectonic movement. One of these was mentioned earlier (see 6.2.1 (c)) with regard to minor floodplains. It is well known that floodplains are a repository of chronological information on erosion phases, but they record the combined effects of orogenic and volcanic land building, as well as the changes in erosion rates which reflect changes in climate. Nevertheless, systematic stratigraphic studies of alluvial deposits in the area could probably contribute considerably to knowledge of the landscape history of the area.

6.3.3 Anthropogenic Influences

Man's modification of his environment has had its effect on landforms as much as on other areas of the ecosystem. Deforestation and overgrazing of land are probably the main causes of landscape modification throughout the world, and have been blamed for a number of disastrous losses of productive land in many countries. The main anthropogenic causes of landform modification in the study area are listed below.

(a) Deforestation - The Land Use map (MAP 7) shows how much of the study area has had the forest cover removed or reduced. In a few areas, gullies are evidence of an obvious loss of soil. However the less obvious but more widespread removal of soil by sheet erosion is probably a much more important factor. Soil erosion and conservation are discussed in section 12.11, but the main manifestations of accelerated erosion on landforms are noted below:

(i) Gullying - Heavier concentrations of runoff water are likely to cause rills and shallow gullies on hillslopes, and renewal of downcutting in stable floodplains. Gullies are also prevalent near roadsides due to channelling of runoff water from the road surface.

(ii) Scalds and Salting - Scalds are found throughout the traprock hills near drainage lines. They may be partly due to overgrazing but footslope salting is also likely as scalded areas are usually found in completely cleared situations. Salt affected areas also appear on the Dumaresq floodplains.

(b) Mining - The most obvious results of mining are found east of Stanthorpe where tin mining of the alluvium on Sugarloaf Creek has completely disturbed sections of floodplain in this area. A reversal of normal surface drainage behaviour for granite country is noted, in that most creeks meander slowly over deep accumulations of silt deposited from mine workings (Birtles 1960).

A more dramatic but extremely localized change to the landscape can be seen at Cement Mills where open-cut mining of limestone has left deep holes in the ground. Waste heaps are also prominent around this area, as they are at other mining centres such as Silver Spur.

6.4 Landform Subdivisions

6.4.1 Criteria for Subdivision

Working within the land system framework, areas were assessed empirically on relative relief, mean slope and limiting slope, and mean elevation. Relative relief and mean elevation were selected as the main determinants for grouping and the land systems were graded according to those parameters On this basis, a disaggregation of the study area into five subdivisions was considered appropriate.

Terminology used below follows as closely as possible the DLU Landform Classification (Appendix 6.1) and all values quoted are rounded.

6.4.2 The Subdivisions (see Fig. 6.2 over)

The Western Lowlands (1) - This area comprises most of Devine LS, Bundella LS and Magee LS. They are depositional lowlands of residual sandstone or coarse transported sediments from high country to the east.

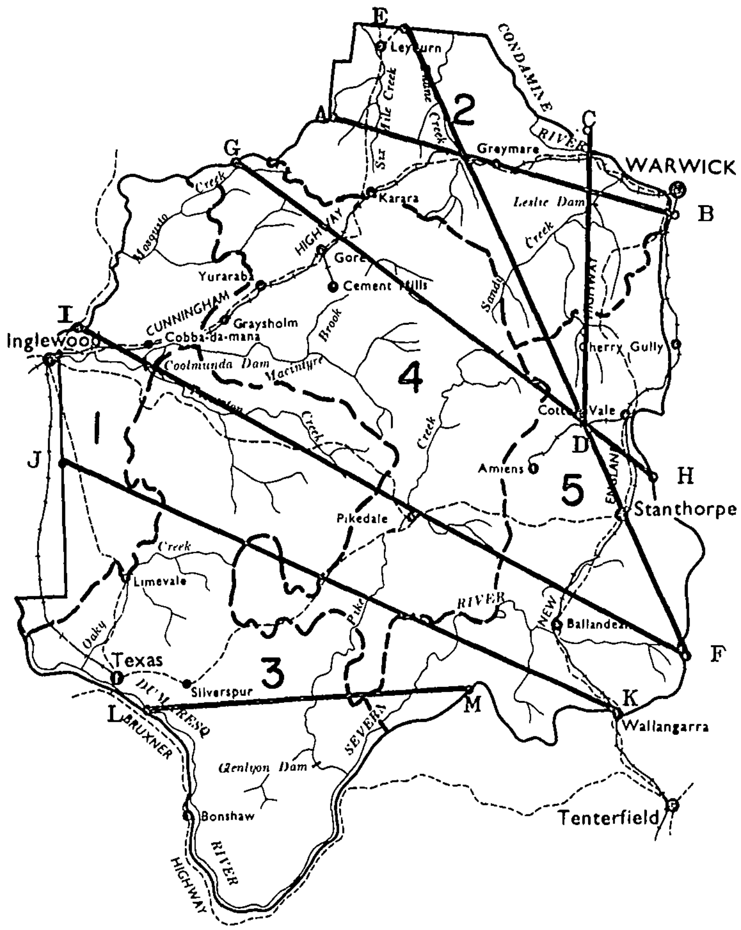
The most appropriate classification is Landform Class (LFC) 6 plains with hills or mountains. They are mainly plains of low and moderate relief with some low hilly interfluves and knolls. Mean slope is 3 per cent going up to a 6 per cent limit, generally, and up to 15 per cent on hilly units. Overall relative relief is 175 m and mean elevation is 350 m.

The Northern Ridgelands (2) - Canal LS, Thane LS, Evandale LS and the lower part of Ironpot LS are represented in this subdivision. The area is mainly plains and low hills, broken up by steeply dipping strike ridges and metamorphosed ridges surrounding the Greymare and Herries intrusions.

Thus it may be classed as LFC2, plains of low relief and LFC5, low hills; with LFC9, hills, sub-dominant. Mean slope is 5 per cent, going up to 12 per cent generally and up to 50 per cent occasionally. Relative relief is 275 m and mean elevation 500 m.

The South-Western Scarps and Foothills (3) - This area has already been mentioned in section 6.3.1 (b), as the main area in which scarp retreat is taking place in the traprock country. Areas approximating parallel slope retreat models are found mainly in the Warroo LS and Bonshaw LS but can also be discerned among the more confused topography of the Texas LS and Glenlyon LS.

The area is predominantly LFC5, low hills with some LFC11, scarp terrain. Floodplains, with the exception of the Dumaresq, are mainly narrow. Mean slope is 8 per cent, generally going up to 20 per cent but with over 40 per cent common in scarp country. Relative relief is 400 m and mean elevation 450 m.



A○——○B = Location of Fig. 6.1 cross-sections

FIG. 6.2 - LANDFORM SUBDIVISIONS

(1) The Western Lowlands.
(2) The Northern Ridgelands.
(3) The South-Western Scarps and Foothills.
(4) The Central Hills.
(5) The Eastern Highlands.

The Central Hills (4) - Pikedale LS, Gore LS, Arcot LS and a small segment of Devine LS comprise this subdivision.

The area is mainly LFC9, hills, with some LFC10, deeply dissected terrain, around the valleys of incised streams. Mean slope is 10 per cent, going up to 20 to 25 per cent generally and occasionally up to 50 per cent. Relative relief is 500 m and mean elevation 600 m.

The Eastern Highlands (5) - This subdivision includes all of the land systems of the granite belt plus Jibbinbar LS and the southern part of Ironpot LS.

It is mainly classed as LFC12, mountains, with areas of LFC8, tablelands - dissected. The latter are small plateaux and elevated basins interspersed throughout the rougher country. Mean slope is 16 per cent going up to vertical in the mountainous areas, and 6 per cent going up to 24 per cent locally in the elevated uplands. Relative relief is 900 m and mean elevation 800 m.

6.5 Acknowledgements

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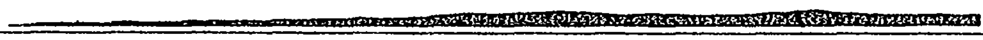
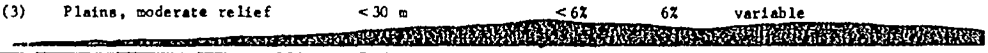
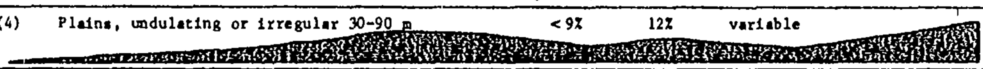
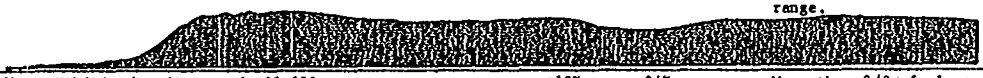
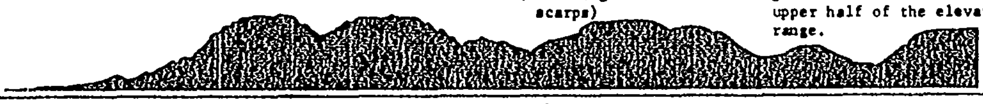
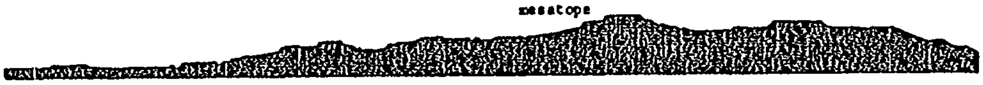
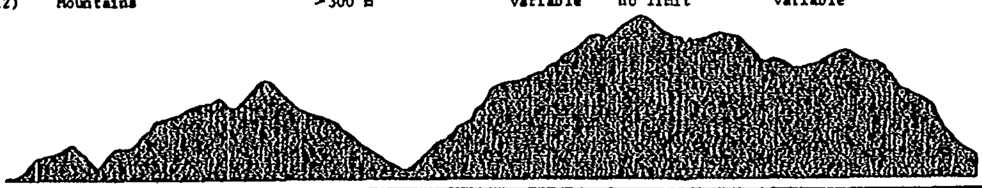
APPENDIX 6.1

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, DIVISION OF LAND UTILISATION

REVISED LANDFORM CLASSIFICATION 24TH MARCH, 1971

[TABLE I for data cards]

CODE NO.	LANDFORM CLASS	RELATIVE RELIEF	MEAN SLOPE	LIMITING SLOPE	PROFILE
(1)	Plains, flat	<6 m	½%	1%	flat
(2)	Plains, low relief	<15 m	<3%	3%	variable 
(3)	Plains, moderate relief	<30 m	<6%	6%	variable 
(4)	Plains, undulating or irregular	30-90 m	<9%	12%	variable 
(5)	Low Hills	90-150 m	<18%	24%	variable 
(6)	Plains, with hills or mountains	>90 m	<21%	12% plains sections, none on hills	More than 2/3 of slopes gentler than 6% is in the lower half of the elevation range. 
(7)	Tablelands/plateaux	<30 m at surface; <150 m overall	<6%	6%	More than 2/3 of slopes gentler than 6% is in the upper half of the elevation range. 
(8)	Tablelands, dissected	30-150 m	<18% (excluding scarps)	24%	More than 2/3 of slopes gentler than 12% is in the upper half of the elevation range. 
(9)	Hills	<300 m	⩽24%	no limit	variable 
(10)	Deeply dissected terrain	<300 m	⩽24%	no limit	More than 2/3 of slopes gentler than 18% is in the upper half of the elevation range. 
(11)	Scarp terrain	>90 m	>24% on scarps ⩽12% on deps or mesatops	no limit on scarps 18% on dips or mesatops	Breaks in slope must be clear enough to delineate scarps from tops without an extensive transition zone.  Note: Separate delineation of other LFCs in LFC 11 will depend on scale of mapping
(12)	Mountains	>300 m	variable	no limit	variable 

Note: (1) Elevation is recorded separately on data cards.
(2) Diagrams indicate only one possible terrain profile for each landform class.

7 SOILS OF THE GRANITE AND TRAPROCK AREA

by B. Powell

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The soils of the area have been mapped at the 1:2 000 000 scale in Sheet 3 of the 'Atlas of Australian Soils' (Northcote 1966). These mapping units are associations of soils delineated as landscapes. Skerman and Allen (1952) mapped and described soils of the Darling Downs which included a northern portion of the study area. Isbell (1962) included small areas near Inglewood and Texas in his examination of the brigalow lands of eastern Australia. Isbell (1957) also mapped and described soils of the adjoining Inglewood-Talwood-Tara-Glenmorgan Region.

In this study, associations of soils have been mapped at the 1:250 000 scale and the component soils described. Some soil properties are discussed and detailed information for a number of soil profiles is presented.

7.1 Soil Mapping Units

Soil mapping units (see MAP 5) are defined using soil profile characteristics, geology and landform. Unit boundaries are plotted using photo-interpretation. To determine the morphology and distribution of soils within units, 400 soil profiles were examined (Fig. 7.1), 50 profiles being sampled and described in detail.

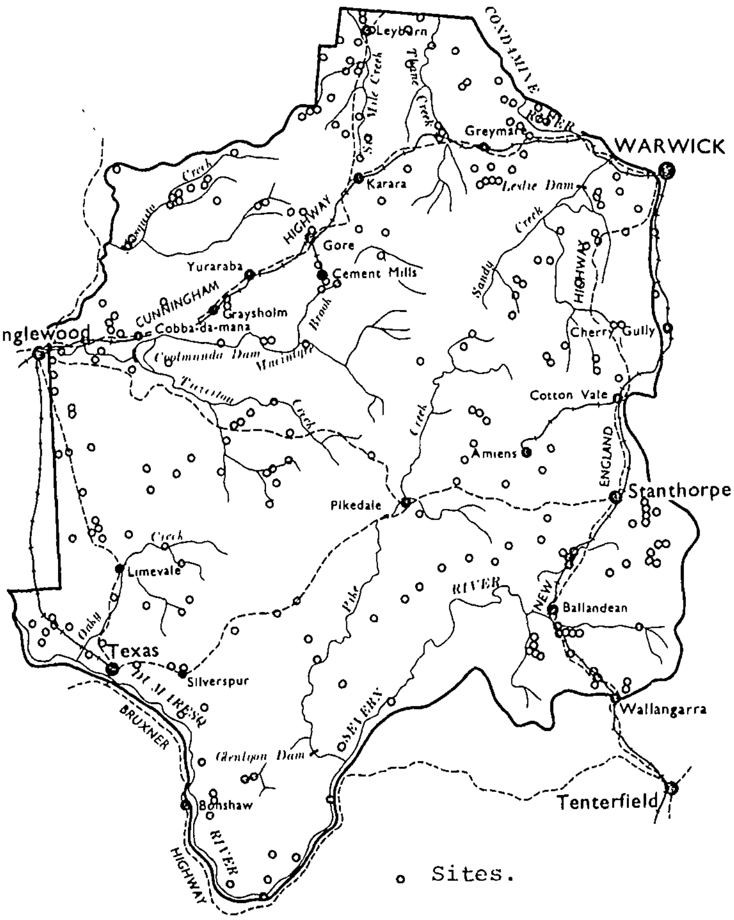

FIG. 7.1 - LOCATIONS OF SOIL PROFILE EXAMINATION SITES

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Soil profiles were examined to a depth of 90 cm using a 7.5 cm diameter soil auger, and classified into principal profile forms (Northcote 1974) and Great Soil Groups (Stace *et al.* 1968).

Within each mapping unit soil profiles were compared and grouped into soil profile classes (Beckett and Webster 1971). Units are associations of soil profile classes and in most cases consist of a dominant soil profile class with associated minor soil profile classes.

Soil profile classes are described in terms of textural profile form and other identifiable soil morphological features. Great Soil Group names are included in the soil profile class terms if they adequately describe a soil profile class, for example gritty siliceous sands.

Twenty-two units are mapped. Units are identified by symbols derived from the geological nature of the area and the principal profile forms of the dominant soils.

A glossary in Appendix 7.1 presents definitions of some of the soil terms used in this report.

Soil profile classes are briefly described below:

Unit Symbol	Brief Description of Soils of Mapping Units
AUg	DEEP, DARK, CRACKING CLAYS* (Ug 5.17). Self-mulching, black heavy clay with lime concretions throughout and an alkaline pH which increases with depth. <u>Dark loams</u> (Um 5.52). Deep, brownish-black, massive, loam to clay-loam of neutral pH. These soils occur in the unit of the following land system 4 - Leslie.
AGn-D	DARK-BROWN, STRUCTURED EARTHS (Gn 3.23, Gn 3.25, Gn 3.42). Deep soil with a hardsetting, massive, brownish-black to dark-brown, clay-loam surface soil commonly underlain by a pale A_2 horizon grading into a dark-brown, neutral to alkaline clay subsoil containing lime concretions. DARK-BROWN, TEXTURE CONTRAST SOILS (Db 1.42, Db 1.43, Dy 2.42, Dd 1.43, Dd 3.23). Deep soil with massive, greyish-yellow-brown, loam to clay-loam surface soil, usually hardsetting, over a bleached A_2 horizon to 30-35 cm, over greyish-yellow-brown to dark-brown, blocky or columnar alkaline clay. Lime may occur at depth. <u>Dark loams</u> (Um 1.43, Um 1.44, Gn 2.43). Deep, dark-brown, massive, sandy-clay-loam to clay-loam of neutral pH, sometimes becoming more clayey and alkaline with depth. <u>Dark, hardsetting clays</u> (Uf 6.31, Uf 6.32, Uf 6.33). Deep, black to dark-brown clay becoming alkaline with depth. Lime concretions in subsoil are common. Clay colour may become browner with depth. These soils occur in units of the following land systems 4 - Glenlyon, 5 - Bonshaw, 5 - Texas.

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* Capital letters indicate dominant soils, underlined letters indicate minor soils.

Unit Symbol	Brief Description of Soils of Mapping Units
AD	YELLOWISH-BROWN AND BROWN, NEUTRAL TO ALKALINE TEXTURE CONTRAST SOILS (Db 1.43, Db 3.13, Dy 2.12, Dy 2.42, Dy 3.43). Moderately deep to deep soil with hardsetting, massive, brownish-black to dull-yellowish-brown, loamy-fine-sand to clay-loam, frequently gravelly, surface soil frequently underlain by a bleached A_2 horizon to 10 to 40 cm over a coarse-blocky or columnar structured, dull-yellowish-brown or mottled brown, neutral to alkaline clay subsoil.
	Red, acid texture contrast soils (Dr 2.41, Dr 4.41, Dr 4.22). Deep soil with dark-brown to brown, loamy-sand to fine-sandy-loam surface soil over a pale or bleached A_2 to 60 cm over red-brown, acid clay subsoil.
	Red and brown, alkaline, structured earths (Gn 3.16, Gn 3.19, Gn 3.55, Gn 3.74). Deep soil with dark-brown to brown loam, fine sandy to fine-sandy-clay-loam surface soil usually underlain by a pale A_2 horizon grading into reddish-brown, mottled brown or yellowish-brown alkaline clay subsoils.
	Sandy-loams (Uc 1.23, Uc 4.22). Deep soil with brown to reddish-brown fine-sandy-laom to sandy-loam surface soil frequently underlain by a pale A_2 horizon over brown, acid to neutral, sandy-loam subsoil.
	Brown, grey and dark cracking clays (Ug 5.1, Ug 5.2, Ug 5.3). Deep soil with large hexagonal cracking dark or dark-brown clay to clay-loam surface veneer over grey, brown or brownish-black neutral to alkaline clay subsoil, usually with lime at depth.
	These soils occur in units of the following land systems 3 - Glenlyon, 4 - Pikedale, 6 - Canal, 5 - Thane, 4 - Gore, 6 - Warroo, 4 - Bonshaw, 4 - Texas, 4 - Magee, 3 - Bundella, 5 - Devine.
GUc-1	GRITTY, SILICEOUS SANDS AMONGST ROCK OUTCROPS (Uc 2.12, Uc 2.21, Uc 2.34). Shallow to deep soil with brownish-black, gritty, coarse-sand to sandy loam surface soil over a bleached gritty coarse-sand to loamy sand to 25 - 90 cm, frequently underlain by a colour B horizon of similar texture and/or a hardpan.
	Shallow, gritty sands (Uc 2.12). Shallow soil with brownish-black, gritty loamy-sand surface soil over a bleached gritty-sand containing rock fragments to 30 cm.
	Yellow, acid texture contrast soils (Dy 5.41, Dy 4.41). Moderately deep soil with brownish-black, loamy-sand to sandy-loam surface soil over a bleached gritty-sand to 30 cm over a yellow or yellow mottled, acid, clay subsoil.
	These soils occur in units of the following land systems 3 and 4 - Roberts, 1 - Eukey, 1 - Summit, 1 - Magnus, 1 - Severnlea, 8 - Washpool, 2 - Jibbinbar, 5 - Pikedale, 1 and 7 - Ironpot, 2 - Evandale, 7 - Warroo, 7 - Texas.

Unit Symbol	Brief Description of Soils of Mapping Units
GUc-2	GRITTY, SILICEOUS SANDS (Uc 2.12, Uc 2.21). Shallow to deep soil with brownish-black, gritty loamy-coarse-sand to sandy-loam surface soil over a bleached gritty-coarse-sand or loamy-sand, overlying a hardpan or becoming brighter coloured with depth (60-90 cm). <u>Yellow, acid, texture contrast soils</u> (Dy 5.41). Deep soil with brownish-black, gritty loamy-sand to sandy-loam surface soil over bleached loamy-sand to 30 cm over yellow and grey, mottled, acid clay subsoil. These soils occur in units of the following land systems 3 - Roberts, 2 - Norman, 2 - Eukey, 2 and 3 - Summit, 2 - Magnus, 5 and 7 - Ironpot, 7 - Warroo.
GDy-Dg	ACID, YELLOW AND GREY, MOTTLED, TEXTURE CONTRAST SOILS (Dy 3.41, Dy 5.41, Dg 2.41). Deep soil with gritty, brownish-black, loamy-sand to light-sandy-clay-loam surface soil over a bleached A_2 horizon to 30-45 cm over mottled, bright-brown and yellowish-grey, acid, clay subsoil becoming more gritty with depth. <u>Gritty, siliceous sands</u> (Uc 2.12). Shallow to deep soil with gritty, brownish-black to dark-grey, loamy-sand to sandy-loam surface soil over bleached gritty-sand to sandy loam. <u>Neutral to alkaline, texture contrast soils</u> (Dy 3.42). A moderately deep to deep soil with brownish-black, light-sandy-clay-loam to sandy-clay-loam surface soil over bleached A_2 horizon to 20-30 cm over mottled, dull-yellowish-brown, neutral to alkaline clay subsoil. <u>Bleached, yellow earths</u> (Gn 3.84, Gn 3.04). Deep soil with gritty, brownish-black, sandy-loam surface soil over bleached, gritty sand A_2 horizon to 60-75 cm grading into mottled, bright-brown and pale-yellow, acid, gritty, clay-loam or clay subsoil. These soils occur in units of the following land systems 4 - Roberts, 2 - Norman, 3 - Eukey, 3 and 4 - Summit, 3 - Magnus, 2 and 3 - Severnlea, 5 - Washpool, 2 - Jibbinbar, 5 - Pikedale, 6 and 7 - Ironpot, 3 - Evandale.
GD1	ACID TO NEUTRAL, TEXTURE CONTRAST SOILS (Dy 3.41, Dy 3.42, Dg 2.42, Dg 4.42). Moderately deep to deep soil with brownish-black to dull-yellowish-brown, sandy-loam surface soil over massive bleached sand A_2 horizon to 30-60 cm over coarse-blocky or columnar, mottled, greyish-yellow-brown to light-yellow, gritty acid to neutral, clay subsoil. <u>Alkaline, texture contrast soils</u> (Dy 5.43). Moderately deep soil with a loose brownish-black light-sandy-clay-loam surface soil over bleached A_2 horizon to 20 cm over mottled, yellowish-brown, alkaline clay subsoil becoming gritty with depth. These soils occur in units of the following land systems 5 - Washpool, 3 and 7 - Ironpot, 3 and 4 - Evandale.

Unit Symbol	Brief Description of Soils of Mapping Unit
GD2	ALKALINE, TEXTURE CONTRAST SOILS (Db 1.33, Db 1.43, Dy 2.43, Dr 2.43, Dg 1.43). Shallow to deep soil with hardsetting, brownish-black to dark-brown light-sandy-clay-loam to clay-loam surface soil over bleached A_2 horizon to 10-35 cm over coarse-blocky or coarse-columnar dull-reddish-brown to light-grey, alkaline clay subsoil. Acid to neutral texture contrast soils (Dy 3.41, Dg 2.42). Moderately deep soil with hardsetting brownish-black sandy loam to sandy-clay-loam surface soil over bleached A_2 horizon to 30-60 cm over mottled, dull-yellowish-brown to grey, acid to neutral clay subsoil. These soils occur in units of the following land systems 4 - Roberts, 4 - Eukey, 2 - Magnus, 3 - Severnlea, 6 and 7 - Washpool, 6 - Ironpot, 7 - Texas.
LGn	RED-BROWN, STRUCTURED EARTHS (Gn 3.13, Gc 2.22). Deep soil with hardsetting, dark-reddish-brown clay-loam surface soil grading into red-brown medium-clay subsoil containing manganiferous concretions and neutral to alkaline at depth. Lime concretions are occasionally present in large amounts. Dark-red, hardsetting, calcareous clays (Uf 6.31). Moderately deep clay with gritty, brownish-black to brown surface soil grading into dark-brown to brownish-black, blocky subsoil with powdery lime throughout. These soils occur in units of the following land systems 2 and 3 - Bonshaw, 1, 2 and 3 - Texas.
SDr-Dy	SHALLOW, GRAVELLY, ACID TEXTURE CONTRAST SOILS (Dr 2.11, Dr 2.21, Dy 2.31). Shallow to moderately deep soil with hardsetting, gravelly, massive, brownish-black, very acid loam to clay-loam surface soil frequently underlain by a thin A_2 horizon (less than 5 cm) to 5-25 cm over reddish-brown to brownish-grey, blocky, acid clay subsoil. Shallow, stony sands (Uc 2.21 Uc 2.31) Shallow soil with dark-grey-brown, loamy-sand surface soil over yellow or pink, bleached sands to variable depth over a colour B horizon and/or overlying a hardpan. These soils occur in units of the following land systems 2 - Ironpot, 1 - Leslie, 4 - Canal, 3 - Devine.

Unit Symbol	Brief Description of Soils of Mapping Unit
SDy-Dr	SHALLOW, GRAVELLY, ACID, BLEACHED TEXTURE CONTRAST SOILS (Dr 5.41, Dy 3.41, Dy 4.41). Moderately deep soil with gravelly, massive, brownish-black to greyish-yellow-brown loamy-sand to light-sandy-clay-loam surface soil over a gravelly, bleached A_2 horizon to 25-40 cm over reddish-brown to dull-yellowish-brown, frequently mottled, blocky or columnar, acid clay subsoil. Neutral to alkaline, texture contrast soils (Dr 2.43, Dy 2.42). Similar to the dominant soil of this unit but with a neutral to alkaline clay subsoil. These soils occur in units of the following land systems 2 - Magee, 3 - Devine.
SDb-Dr	RED-BROWN, ALKALINE, TEXTURE CONTRAST SOILS (Dr 2.13, Dr 2.43, Db 1.42, Dd 1.13). Moderately deep to deep soil with a hardsetting, commonly gravelly, brownish-black to brown loam, fine sandy to clay-loam surface soil, frequently underlain by a bleached A_2 horizon to 10-25 cm over coarse-blocky or columnar, reddish-brown to brownish-grey, neutral to alkaline clay subsoil. Acid, texture contrast soils (Db 2.41). Similar to the dominant soil of this unit but with an acid clay subsoil. These soils occur in units of the following land systems 2 - Bundella, 4 - Devine.
SD-Gn	BROWN, ACID, TEXTURE CONTRAST SOILS (Dr 2.12, Dr 3.41, Dr 4.41, Db 2.42, Dy 2.41, Dy 3.41). Moderately deep to deep soil with an occasionally gravelly, usually hardsetting, brownish-black to dark-brown loamy-sand to light-sandy-clay-loam surface soil usually underlain by a bleached A_2 horizon to 10-60 cm over dark-reddish-brown, brown to bright-brown, commonly mottled, acid, blocky clay subsoil. RED, MASSIVE EARTHS (Gn 2.11, Gn 2.12, Um 5.52). Moderately deep to deep soil with a frequently gravelly, dark-reddish-brown to dark-brown, sandy-clay-loam surface soil grading into a massive, dark-reddish-brown to brown, acid to neutral, sandy-clay-loam or sandy-clay subsoil. Neutral to alkaline, texture contrast soils (Dy 2.42). Moderately deep soil with a hardsetting, brownish-black sandy-loam surface soil over a bleached A_2 horizon to 35 cm over yellowish-brown, neutral to alkaline clay subsoil mottled at depth. Earthy sands (Uc 1.22). Deep sandy-loam with brownish-black surface soil over bright-brown subsoil. Brown, hardsetting clays (Uf 6.31). Deep sandy-clay with a hardsetting, brownish-black surface soil over dark-brown subsoil. These soils occur in units of the following land systems 3 - Ironpot, 1 and 2 - Leslie.

Unit Symbol	Brief Description of Soils of Mapping Units
SDb	BROWN, NEUTRAL TO ALKALINE TEXTURE CONTRAST SOILS (Db 2.33, Db 3.13, Dy 2.22, Dy 2.43, Dy 4.12). Deep soil with brownish-black loamy-sand to sandy-clay-loam surface soil, frequently underlain by an A_2 horizon to 10-40 cm over brown to yellowish-brown, neutral to alkaline, medium-blocky clay subsoil containing manganese and/or lime concretions. <u>Grey, brown and dark, cracking clays</u> (Ug 5.1, Ug 5.2, Ug 5.3). Deep soil with dark-brown to brownish-black, light-clay surface soil with fine self-mulching surface between large cracks over blocky, alkaline medium to heavy-clay to 45-60 cm over yellowish-brown to olive-brown clay. Lime and/or manganese concretions occur in the subsoil. <u>Alkaline, texture contrast soils</u> (Dy, Db). Deep texture contrast soil similar to the dominant soil of this unit but with a bleached A_2 horizon over a mottled, yellow to brown, coarse-blocky or coarse-columnar alkaline clay subsoil. These soils occur in units of the following land system 2 and 3 - Leslie.
SDy-Uc	YELLOW, ACID, TEXTURE CONTRAST SOILS (Dy 2.41, Dy 3.41, Dy 5.41). Moderately deep to deep soil with a frequently gravelly, brownish-black to brownish-grey sand to sandy-clay-loam surface soil over a bleached A_2 horizon to 30-60 cm over greyish-brown to bright-brown, frequently mottled, acid clay subsoil. DEEP, BLEACHED, SILICEOUS SANDS (Uc 1.23, Uc 2.12, Uc 2.34). Deep sand with a dark-brown to greyish-yellow-brown, loamy-sand surface soil over a sand A_2 horizon becoming increasingly bleached with depth, commonly becoming more yellow and clayey at 70 cm. <u>Yellow, acid texture contrast soils</u> (Dy 5.81, Gn 3.84). Deep soil with loamy-sand surface over a frequently gravelly, bleached A_2 horizon to 60-80 cm over a yellow acid, sandy-clay subsoil. <u>Earthy sands</u> (Uc 5.21, Gn 2.34). Deep sand with dark-brown surface soil over a reddish-brown subsoil or over a bleached A_2 horizon becoming bright-yellow and commonly more clayey with depth. <u>Neutral to alkaline, texture contrast soils</u> (Dg 4.42). Deep soil with a loose, dull-brown sand surface soil over a bleached A_2 horizon to 70 cm over a mottled, dull-yellow-orange, neutral to alkaline clay subsoil. <u>Red, acid, texture contrast soils</u> (Dr 2.41). Moderately deep to deep soil with a red, acid, clay subsoil by 60 cm. These soils occur in units of the following land systems 3 - Devine, 5 - Canal.

Unit Symbol	Brief Description of Soils of Mapping Unit
SDy-Db	YELLOW TO BROWN, NEUTRAL TO ALKALINE, TEXTURE CONTRAST SOILS (Db 1.42, Db 1.43, Dy 2.41, Dy 3.42, Dy 3.43). Moderately deep to deep soil with a hardsetting, frequently gravelly, brownish-black to greyish-brown loamy-sand to sandy-clay-loam surface soil over a bleached A_2 horizon to 20-40 cm, over brown or frequently mottled, greyish-brown to bright-yellowish-brown, coarse-blocky or columnar neutral to alkaline clay subsoil.
	Acid texture contrast soils (Dy 2.41). These soils fit the description of the dominant soils 'Yellow acid, texture contrast soils' in unit SDy-Uc.
	Red, hardsetting clays (Uf 6.31). Moderately deep clay with a hardsetting, dark-reddish-brown surface soil over a red, gravelly, blocky, acid subsoil.
	These soils occur in units of the following land systems 5 - Canal, 3 - Magee, 4 and 5 - Devine.
TUm-D	SHALLOW, GRAVELLY LOAMS (Um 2.12, K-Um 2.12, Um 2.21, Um 5.51) Shallow, gravelly massive loam to clay-loam with a brownish-black to brown surface soil over a brown or bleached acid subsoil.
	SHALLOW, GRAVELLY TEXTURE CONTRAST SOILS (Dr, Dy, Db). Shallow gravelly soil with a massive brownish-black to dark-brown loam to sandy-clay-loam surface soil over a bleached A_2 horizon with increasing gravel to 15-30 cm, over coarse-blocky or columnar; reddish-brown, brown to dull-yellowish-brown acid to neutral clay subsoil.
	Shallow to deep gravelly earths (K-Gn 2.41, Gn 2.11, Gn 3.11). Shallow to deep gravelly soil with a massive, brownish-black to brown sandy-loam to light-sandy-clay-loam surface soil frequently over a pale A_2 horizon grading into a gravelly massive or weakly structured, dull-yellowish-brown to reddish-brown, acid clay-loam to clay subsoil.
	Shallow gravelly clays (Uf 6.31). Shallow, gravelly blocky red-brown clay with a thin (2 cm) dark-brown, clay-loam, hardsetting surface veneer.
	These soils occur in units of the following land systems 1 - Roberts, 3 - Norman, 1 - Washpool, 1 - Jibbinbar, 1 - Glenlyon, 1 and 2 - Pikedale, 1 - Canal, 1 - Thane, 1 - Evandale, 1 and 2 - Gore, 1 and 2 - Warroo, 1 - Arcot, 1 and 2 - Bonshaw, 1 - Texas, 1 - Magee, 1 - Bundella, 1 - Devine.

Unit Symbol	Brief Description of Soils of Mapping Unit
TD	SHALLOW, GRAVELLY TEXTURE CONTRAST SOILS (Dr, Dy, Db). Shallow to moderately deep soil with a gravelly, massive brownish-black to brown sandy-loam to clay-loam surface soil usually underlain by bleached A_2 horizon to 10-30 cm over brown, reddish brown or yellowish-brown clay subsoil. <u>Shallow, gravelly loams</u> (Um). These soils fit the description of the dominant soil 'Shallow gravelly loams' in unit TUm-D. <u>Deep, gravelly texture contrast soils</u> (Dr 2.41, Dy 2.41, Dy 3.41). Deep soil with a gravelly, massive, brownish-black sandy-loam to clay-loam surface soil over bleached A_2 horizon to 10-30 cm over reddish-brown to dull-yellowish-brown, alkaline clay subsoil. These soils occur in units of the following land systems 2 - Roberts, 2 - Washpool, 1 and 2 - Glenlyon, 2 and 3 - Pikedale, 1 and 2 - Canal, 2 and 3 - Thane, 3 and 4 - Gore, 3, 4 and 5 - Warroo, 3 - Bonshaw, 2 and 3 - Texas, 2 - Magee, 2 - Devine.
TDr-Db	SHALLOW, GRAVELLY, RED-BROWN, ACID TO NEUTRAL TEXTURE CONTRAST SOILS (Dr 2.11, Dr 2.12, Db 2.12, Dr 2.41). Shallow soil with a hardsetting, gravelly, medium-crumb, black loam to clay-loam surface soil infrequently underlain by a bleached A_2 horizon to 10-20 cm over brown or reddish-brown, blocky, acid to neutral clay subsoil. <u>Alkaline, texture contrast soils</u> (Db 2.43, Dy 4.42). Deep soil with greyish-brown or dark-brown, loam surface soil over a bleached A_2 horizon to 25-30 cm over a dull-yellow-orange or dark-brown, neutral to alkaline clay subsoil. <u>Shallow gravelly loams</u> (Um). These soils fit the description of the dominant soils 'Shallow gravelly loams' in Unit TUm-D. <u>Brown structured earths</u> (Gn 3.21). Deep soil with a dark brown, crumb structured, clay loam surface soil grading into a blocky, brown, acid clay subsoil. These soils occur in units of the following land systems 1, 2 and 3 - Pikedale, 1 - Ironpot.
MUg-D	GREY AND BROWN CRACKING CLAYS (Ug 5.13, Ug 5.24). Deep clay with self-mulching surface soil over grey or brown, blocky alkaline subsoil with gypsum and/or lime evident; commonly gilgaied. ALKALINE, TEXTURE CONTRAST SOILS (Db 2.13, Db 4.43, Dy 2.13, Dy 2.43, Dy 3.43). Deep soil with massive, usually hardsetting, brownish-black, dark-reddish-brown or yellowish-grey sandy-loam to clay-loam surface soil frequently underlain by a thin (less than 5 cm), bleached A_2 horizon to 10-30 cm over a commonly gravelly, coarse columnar or coarse-blocky, reddish-brown to greyish-brown, alkaline clay subsoil, frequently containing lime. <u>Red cracking clays</u> (Ug 5.3, Ug 5.4). Deep clay with a cracking surface which has a thin (2 cm) surface veneer of dark-red clay-loam over a strongly structured red clay containing lime at depth. These soils occur in units of the following land systems 2 - Bundella, 4, 5 and 8 - Devine.

Unit Symbol	Brief Description of Soils of Mapping Units
MDb-Dy	GRAVELLY, BROWN AND YELLOWISH-BROWN, ALKALINE TEXTURE CONTRAST SOILS (Db 1.42, Dy 2.42, Dy 2.43). Deep soil with a hardsetting, massive, gravelly, brownish-black to brown fine-sandy-loam to loam surface soil over a gravelly, bleached A_2 horizon to 20-35 cm over columnar, dark-brown to yellowish-brown, neutral to alkaline clay subsoil. <u>Acid, gravelly texture contrast soils</u> (Dy, Db). Soil similar to the dominant soil of unit MDb-Dy but with an acid, clay subsoil. <u>Red, massive earths</u> (Gn 2.11). A moderately deep to deep soil with dark-reddish-brown, loam to clay-loam surface soil grading to massive, acid, red clay subsoil. These soils occur in the unit of the following land system 2 - Bundella.
MDy-Db	GRAVELLY, BROWN AND YELLOWISH-BROWN, ACID TEXTURE CONTRAST SOILS (Db 1.41, Dy 2.41, Dy 2.42). A moderately deep to deep soil with a hardsetting massive, gravelly, greyish-yellow-brown to dark-brown fine-sandy-loam to loam surface soil over a gravelly bleached A_2 horizon to 20-35 cm over a columnar, brown to dull-yellowish-brown, acid to neutral clay subsoil. <u>Alkaline, texture contrast soils</u> (Dy, Db). Soil similar to the dominant soil of unit MDy-Db but with a coarse-blocky or columnar, alkaline clay subsoil. <u>Red, gravelly, acid texture contrast soils</u> (Dr 2.41). Deep soil with a hardsetting, gravelly, dark-brown loam surface soil over a gravelly, bleached A_2 horizon to 30 cm over a reddish-brown, clay subsoil. These soils occur in the unit of the following land system 2 - Bundella.

7.2 Soil Properties

Assessment of soil physical properties is based on field observation and the CEC/% clay ratio (see Glossary) while soil chemical properties assessment is based on interpretation of laboratory analysis of soil samples (see Appendices 7.2 and 7.3). The analytical methods used are described in Appendix 7.4. The amount and reliability of the information on soil properties is limited by the extent of field observation (400 described sites) and the intensity of soil sampling (50 sites).

Soil profile morphology and chemical data of selected soil profiles representing dominant or important soil profile classes are detailed in Appendix 7.5.

A summary of soil properties of the dominant soil profile classes is presented in Table 7.1 (pp. 7-14 and 7-15).

Two aspects of soil properties are discussed:

(1) The properties of dominant or important soil profile classes.

(2) The influence of geology on soil chemical properties.

7.2.1 The Properties of Dominant or Important Soil Profile Classes

The deep, dark, cracking clays of unit AUg combine high fertility (except for nitrogen) with a self-mulching surface and well structured soil profile. The self-mulching surface absorbs large amounts of water when dry, while the CEC/% clay ratio in excess of 0.6 combined with low sodicity indicates favourable soil structure. Exchangeable calcium and exchangeable magnesium levels are high with the calcium decreasing and magnesium, sodicity and salinity increasing below 60 cm deep.

The dark-brown, structured earths and the dark-brown texture contrast soils of unit AGn-D have a wide range of soil properties. The soils are reasonably fertile but unfavourable soil physical properties are frequently found. Hardsetting soil surfaces reduce water infiltration rates while high exchangeable sodium levels indicate the dispersive nature (see Glossary) of the clay subsoils. Soils on scalded areas devoid of vegetation have been found to be highly saline, sodic and alkaline. Generally, exchangeable calcium levels were high but only moderate exchangeable magnesium levels were recorded CEC/% clay ratios in the 0.2 to 0.4 ran were recorded.

The yellowish-brown and brown, neutral to alkaline texture contrast soils of unit AD are usually adequate in phosphorus and potassium but low in nitrogen. Hardsetting soil surfaces frequently occur and the coarse subsoil structure combined with low salinity and moderate sodicity indicate a degree of dispersion in the clay subsoils. Hence there are limitations in water absorption and storage. Calcium is the dominant exchangeable cation but magnesium levels increase with depth. CEC/% clay ratios of 0.23 to 0.40 were recorded in the clay subsoil.

The gritty siliceous sands of unit GUc1 and GUc2 are very infertile and strongly leached. They are characterised by a high content of grit and a low clay content indicating a low CEC and water holding capacity. Salinity is low and calcium is the dominant exchangeable cation. Hardpans frequently occur below the bleached horizon and may cause a perched water-table, particularly in gently sloping areas.

The acid to neutral, texture contrast soils of unit GD1 and the alkaline, texture soils of unit GD2 are both infertile, of low salinity, and usually have a hardsetting surface condition. Coarse structure and a high exchangeable sodium level indicate the dispersive nature of the clay subsoil. Magnesium is the dominant exchangeable cation and the CEC/% clay ratio varies from 0.2 to 0.5.

The red-brown structured earths of unit LGn have fair general fertility but are frequently hardsetting. Salinity and sodicity increase to high levels at depth possibly indicating dispersion of the clay subsoil. The exchangeable potassium level is comparatively high in the surface soil. Calcium is the dominant exchangeable cation with magnesium levels increasing with depth. CEC/% clay ratios in the 0.24 to 0.36 range were recorded in one soil profile.

The shallow, gravelly, acid, bleached, texture contrast soils of unit SDy-Dr are generally of low fertility with a hardsetting surface. These soils are exceptionally gravelly and increase slightly in salinity with depth. Magnesium is the dominant exchangeable cation while exchangeable calcium levels are very low. Coarse structure, low salinity, and high sodicity indicate the dispersive nature of the clay subsoil. CEC/% clay ratios of 0.25 were recorded in the soil profile.

The red-brown, alkaline texture contrast soils of unit SDb-Dr are of low fertility and have a hardsetting surface. These soils are frequently gravelly and increase slightly in salinity with depth. Magnesium is the dominant exchangeable cation while calcium levels are very low. Coarse structure, low salinity and high sodicity indicate the dispersive nature of the clay subsoil. CEC/% clay ratios in the range of 0.23 to 0.33 were recorded.

The brown, acid texture contrast soils of unit SD-Gn are generally of low to fair fertility and usually have a hardsetting surface. Salinity levels are low and increase slightly below 60 cm deep. Calcium is usually the dominant surface exchangeable cation but magnesium dominates the clay subsoils. The variable sodicity and medium to coarse structure indicate that the clay subsoils are not always of a dispersive nature. The subsoil CEC/% clay ratio varies from 0.17 to 0.40 indicating a wide range of clay minerals in the clay fraction.

The red, massive earths of unit SD-Gn are of fair fertility and their surface permits rapid water entry. The massive subsoil is very porous and of low salinity and sodicity, but water holding capacity is probably low. Calcium is the dominant exchangeable cation and the CEC/% clay ratio is 0.26.

The grey, brown and dark cracking clays of unit SDb are of low fertility and have a fine self-mulching surface between large hexagonal cracks. Infiltration rates of the dry soil would be high initially. Salinity is low but it increases gradually at depth as does sodicity. Calcium is the dominant exchangeable cation with magnesium being subdominant and increasing with depth. The CEC/% clay ratio of 0.45 to 0.54 indicates that montmorillonite is not necessarily the dominant mineral in the clay fraction and that the water holding capacity is proportionally lower.

The yellow, acid texture contrast soils of unit SDy-Uc are of low fertility, are frequently hardsetting and frequently have deep bleached A_2 horizons of low water holding capacity. The high sodicity combined with low to moderate salinity and coarse structure indicate the dispersive nature of the clay subsoil. This may result in perched water tables occurring above the clay subsoil. Magnesium is the dominant exchangeable cation while calcium levels are very low. The low CEC/% clay ratios of 0.1 to 0.2 indicate a low activity clay, possibly kaolinite, dominant in the clay fraction.

TABLE 7.1 - SUMMARY OF SOIL PROPERTIES

MAP UNIT	DOMINANT SOIL	GENERAL SOIL FERTILITY	P	N	K	PHYSICAL PROPERTIES	CATEGORIES* SALINITY	SODICITY	ALKALINITY
AUg	Deep, dark, cracking clays	High	Very high	Low	Adeq	Well structured soil	0	1	1
AGn-D	Dark-brown structured earths	Fair	Very fair-high	Fair-very fair	Adeq	Hardsetting surface	0	0-1	1
	Dark-brown texture contrast soils	Fair	Very fair-high	Fair	Adeq	Hardsetting surface with poorly structured subsoil	1-2	2	1-2
AD	Yellowish-brown and brown, neutral to alkaline texture contrast soils	Fair	High	Low	Adeq	Hardsetting surface with poorly structured subsoil	0	0-1	0-1
GUc-1	Gritty siliceous sands amongst rock outcrops	Low	Very low	Low	Low	Excessively drained, usually stony and shallow	0	0	0
GUc-2	Gritty siliceous sands	Low	Very low	Low	Low-adeq	Occasionally stony or shallow; frequently excessively drained	0	0	0
GDy-Dg	Acid, yellow and grey, mottled texture contrast soils	Fair-low	Very low	Low-very fair	Low-adeq	Moderately well structured soil commonly with poorly drained subsoil	0	0-1	1
GD1	Acid to neutral texture contrast soils	Low	Very low	Low	Adeq	Commonly hardsetting surface, poorly structured subsoil	0	1-2	0
GD2	Alkaline texture contrast soils	Low-fair	Low	Low-very fair	Low-adeq	Hardsetting surface; poorly structured subsoil	0	2	1
LGn	Red-brown structured earths	Fair	Fair	Very fair	Adeq	Hardsetting surface; well structured subsoil	2	2	1
SDr-Dy	Shallow, gravelly, acid texture contrast soils	Low	-	-	-	Hardsetting surface; gravelly; shallow.	-	-	-
SDy-Dr	Shallow, gravelly acid, bleached texture contrast soil	Low-fair	Very low	Low-fair	Adeq	Commonly a hardsetting surface; shallow; gravelly; poorly structured subsoil	0	2	1
SDb-Dr	Red-brown, alkaline texture contrast soils	Low	Very low	Low	Low	Hardsetting surface; gravelly; poorly structured subsoil	0	2	1
SD-Gn	Brown, acid texture contrast soil	Low-fair	Very low-fair	Low-fair	Adeq	Usually hardsetting surface; well structured subsoil	0	1-2	0
	Red massive earths	Fair	Low	Fair	Adeq	Commonly a loose surface; porous subsoil	0	0	0

Soil fertility assessment based on soil analysis interpretation in Appendix S-II.

* Northcote and Skene (1972) - summary of categories in Appendix S-III.

TABLE 7.1 - SUMMARY OF SOIL PROPERTIES (CONTINUED)

MAP UNIT	DOMINANT SOIL	GENERAL SOIL FERTILITY	P	N	K	PHYSICAL PROPERTIES	CATEGORIES* SALINITY	SODICITY	ALKALINITY
SDb	Brown; neutral to alkaline texture contrast soils.	Low-fair	Very low	Low	Adeq.	Commonly hardsetting surface; usually a well structured subsoil.	0	1-2	1
SDy-Uc	Yellow, acid texture contrast soils.	Low-very low	Very low	Low	Low	Frequently a hardsetting surface; poorly structured subsoil.	0	2	0
	Deep, bleached siliceous sands.	Very low	Very low	Very low	Low	Loose surface; frequently excessively drained.	0	0	0
SDy-Db	Yellow to brown, neutral to alkaline texture contrast soils.	Very low	Very low	Very low	Low	Hardsetting surface; frequently gravelly; poorly structured subsoil.	0	2	1
TUm-D	Shallow, gravelly loams.	High-low	Very low-high	Low-very fair	Adeq.	Frequently a hardsetting surface; gravelly; shallow.	0	0-1	0
	Shallow, gravelly texture contrast soils.	Low-fair	Low-very low	Low-very fair	Adeq.	Frequently a hardsetting surface; gravelly; shallow; commonly poorly structured subsoil.	0	0-2	0-1
TD	Shallow, gravelly texture contrast soils.	Fair	Very low-fair	Fair-very fair	Adeq.	Frequently hardsetting surface; gravelly; shallow; commonly poorly structured subsoil.	0	1-2	0-1
TDr-Db	Shallow, gravelly, red-brown, acid to neutral texture contrast soils.	Fair	Very low	Fair	Adeq.	Hardsetting surface; shallow; gravelly; well structured subsoil.	0	0-1	0
MUg-D	Grey and brown cracking clays.	Low-fair	Low	Low-very fair	Adeq.	Commonly strong gilgai microrelief well structured.	0	1-2	1
	Alkaline texture contrast soils.	Fair	Low	Fair-very fair	Adeq.	Frequently hardsetting surface soil; poorly structured subsoil.	0	2	1-2
MDb-Dy	Gravelly, brown and yellowish-brown alkaline texture contrast soils.	Low	Very low	Low	Low	Hardsetting surface; gravelly; poorly structured subsoil.	0	2	1
MDy-Db	Gravelly; brown and yellowish-brown acid texture contrast soils.	Low	Very low	Low	Adeq.	Hardsetting surface; gravelly; poorly structured subsoil.	0	2	0

Soil fertility assessment based on soil analysis interpretation in Appendix S-II.

* Northcote and Skene (1972) - summary of categories in Appendix S-III.

The deep, bleached siliceous sands of unit SDy-Uc are similarly of low fertility and have strongly leached, low water holding capacity, bleached A_2 horizons. The soils have a low CEC and salinity level. Calcium is the dominant exchangeable cation although all cations are in low amounts. Frequently a hardpan at depth may cause a perched water table to develop above it.

The shallow, gravelly loams of unit TUm-D show a wide range of soil properties, possibly because of variability in parent material and topographic situation. The soils have low to high fertility and frequently have a hardsetting surface. Water holding capacity appears to be low since the CEC/% clay ratio is in the range 0.12 to 0.22. Calcium is usually the dominant exchangeable cation, although magnesium is subdominant and occasionally dominant in the subsoil.

The shallow, gravelly, texture contrast soils of unit TUm-D and unit TD have low to fair soil fertility and usually have a hardsetting surface. Salinity is low and increases slightly in the subsoil. Calcium is the dominant exchangeable cation in the surface soil with magnesium being subdominant, while in the subsoil magnesium is dominant and calcium levels decline with an increase in sodicity. The coarse structure and high sodicity indicate the dispersive nature of the clay subsoil. The CEC/% clay ratio range is 0.22 to 0.33 in the clay subsoil, but some subsoils appear to have good aggregate structure.

The shallow, gravelly, red to brown acid to neutral, texture contrast soils of unit TDr-Db have fair fertility and a hardsetting but porous surface soil of granular structure.

The surface soil CEC/% clay ratio is similar to that of the clay subsoil, namely 0.25 to 0.35. Where a bleach had developed this ratio is lower, as may be the water holding capacity. Calcium is the dominant exchangeable cation in the surface with magnesium subdominant while in the subsoil the position is reversed. Medium-blocky aggregates and low sodicity and salinity indicate a favourable subsoil structure.

The grey and brown, cracking clays of unit MUg-D are of low to fair fertility and are frequently gilgaied. Pools of water may accumulate in the gilgai depressions after rain. Their cracking or self-mulching surface allows rapid water entry in a dry soil. The surface soil salinity is low but it increases below 30 cm coinciding with the presence of lime. When gypsum crystals occur they are observed above lime accumulations in the soil profile. Calcium is the dominant exchangeable cation with magnesium subdominant and sodium increasing with depth. The CEC/% clay ratio range of 0.53 to 0.63 indicates a fairly high montmorillonite content in the clay fraction and therefore favourable soil structure.

The alkaline texture contrast soils of unit MUg-D are of fair fertility and frequently have a hardsetting surface. Salinity is low in the surface but increases slightly in the subsoil. Calcium is the dominant exchangeable cation with magnesium being subdominant. High sodicity and coarse columnar or blocky structure indicate the dispersive nature of the clay subsoil. The CEC/% clay ratios range from 0.17 to 0.25 indicating a high proportion of low activity minerals in the clay fraction.

The gravelly, brown and yellowish-brown texture contrast soils of unit MDb-Dy and unit MDy-Db are of low fertility and have a hardsetting surface. Surface salinity is low with a slight increase in the subsoil. The dominant exchangeable cation is magnesium with sodium subdominant and calcium levels low. Coarse structure, high sodicity and low salinity indicate the dispersive nature of the clay subsoil. The subsoil CEC/% clay ratio range of 0.14 to 0.25 indicates a high proportion of low activity minerals in the clay fraction.

7.2.2 The Influence of Geology on Soil Chemical Properties

There is some evidence of a relationship between parent material and the chemical properties of soils.

The properties of soils developed on alluvium depend on the source of the alluvia. The dark, cracking clays of unit AUg have developed from mixed alluvium of the Condamine River system with a large component of basaltic material, where as the soils of unit AGn-D are derived from mixed alluvium of granitic and traprock origin. Soils of unit AD have developed from alluvium derived from traprock and/or sandstone. In this unit red-brown subsoils were commonly found where sandstone had an influence.

Generally the soils developed on alluvium are adequate in phosphorus and potassium, low in nitrogen, have sodic subsoils, and low salinity. An exception is the high salinity in some texture contrast soils of unit AGn-D. Calcium is the dominant exchangeable cation with magnesium subdominant and frequently increasing at depth.

Several granite types of different mineral composition occur in the study area and this is indicated by differences in certain chemical soil properties.

Soils developed on Stanthorpe adamellite have a lower exchangeable potassium than soils developed on other granite types, while soils in unit GDy-Dg developed on Ruby Creek granite exhibit a distinct bright-orange mottle in the clayey subsoil. An unusual feature of soils developed on Dundee-adamellite-porphyrite is the high acid-extractable P values recorded at the base of the subsoil. Soils developed on this parent material were always found to be texture contrast soils with sodic subsoils.

Generally the soils developed on granite have low phosphorus and, low to adequate potassium, and low salinity. Calcium is the dominant exchangeable cation in the surface soil while magnesium dominate the subsoil exchange complex.

Soils developed on limestone have fair nitrogen and phosphorus and adequate potassium but are quite saline and sodic with depth. Calcium is the dominant exchangeable cation while magnesium is subdominant and increasing at depth.

Soils developed on Marburg sandstone can be split into two groups on the basis of chemical properties. The soils of unit SD-Gn and unit SDb, located near Warwick are different from the other soils developed on sandstone. The soils of unit SD-Gn and unit SDb have fair to low phosphorus, low nitrogen, adequate potassium are slightly saline and have variable sodicity. Calcium is the dominant exchangeable cation with magnesium subdominant and frequently increasing to dominance in the clay subsoils. Subsoil CEC/% clay ratios range from 0.20 to 0.54. The other soils on sandstone, located between Leyburn and Texas, are very low in nitrogen, phosphorus, and potassium, are slightly saline and have sodic subsoils.

Calcium and magnesium are co-dominant exchangeable cations in the surface soil but magnesium dominates the clay subsoil while calcium levels are very low. Clay subsoil CEC/% clay ratios are less than 0.2 indicating a high proportion of low activity minerals, possible kaolinite, in the clay fraction.

The chemical properties of soils developed on traprock vary considerably, probably because of variable parent materials and different topographical situations. Phosphorus levels are variable but commonly low while nitrogen is usually fair and potassium adequate. Salinity levels are low and sodicity is variable but tends to increase in the clay subsoils of texture contrast soils. Calcium is the dominant surface exchangeable cation with magnesium frequently subdominant, but magnesium dominates the subsoils white calcium levels may range from being co-dominant to negligible.

The soils of mixed origin in unit MUg-D are understandably variable in chemical properties. These soils have developed from mixed colluvium and/or alluvium derived from basalt, sandstone and/or shale. Generally they are found to have low phosphorus, fair nitrogen and adequate potassium are slightly saline, and have sodic subsoils. Calcium is the dominant exchangeable cation with magnesium subdominant.

The gravelly texture contrast soils of mixed origin running off sandstone and traprock between Texas and Inglewood have remarkedly consistent chemical properties. They have low nitrogen, phosphorus and potassium levels are slightly saline and have sodic clay subsoils. Magnesium is the dominant exchangeable cation with very low levels of exchangeable calcium being recorded. The clay subsoil CEC/% clay ratio range of 0.14 to 0.25 indicates a high proportion of low activity minerals in the clay fraction. These soils are very similar in chemical properties to the soils developed on sandstone between Leyburn and Texas, and may indicate a dominant influence of sandstone in their formation.

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APPENDIX 7.1

GLOSSARY

CEC/% Clay Ratio: $\frac{\text{cation exchange capacity}}{\text{percentage clay}}$

This is a semi-quantitative measurement of the proportion of clay minerals in the clay fraction. For a pure montmorillonite clay, the CEC/% clay ratio is approximately 1.0 while for pure kaolinite clay the ratio is less than 0.1. For field surface soil samples organic matter makes a significant contribution to the measured cation exchange capacity. Assuming a CEC of 200 m equiv. per 100 g for soil organic matter, the corrected CEC (attributable to soil minerals) may be calculated from the equation:

(CEC) corr = (CEC) meas -2(OM) where (CEC) corr = corrected soil cation exchange capacity; (CEC) meas = measured soil cation exchange capacity; (OM) = percentage organic matter in the soil sample (Coughlan, 1969).

Three categories of soils are recognised in this survey on a clay mineral basis:

1. Soils with a CEC/% clay ratio greater than 0.6. This ratio range indicates a high proportion of montmorillonite in the clay fraction. Montmorillonite has favourable properties in the form of a high CEC and high water holding capacity.

2. Soils with a CEC/% clay ratio of 0.2 to 0.6. This ratio range can indicate many combinations of minerals in the clay fraction, hence deductions on clay mineralogy are impossible.

3. Soils with a CEC/% clay ratio less than 0.2. This ratio range indicates a high proportion of a low activity clay mineral (commonly kaolinite) in the clay fraction. Kaolinite has a low CEC and low water holding capacity.

COLOURS - Colours were recorded from the 'Standard Soil Colour Charts' by M. Oyama and H. Takehara (Japan, 1967).

CRACKING CLAYS - Refers to those shrinkable clay soils which develop and exhibit during a dry season or period cracks as wide, or wider than, 6 mm and which penetrate at least 30 cm into the solum (from Northcote 1974).

DISPERSION - Dispersion and the other extreme, flocculation are properties of clay sized soil particles. In the state of dispersion the individual particles are kept separate from one another, where as flocculation is the process whereby the particles are coagulated to form floccular aggregates. These reactions take place in the soil. The degree and permanence of flocculation depends upon the nature of the ions present; calcium and magnesium are very effective in this role. Dispersion however is accomplished by potassium and more particularly by sodium, especially when salinity is low. Thus depending upon the nature of the cations present in the soil, it may either be a floccular or aggregated state (usually this is desirable for plant growth) or in a dispersed and coarse aggregated to massive condition (reduced water and root penetration and reduced aeration, frequently causing poor plant growth) (source - Fitzpatrick 1971).

INTERGRADES - A soil that possesses moderately well-developed distinguishing characteristics of two or more genetically related great soil groups (SSSA Terminology Committee 1965). In this study intergrades of Great Soil Groups are regarded as soils with characteristics which do not fit any particular Great Soil Group description but have features common to two Great Soil Groups.

GREAT SOIL GROUPS - Great Soil Group names were taken from Stace *et al.* (1968).

SODICITY - Refers to the exchangeable sodium percentage (ESP) of a soil. ESP is the extent to which the adsorbtion complex of a soil is occupied by sodium. It is expressed as follows:

$$ESP = \frac{\text{exchangeable sodium (m equiv. per 100 g soil)}}{\text{cation-exchange capacity (m equiv. per 100 g soil)}} \times 100$$

(SSSA Terminology Committee 1965).

SOIL ASSOCIATION - Is a group of defined and named taxonomic soil units, regularly geographically associated in a defined proportional pattern (USDA Soil Survey Manual, 1952). In this study a soil association is defined as a group of soil profile classes regularly geographically associated which occur in the proportions: dominant soil(s) $\geq$ 70%; minor soil(s) $\leq$ 30%.

SOIL DEPTH - The depth of solum, i.e. the A and B horizons. In this study 3 categories were defined:

(1) A shallow soil profile which is less than 60 cm deep.

(2) A moderately deep soil profile which is 60-90 cm deep.

(3) A deep soil profile which is greater than 90 cm deep.

SOIL PROFILE CLASS - Is a group of similar profiles usually defined on their morphology (Beckett and Webster 1971). In this study the soil profiles are grouped on their similar textural profile forms and other characteristics common to all or most of the soil profiles in the group.

SOIL MAPPING UNIT - Is an area coherant enough to be represented on a map, of which the soil can be adequately described in a simple statement, commonly but not necessarily in terms of its main profile classes (Beckett and Webster 1971).

A mapping unit can also be regarded as an area or group of areas in which (it is hoped) the soil is less variable than in the larger landscape (Beckett and Webster 1971).

TEXTURAL PROFILE FORM TERMS - The textural profile form terms used in this survey are:

1. Sands - soil profiles with texture grades of sand to clayey-sand (Northcote equivalent ≑ Uc).

2. Sandy-loams - soil profiles with texture grades of sandy-loam to light-sandy-clay-loam (Northcote equivalent ≑ Uc).

3. Loams - soil profiles with texture grades of loam to fine-sandy-clay-loam (Northcote equivalent = Um).

4. Clays - soil profiles with texture grades of sandy-clay to heavy-clay (Northcote equivalent = Uf, Ug).

5. Earths - soil profiles which gradually increase in clay content with depth. The texture difference between consecutive horizons is less than 1½ texture groups, while the range of texture throughout the entire solum exceeds the span covered by one texture group (for definitions of texture groups see Northcote 1974).

6. Texture contrast soils - soil profiles which abruptly increase in clay content at the boundary of the A and B horizons. The distance from the bottom of the A horizon to the top of the main B horizon occurs over a vertical interval of 10 cm or less, and there is a texture contrast of 1½ texture groups or greater between the A and B horizons.

APPENDIX 7.2

INTERPRETATION OF SOIL ANALYTICAL RESULTS

Total Nitrogen (Kjeldahl)

N%	
Very low	< 0.05%
Low	0.05 - 0.09
Fair	0.10 - 0.14
Very fair	0.15 - 0.24
High	0.25 - 0.49
Very high	> 0.50

Available Phosphorus (.01N H_2SO_4 Extraction)

P	
Very low	< 10 ppm
Low	10-20 ppm
Fair	20-35 ppm
Very fair	35-45 ppm
High	45-100 ppm
Very high	> 100 ppm

Source: Agricultural Chemistry Branch, Queensland Department of Primary Industries.

Soluble Salts

	% TSS	Cl ppm
Very low	< 0.05	< 100
Low	0.05 - 0.15	100 - 300
Medium	0.15 - 0.30	300 - 600
High	0.30 - 0.70	600 - 2000
Very high	> 0.70	> 2000

Source: Agricultural Chemistry Branch, Queensland Department of Primary Industries.

Potassium

Crack and Isbell (1970) use the value of 0.2 m equiv. per 100 g of exchangeable potassium, as a critical deficiency level.

Organic Carbon (Walkley and Black Values)

	% Org. C
Very low	< 0.59
Low	0.59 - 1.75
Medium	1.76 - 2.9
High	3.0 - 5.8
Very high	> 5.8

Many Australian soils have been recorded in the 1.2% to 2.3% range.

Source: Agricultural Chemistry Branch, Queensland Department of Primary Industries.

APPENDIX 7.3

SOIL SALINITY, SODICITY AND ALKALINITY CATEGORIES

Northcote and Skene (1972)

I. Salinity Categories

The chloride ion was used as the criteria of salinity and is expressed as percent sodium chloride equivalent (610 ppm Cl is equivalent to 0.1% NaCl).

0 - Non-saline in either the surface (0.1% NaCl) or subsoil (0.2%).

1 - Surface salinity:surface soils contain 0.1% NaCl (if loams and coarse soils) or 0.2% (if clay loam and clays).

2 - Subsoil salinity:soils lacking surface salinity but containing 0.3% NaCl in the subsoil.

II. Sodicity Categories

Exchangeable sodium as a percentage of the total cation exchange capacity was the criteria used for sodicity.

0 - Non-sodic: the ESP is less than 6.	) within the
1 - Sodic: the ESP is from 6 to 14.	) first
2 - Strongly sodic: the ESP is 15 or more.	) metre

(ESP - exchangeable sodium percentage.)

III. Alkalinity Categories

The criteria used for alkalinity was the pH of a 1:5 soil: water suspension.

0 - acid or not significantly alkaline. pH less than 8.	) within the) first
1 - Alkaline: pH 8.0 to 9.5	) metre
2 - Strongly alkaline: pH greater than 9.5.	))

APPENDIX 7.4

SOIL ANALYTICAL METHODS

Sample Preparation

All samples were dried at 40° C in a forced air draught. Gravel was sieved out, using a 2 mm seive, while samples not containing gravel were ground to less than 2 mm. All determinations were carried out using the < 2 mm soil fraction and the results were uncorrected for gravel percentage.

Particle Size Distribution

Particle size determinations were conducted using a modification of the hydrometer method of Piper (1942). The modification was that the soils were dispersed with sodium hexa metaphosphate and sodium hydroxide.

Soluble Salts

A 1:5 soil:deionized water suspension was shaken for one hour and the electrical conductivity (EC) was determined at 20° C. This was converted to percent total soluble salts (TSS) using the factor of Piper (1942):

$$\% \text{ TSS} = \text{EC mmhos (at } 20^{\circ} \text{ C)} \times 0.375.$$

This factor is an approximation, particularly for soils with unusually high concentrations of sulphates, bicarbonates or calcium salts.

pH

After determination of electrical conductivity, the same suspension was then used to determine pH using a glass electrode and saturated calomel electrode.

Chlorides

Chlorides were determined on the same stirred suspension, after conductivity and pH readings were completed, using a specific ion electrode (Haydon, Williams and Ahern 1974).

Organic Carbon

The wet combustion method of Walkley and Black (1934) was used on finely ground samples. The reduced chromic ion (Cr^{+++}) was read colour-metrically (Sims and Haby 1971). Results reported are uncorrected Walkley and Black values.

Total Nitrogen

The Kjeldahl method was used.

'Available' Phosphorus

Acid extractable P was determined by the Kerr and von Stieglitz (1938) method.

Exchangeable Cations

5 g of soil was shaken for 1 hour in 100 mls of molar aqueous ammonium chloride (pH 7.0), filtered and leached with a further 100 mls. Cations were determined on the leachate, sodium and potassium by flame photometer, and calcium and magnesium, after suitable dilution with a strontium chloride solution, on an atomic absorbtion spectrophotometer.

The cation exchange capacity was found by displacing the ammonium adsorbed in the extraction of the exchangeable cations, with sodium sulphate.

Exchangeable calcium figures may be inflated on soils containing carbonate and gypsum.

Low exchange capacity figures, particularly on very low clay content soils do not reproduce well, and care must be exercised with their interpretation.

Because soils were not prewashed, exchangeable sodium values were corrected by an amount equivalent to the chloride content.

APPENDIX 7.5

PROFILE MORPHOLOGY AND CHEMICAL DATA OF DOMINANT OR IMPORTANT SOIL PROFILE CLASSES

Note:

1. The colour notation is that for a MOIST soil sample.
2. For interpretation of chemical data, see Appendices 7.2 and 7.3.
3. Location co-ordinates are taken from the 20 000 metre transverse mercator grid at the scale 1:250 000.

MAPPING UNIT AUg

LOCATION Site 208; near Condamine River; 389500 mE, 6885250 mN.

SOIL PROFILE CLASS Dark, cracking clays.

PRINCIPAL PROFILE FORM Ug 5.17

GREAT SOIL GROUP Black earths.

PARENT MATERIAL Pleistocene alluvium.

LANDFORM Flat plain.

VEGETATION Cleared; river red gums on river bank.

PROFILE

0-10 cm	black (10YR2/1)	heavy-clay	self-mulching surface; fine blocky; very firm; few lime nodules
10-60 cm	olive-black (5Y3/1)	heavy-clay	blocky; extremely firm; few lime nodules
60-90+ cm	olive-black (5Y3/1)	heavy-clay	blocky; extremely firm; many lime nodules

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations Ca	Mg	K	Na	CEC	Particle Size CS	FS	Silt	Clay
							m equiv. per 100 g					percent			
0-10	7.4	0.026	24	1.22	0.08	> 150	27	25	0.88	1.7	44	2	9	20	69
10-20	8.4	0.034	<18			> 150						2	9	14	75
20-30	8.7	0.045	18			> 150	>30	>30	0.47	2.7	51	3	9	13	75
30-60	8.9	0.056	38			> 150	>30	>30	0.43	3.7	52	4	10	13	73
60-90	9.0	0.086	159			> 150	25	>30	0.31	6.2	52	5	8	13	74

MAPPING UNIT AGn - D

LOCATION Site A165; near Dumaresq River; 318000 mE, 6807750 mN.

SOIL PROFILE CLASS Dark-brown structured earths.

PRINCIPAL PROFILE FORM Gn 3.4

GREAT SOIL GROUP Alluvial soils.

PARENT MATERIAL Pleistocene alluvium.

LANDFORM Flat plain.

VEGETATION Cleared; river red gums and white box.

PROFILE

0-10 cm	brownish-black (10YR3/2)	clay-loam	hardsetting surface; granular; firm
10-20 cm	brownish-black (10YR3/1)	clay-loam	massive; firm
20-35 cm	brownish-black (10YR3/1)	heavy clay-loam	massive; very firm
35-40+ cm	black (10YR2/2)	light-clay	coarse-blocky; extremely firm

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations Ca	Mg	K	Na	CEC	Particle Size CS	FS	Silt	Clay
							m equiv. per 100 g					percent			
0-10	6.1	0.026	33	2.2	0.17	97	8.9	3.0	0.96	0.18	13	11	19	26	44
10-20	6.6	0.015	24			73									
20-30	7.0	0.014	18			69	10	3.3	0.33	0.40	13	10	21	25	44
30-35	7.0	0.014	22			63									
35-40	7.1	0.021	24			68	11	3.8	0.35	0.62	15	7	20	25	48

MAPPING UNIT AGn - D

LOCATION Site AA121; near Rodger Creek, 383750 mE, 6882000 mN.

SOIL PROFILE CLASS Dark-brown texture contrast soils.

PRINCIPAL PROFILE FORM Db 3.43

GREAT SOIL GROUP Solodics.

PARENT MATERIAL Pleistocene alluvium.

LANDFORM Flat plain.

VEGETATION Cleared open-forest of rough-barked apple, poplar box and fuzzy box.

PROFILE

0-10 cm	greyish-yellow-brown (10YR4/2)	silty-loam	loose surface; weak crumb; friable
10-30 cm	dull-yellowish-brown (10YR5/3), bleach when dry	silty-clay-loam	massive; friable
30-70 cm	dark-brown (10YR3/3)	medium-clay	fine-angular-blocky; very firm
70-90+ cm	dull-yellowish-orange (10YR6/4)	light-clay	massive; friable; moderate powdery lime

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations Ca	Mg	K	Na	CEC	Particle Size CS	FS	Silt	Clay
							m equiv. per 100 g					percent			
0-10	5.2	0.025	29	2.0	0.24	74	5.4	1.8	0.93	0.08	13	3	34	28	35
10-20	6.2	0.026	36			31									
20-30	6.3	0.029	42			27	4.4	2.0	0.98	0.60	9	3	34	28	35
30-70	6.8	0.073	217			25	13	4.4	0.74	1.3	18	4	23	23	50
70-90	8.2	0.208	886			73	>30	5.7	0.35	0.40	12	3	27	30	40

MAPPING UNIT AGn - D

LOCATION Site 128; near Dumaresq River; 316750 mE, 6808500 mN.

SOIL PROFILE CLASS Dark-brown texture contrast soils.

PRINCIPAL PROFILE FORM Db 1.43

GREAT SOIL GROUP Solodics

PARENT MATERIAL Pleistocene alluvium.

LANDFORM Flat plain.

VEGETATION Cleared; river red gums.

PROFILE

0-20 cm	greyish-yellow-brown (10YR4/2)	loam	hardsetting surface; massive; friable
20-22 cm	greyish-yellow-brown (10YR4/2) (bleach when dry)	sandy-clay-loam	massive; friable
22-120 cm	dull-yellowish-brown (10YR4/3)	light-medium-clay	blocky; very firm
120-190+ cm	dull-brown (7.5YR5/3)	sandy-clay	blocky; firm

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N % NO_3 ppm	Avail. P ppm	Exchangeable Cations Ca	Mg	K	Na	CEC	Particle Size CS	FS	Silt	Clay
							m equiv. per 100 g					percent			
0-20	7.5	0.128	453		10	53	6.8	4.4	0.3	4.3	13	30	33	20	21
20-30	8.4	0.413	1793		12	57						1	20	38	47
30-60	8.4	0.806	>2000		19	76	4.5	6.4	0.2	>10	15	0	22	33	47
60-120	8.6	0.900	>2000		21	64						0	22	36	44
120-190	9.3	0.739	>2000		20	>150	3.2	5.8	0.4	>10	18	32	13	11	42

MAPPING UNIT **AD**

LOCATION Site A202; near 'Glenrosa' property; 347 750 mE, 6 836 750 mN.

SOIL PROFILE CLASS Yellowish-brown and brown, neutral to alkaline, texture contrast soils

PRINCIPAL PROFILE FORM Dy 2.42

GREAT SOIL GROUP Solodics

PARENT MATERIAL Pleistocene alluvium.

LANDFORM Flat plain.

VEGETATION Native pasture; yellow box and rough-barked apple.

PROFILE

0-10 cm	dark-brown (10YR3/3)	loam (gravelly)	hardsetting surface; massive; friable
10-45 cm	dull-yellowish-brown (10YR5/4), bleach when dry	light-sandy-clay-loam	massive; friable; moderate water-worn gravel (5-15 mm)
45-60 cm	dull-yellowish-brown (10YR5/4)	light-medium-clay	coarse-blocky; firm
60+ cm	hardpan		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations Ca	Mg	K	Na	CEC	Particle Size CS	FS	Silt	Clay
							m equiv. per 100 g					percent			
0-10	5.9	0.009	20	1.17	0.10	63	4.5	1.7	0.78	0.18	8	44	15	17	24
10-20	5.8	0.007	<18			45									
20-30	6.4	0.006	<18			34	2.9	1.1	0.65	0.22	5	42	18	15	25
30-45	6.8	0.007	<18			41									
45-60	7.1	0.005	<18			40	6.4	3.5	1.1	0.50	10	26	17	13	44

MAPPING UNIT **AD**

LOCATION Site A136; near Canal Creek; 360 000 mE, 6 902 500 mN.

SOIL PROFILE CLASS Red and brown, alkaline earths.

PRINCIPAL PROFILE FORM Gn 3.16

GREAT SOIL GROUP Solodic - red earth intergrades.

PARENT MATERIAL Alluvium.

LANDFORM Flat plain.

VEGETATION Cleared; poplar box, river red gums, rough-barked apple.

PROFILE

0-10 cm	brown (7.5YR4/3)	loam, fine-sandy	loose surface; massive; friable
10-30 cm	dark-brown (7.5YR3/4)	fine-sandy-clay-loam	massive; friable
30-50 cm	reddish-brown (5YR4/8)	clay-loam	massive; friable
50-90+ cm	dark-reddish-brown (5YR3/5)	light-medium-clay	angular-blocky; firm

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations Ca	Mg	K	Na	CEC	Particle Size CS	FS	Silt	Clay
							m equiv. per 100 g					percent			
0-10	6.1	0.012	20	1.2	0.09	48	3.4	0.8	1.1	0.08	7	5	46	27	22
10-20	6.5	0.012	<18			24									
20-30	7.5	0.014	<18			16	5.[illegible]	1.6	1.1	0.12	8	3	42	25	30
30-50	7.1	0.025	24			12									
50-60	8.5	0.056	72			8	11	3.8	1.2	0.75	11	3	35	24	38
60-90	8.5	0.060	168			7	9.1	4.6	1.2	0.88	11	2	36	28	34

MAPPING UNIT **GUc - 1**

LOCATION Site A158; near Mt. Norman; 399 000 mE, 6 810 500 mN

SOIL PROFILE CLASS Gritty siliceous sands amongst rock outcrops

PRINCIPAL PROFILE FORM Uc 2.34

GREAT SOIL GROUP Siliceous sands

PARENT MATERIAL Stanthorpe adamellite

LANDFORM Hills with tor outcrops; midslope

VEGETATION Forest of silver topped stringybark, Deane's gum and cypress pine

PROFILE

0-15 cm	brownish-black (10YR3/2)	coarse sand (gritty)	loose surface; single grain; loose
15-30 cm	dull-yellowish-brown (10YR4/3)	coarse sand (gritty)	single grain; loose
30-50 cm	dull-yellowish-brown (10YR4/3)	coarse sand (gritty)	single grain; loose
50-60 cm	dull-yellowish-brown (10YR5/3) with orange mottle, bleach when dry	coarse sandy loam (gritty)	single grain; loose
60+ cm	hardpan		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations Ca	Mg	K	Na	CEC	Particle Size CS	FS	Silt	Clay
							m equiv. per 100 g					percent			
0-10	5.3	0.009	<18	1.4	0.068	5	2.1	0.9	0.16	0.12	6	68	17	<1	14
10-20	5.5	0.006	<18			<5									
20-30	5.9	0.006	<18			<5	2.4	0.4	0.09	0.08	2	61	24	3	12
30-50	6.2	0.006	<18			<5									
50-60	6.3	0.006	<18			<5	1.7	0.7	0.09	0.18	2	53	23	5	[illegible]

MAPPING UNIT **GUc - 2**

LOCATION Site 210; SE of Amiens; 385 750 mE, 6 821 400 mN

SOIL PROFILE CLASS Gritty siliceous sands

PRINCIPAL PROFILE FORM Uc 2.12

GREAT SOIL GROUP Siliceous sands

PARENT MATERIAL Stanthorpe adamellite

LANDFORM Plains, undulating; mid lower slope

VEGETATION Open-forest of New England blackbutt and silver-leafed stringybark

PROFILE

0-30 cm	brownish-black (10YR3/2)	loamy-sand (gritty)	loose surface; loose
30-40 cm	greyish-yellow-brown (10YR5/2), bleach when dry	coarse-sand (gritty)	loose
40+ cm	hardpan		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations Ca	Mg	K	Na	CEC	Particle Size CS	FS	Silt	Clay
							m equiv. per 100 g					percent			
0-10	5.5	.015	25	1.0	.07	<5	0.8	0.6	0.09	0.6	4	72	15	5	8
10-20	5.7	.015	24			<5						73	14	5	8
20-30	5.9	.015	27			<5	0.7	0.2	0.03	0.28	3	72	14	5	9
30-40	5.9	.015	27			<5						70	18	4	8

MAPPING UNIT **GUc - 2**

SOIL PROFILE CLASS Gritty siliceous sands

GREAT SOIL GROUP Siliceous sands-earthy sands intergrade

LANDFORM Irregular low hills; midslope

LOCATION Site A151; near Ironpot Creek; 388 750 mE, 6 870 500 mN

PRINCIPAL PROFILE FORM Uc2.21

PARENT MATERIAL Herries adamellite

VEGETATION Open forest of grass trees and narrow-leaf ironbark

PROFILE

0-10 cm	brownish-black (10YR3/1)	light-sandy-clay-loam (gritty)	loose surface; massive; very friable
10-20 cm	dull brown (7.5YR5/4), bleach when dry	light-sandy-clay-loam (gritty)	massive; very friable
20-45 cm	orange (7.5YR6/6)	light-sandy-clay-loam (gritty)	massive; very friable
25-90+ cm	yellowish-brown (10YR5/6)	loam (gritty)	massive; very friable

Depth *cm*	pH *1:5*	TSS %	Cl *ppm*	Org. C %	N %	Avail. P ppm	Ca	Exchangeable Cations Mg	K	Na	CEC	CS	FS	Particle Size Silt	Clay
								m equiv. per 100 g						percent	
0-10	6.2	0.009	<18	0.70	0.07	<5	4.6	0.6	0.33	0.08	6	58	19	5	18
10-20	6.3	0.006	<18			<5									
20-30	6.2	0.007	<18			<5	2.4	0.3	0.11	0.08	3	58	19	5	18
30-45	6.0	0.007	<18			<5									
45-60	6.2	0.005	<18			<5	4.0	1.0	0.13	0.18	6	53	22	4	21
60-90	6.5	0.006	<18			<5	4.0	1.3	0.13	0.25	6	53	21	5	21

MAPPING UNIT **GDy - Dg**

LOCATION Site A203; near Storm King Dam; 401 750 mE, 6 820 250 mN

SOIL PROFILE CLASS Acid, yellow and grey, mottled, texture contrast soils

PRINCIPAL PROFILE FORM Dy 3.41

GREAT SOIL GROUP Yellow podzolics

PARENT MATERIAL Stanthorpe adamellite

LANDFORM Plains of moderate relief; lower slope

VEGETATION Native pasture

PROFILE

0-20 cm	brownish-black (10YR3/2)	light-sandy-clay-loam	hardsetting surface; weak crumb; very friable
20-30 cm	dull-yellow-orange (10YR6/4), bleach when dry	sandy-clay-loam (gritty)	weak crumb; very friable
30-45 cm	dull-yellow-orange (10YR6/4), bleach when dry	sandy-clay-loam	weak crumb; friable
45-60 cm	bright-brown (7.5YR5/8) with red and yellow mottle	light-clay	moderate blocky; friable to firm
60-90+cm	bright-yellowish-brown (10YR6/7) with red mottle, becoming redder with depth	light-clay	moderate blocky; friable to firm

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Exchangeable Cations Mg	K	Na	CEC	CS	FS	Particle Size Silt	Clay
								m equiv. per 100 g						percent	
0-10	5.9	0.011	<18	1.09	0.08	9	2.7	0.4	0.11	0.28	5	53	17	13	17
10-20	6.0	0.006	<18			4									
20-30	5.5	0.006	<18			<2	1.5	0.3	0.05	0.10	3	46	21	16	17
30-45	6.1	0.003	<18			<2									
45-60	6.2	0.003	<18			<2	2.5	1.5	0.23	0.35	5	27	18	11	44
60-90	6.3	0.041	<18			<2	3.0	1.9	0.45	0.50	5	22	18	10	50

MAPPING UNIT **GD - 1**

LOCATION Site A055; South of Lake Leslie; 394 000 mE, 6 870 000 mN

SOIL PROFILE CLASS Acid and neutral, texture contrast soils

PRINCIPAL PROFILE FORM Dy 5.41

GREAT SOIL GROUP Soloths

PARENT MATERIAL Herries adamellite

LANDFORM Lower slopes of hills

VEGETATION Cleared; narrow-leaf ironbark, brown box and bulloak

PROFILE

0-5 cm	brownish-black (7.5YR3/2)	sandy-loam	loose surface; weak crumb; friable
5-30 cm	dull-brown (7.5YR5/3), bleach when dry	loamy-sand (equivalent)*	massive, very firm
30-60 cm	bright-yellowish-brown (10YR6/6) with dull-brown mottle	medium-clay	medium-blocky; very firm
60-70 cm	yellowish-brown (10YR5/6) with grey mottle	coarse-sandy-clay (gritty)	blocky; firm
70-85 cm	yellowish-brown (10YR5/8) with grey mottle	coarse-sandy-clay	massive; friable
85+ cm	weathered granite		

* No dark organic stain.

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Exchangeable Cations Mg	K	Na	CEC	CS	FS	Particle Size Silt	Clay
								m.equiv. per 100 g						percent	
0-10	5.6	0.008	<18	0.80	0.06	<5	2.6	1.2	0.23	0.12	6	52	24	5	19
10-20	5.6	0.008	18			<5									
20-30	5.9	0.016	54			<5	0.8	0.8	0.09	0.53	3	53	24	5	19
30-60	5.9	0.090	561			<5	1.0	6.0	0.20	3.62	11	29	10	5	56
60-70	6.0	0.110	652			<5									
70-85	6.0	0.083	507			<5	1.9	3.8	0.09	3.10	8	58	7	4	31

MAPPING UNIT **GD - 1**

LOCATION Site AA124; near Greymare Creek; 378 750 mE, 6 878 000 mN

SOIL PROFILE CLASS Acid and neutral texture contrast soils

PRINCIPAL PROFILE FORM Dy 4.42

GREAT SOIL GROUP Solodics

PARENT MATERIAL Greymare Granodiorite

LANDFORM Plains, undulating; midslope

VEGETATION Cleared; yellow box

PROFILE

0-15 cm	dark-brown (10YR3/3)	sandy-loam	loose surface; massive; friable
15-40 cm	dull-yellow-orange (10YR6/3), bleach when dry	sand	massive; very firm
40-55 cm	greyish-yellow-brown (10YR4/2), with mottling (10YR5/2, 10YR6/2)	light-medium-clay (gritty)	coarse-angular-blocky; very firm
55-70 cm	greyish-yellow-brown (10YR5/2)	sandy-clay (gritty)	angular-blocky; firm
70+ cm	weathered granodiorite		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Exchangeable Cations Mg	K	Na	CEC	CS	FS	Particle Size Silt	Clay
								m equiv. per 100 g						percent	
0-10	7.4	0.014	29	0.5	0.07	6	2.3	0.5	0.40	0.08	6	56	22	8	14
10-20	6.8	0.008	18			<5						56	26	6	12
20-30	7.1	0.007	22			<5	1.2	0.4	0.16	0.08	2				
30-40	7.0	0.007	27			<5						42	17	4	37
40-55	7.0	0.036	47			<5						42	19	4	35
55-60	6.8	0.024	43			<5	3.9	4.0	0.56	1.62	9				
60-70	6.8	0.019	51			<5									

MAPPING UNIT GD - 2

LOCATION Site A156; near Washpool Creek; 383 750 mE

SOIL PROFILE CLASS Alkaline texture contrast soils

PRINCIPAL PROFILE FORM Dy 4.43

GREAT SOIL GROUP Solodics

PARENT MATERIAL Alluvium and colluvium from Stanthorpe adamellite

LANDFORM Flat plains

VEGETATION Cleared; native pasture; brown box, fuzzy box

PROFILE

0-10 cm	dark-brown (10YR3/3)	light-sandy-clay-loam	loose surface; massive; friable
10-35 cm	greyish-yellow-brown (10YR4/2), bleach when dry	light-sandy-clay-loam	massive, friable
35-42 cm	yellowish-brown (2.5Y5/3)	medium-clay	blocky; very firm
42-45 cm	yellowish-brown (2.5Y5/3)	sandy-clay (gritty)	hardpan; weathered granite
45+ cm	weathered granite		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g					Particle Size percent			
							Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
0-10	5.4	0.036	105	0.70	0.09	14	2.2	0.9	0.18	0.8	5	46	18	18	18
10-20	5.9	0.043	110			<5									
20-30	7.7	0.058	199			<5	1.8	1.4	0.03	1.8	4	48	18	15	19
30-35	8.0	0.090	507			<5									
35-42	8.4	0.240	959			<5	5.3	11.0	0.18	7.3	24	29	10	10	51

MAPPING UNIT LGn

LOCATION Site A169; near Limevale; 321 000 mE, 6 814 500 mN

SOIL PROFILE CLASS Red-brown structured earths

PRINCIPAL PROFILE FORM Gn 3.13

GREAT SOIL GROUP Terra rossa

PARENT MATERIAL Limestone

LANDFORM Plains of moderate relief; ridge

VEGETATION Cleared; brown box

PROFILE

0-15 cm	dark-reddish-brown (2.5YR3/3)	clay-loam	hardsetting surface; massive; friable
15-35 cm	dark-reddish-brown (2.5YR3/6)	light-clay	very-fine-blocky;friable; fine manganifero gravel
35-45 cm	dark-reddish-brown (2.5YR3/6)	medium-clay	fine-angular-blocky; friable to firm
45-60 cm	reddish-brown (2.5YR4/6)	medium-clay	fine-angular-blocky; firm
60-90+ cm	reddish-brown (5YR4/8)	medium-clay	fine-angular-blocky; firm

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g					Particle Size percent			
							Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
0-10	6.4	0.028	29	2.6	0.17	29	13	4.4	2.0	0.80	19	18	18	23	41
10-20	7.4	0.022	40			18									
20-30	7.8	0.058	190			9	11	5.6	1.3	1.12	15	14	14	17	55
30-35	8.4	0.158	652			6									
35-45	8.2	0.255	1086			<5									
45-60	8.1	0.319	1738			<5	9	11	0.78	2.6	17	10	7	13	70
60-90	8.5	0.398	>1810			<5	12	12	0.74	4.4	17	9	8	10	67

MAPPING UNIT SDy - Dr

LOCATION Site A170; west of Brown's Mountain; 323 500 mE, 6 814 500 mN

SOIL PROFILE CLASS Shallow, gravelly, acid, bleached, texture contrast soils

PRINCIPAL PROFILE FORM Dr 5.41

GREAT SOIL GROUP Soloths

PARENT MATERIAL Marburg sandstone

LANDFORM Plains of low relief; midslope

VEGETATION Mixed forest of narrow-leaf ironbark, cypress pine and occasional rusty gum

PROFILE

0-10 cm	brownish-black (7.5YR3/2)	light-sandy-clay-loam	loose surface; massive; friable, waterworn gravel
10-30 cm	dull-reddish-brown (5YR5/3), bleach when dry	sandy-clay-loam	massive; friable; very gravelly (waterworn and angular)
30-65 cm	reddish-brown (5YR4/6) with dull-brown mottle	medium-clay	blocky; very firm
65+ cm	dense waterworn gravel		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g					Particle Size percent			
							Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
0-10	6.5	0.022	42	2.1	0.11	8	7.3	1.5	0.35	0.08	9	29	38	12	21
10-20	6.5	0.014	22			<5									
20-30	5.9	0.021	58			<5	1.3	3.7	0.31	0.65	7	23	29	12	36
30-60	5.5	0.090	362			<5	1.4	12	0.67	2.4	15	13	15	10	62
60-65	5.3	0.094	380			<5									

MAPPING UNIT SDb - Dr

LOCATION Site A193 nglewood-Texas Rd; 313 000 mE, 6 850 500 mN

SOIL PROFILE CLASS Red-brown, alkaline, texture contrast soils

PRINCIPAL PROFILE FORM Dr 2.43

GREAT SOIL GROUP Solodized solonetz

PARENT MATERIAL Colluvium from Marburg sandstone

LANDFORM Plains of moderate relief; midslope

VEGETATION Forest of narrow-leaf ironbark and white box with *Acacia ixiophylla* understorey

PROFILE

0-10 cm	brown (7.5YR4/4) with thin bleach at 10 cm	light-sandy-clay-loam	hardsetting surface; massive; friable
10-40 cm	dark-reddish-brown (5YR3/3) with colour variations	light-medium clay	columnar; very firm
40-60 cm	dark-brown (7.5YR3/4) and bright-reddish-brown (5YR5/6)	light-medium clay	columnar; very firm
60-90+ cm	reddish-brown (5YR4/8)	light-clay	massive; very firm

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g					Particle Size percent			
							Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
0-10	5.6	0.011	31	1.4	0.10	2	0.5	2.3	0.18	1.1	7	23	38	14	25
10-20	6.5	0.062	136			< 2									
20-30	7.8	0.068	217			< 2	<0.1	14	0.09	6.2	16	16	28	10	46
30-60	8.5	0.061	244			< 2	<0.1	15	0.23	6.6	16	10	31	11	48
60-90	8.9	0.041	235			< 2	<0.1	12	0.31	5.5	12	4	38	14	44

MAPPING UNIT **SD - Gn**

SOIL PROFILE CLASS Brown, acid, texture contrast soils

GREAT SOIL GROUP Soloths

LANDFORM Undulating plains; ridge

LOCATION Site A150; East of Lake Leslie; 395 000 mE, 6 874 250 mN

PRINCIPAL PROFILE FORM Dr 4.41

PARENT MATERIAL Marburg sandstone

VEGETATION Forest of narrow-leaf ironbark (dominant) and rusty gum with an understorey of wild rosemary

PROFILE

0-10 cm	dark-brown (7.5YR3/3)	sandy-loam	loose surface; weak crumb; friable
10-30 cm	bleach when dry	sandy-clay-loam	massive; friable; angular chert and rounded quartz gravel
30-60 cm	reddish-brown (5YR4/6)	heavy-clay	blocky; extremely firm
60-70 cm	dark-reddish-brown (5YR3/6)	sandy-clay (gritty)	massive; firm
70-75 cm	dark-red (10R3/4) and yellowish-brown (2.5Y5/3)	light-medium clay	blocky; firm
75+ cm	weathered sandstone		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g Ca	Mg	K	Na	CEC	Particle Size percent CS	FS	Silt	Clay
0-10	5.3	0.014	45	0.70	0.09	34	3.3	1.1	0.49	0.15	7	51	29	4	16
10-20	5.1	0.013	31			22									
20-30	5.1	0.009	24			13									
30-60	5.0	0.012	42			<5	2.1	1.0	0.43	0.30	5	46	26	5	23
60-70	5.0	0.017	58			<5	1.0	3.6	0.56	0.78	10	26	10	2	62
70-75	4.7	0.027	119												

MAPPING UNIT **SD - Gn**

SOIL PROFILE CLASS Massive red earths

GREAT SOIL GROUP Red earths

LANDFORM Midslopes of hills

LOCATION Site C 02; SW of Warwick; 400 500 mE, 6 873 750 mN

PRINCIPAL PROFILE FORM Um 5.51

PARENT MATERIAL Marburg sandstone

VEGETATION Cleared; narrow-leaf ironbark upslope

PROFILE

0-10 cm	dark-brown (7.5YR3/3)	sandy-clay-loam	loose surface; massive, very friable
10-30 cm	dark-brown (7.5YR3/3)	sandy-clay-loam	massive; friable; ferromanganiferous gravel
30-60 cm	reddish-brown (5YR4/6)	coarse-sandy-clay-loam	massive; friable; ferromanganiferous gravel
60-90+ cm	brown (7.5YR4/6)	coarse-sandy-clay-loam	massive; friable; ferromanganiferous gravel

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g Ca	Mg	K	Na	CEC	Particle Size percent CS	FS	Silt	Clay
0-10	6.2	0.020	31	1.5	0.16	12	5.4	1.8	1.0	0.12	10	43	15	13	29
10-20	6.3	0.018	31			10									
20-30	6.3	0.010	22			9	4.0	1.0	0.65	0.08	7	55	10	6	29
30-60	5.9	0.009	24			7	2.5	1.0	0.47	0.08	6	54	16	5	25
60-90	6.4	0.006	31			<5	1.8	0.9	0.33	0.22	6	55	14	5	26

MAPPING UNIT **SDy - Uc**

SOIL PROFILE CLASS Yellow, acid, texture contrast soils

GREAT SOIL GROUP Soloths

LANDFORM Plains, undulating; midslope

LOCATION Site A143; West of Mosquito Creek; 325 000 mE, 6 870 750 mN

PRINCIPAL PROFILE FORM Dy 3.41

PARENT MATERIAL Marburg sandstone

VEGETATION Mixed forest of cypress pine (dominant), bulloak and brown box

PROFILE

0-10 cm	brownish-black (10YR3/2)	loamy-sand	hardsetting surface; massive, very friable
10-30 cm	yellowish-brown (10YR5/6)	sand	massive; very friable
30-50 cm	dull-yellow-orange (10YR6/4), bleach when dry	loamy-sand (equivalent)*	massive; very friable; fine round gravel
50-90+ cm	yellowish-brown (10YR5/8) becoming reddish-brown (2.5YR4/8) at 85 cm	medium clay	blocky; very firm

* No dark organic stain.

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g Ca	Mg	K	Na	CEC	Particle Size percent CS	FS	Silt	Clay
0-10	5.1	0.007	<18	0.8	0.04	<5	0.2	<0.2	0.03	0.12	2	60	24	8	8
10-20	5.2	0.004	<18			<5									
20-30	4.7	0.013	43			<5	0.5	<0.2	<0.02	0.08	1	57	28	5	10
30-50	5.4	0.005	<18			<5									
50-60	5.7	0.012	51			<5	<0.2	2.6	<0.02	0.93	4	36	18	4	42
60-90	5.9	0.019	105			<5	<0.2	5.8	0.03	1.9	7	25	16	3	56

MAPPING UNIT **SDy - Uc**

SOIL PROFILE CLASS Deep, bleached siliceous sands

GREAT SOIL GROUP Siliceous sands - earthy sands intergrade

LANDFORM Plains, undulating; midslope

LOCATION Site A138; SW of Leyburn; 356 500 mE, 6 899 500 mN

PRINCIPAL PROFILE FORM Uc 2.31

PARENT MATERIAL Marburg sandstone

VEGETATION Mixed forest of rusty gum, pink bloodwood, blue gum and occasional bulloak with wild rosemary understorey

PROFILE

0-10 cm	brownish-grey (10YR5/1)	loamy-sand	loose surface; single grain; loose
10-60 cm	greyish-yellow-brown (10YR6/2), bleach when dry	loamy-sand (equivalent)*	single grain; loose
60-70 cm	dull-yellow-orange (10YR6/4), bleach when dry	loamy-sand (equivalent)*	single grain; loose
70-80 cm	dull-yellow-orange (10YR6/4), bleach when dry	clayey-sand	massive; loose to very friable
80-90+ cm	yellowish-brown (10YR5/6) with slight mottling	sandy loam	hardpan

* No dark organic stain.

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g Ca	Mg	K	Na	CEC	Particle Size percent CS	FS	Silt	Clay
0-10	5.5	0.005	25	0.70	0.05	<5	1.2	0.2	0.09	0.08	3	64	24	2	10
10-20	6.2	0.004	18			<5									
20-30	5.5	0.004	<18			<5	0.8	<0.2	0.05	0.12	2	60	24	5	11
30-60	5.4	0.005	<18			<5	0.3	<0.2	0.05	0.18	1	60	24	3	13
60-70	5.2	0.006	20			<5									
70-80	5.2	0.004	49			<5									
80-90	4.8	0.004	38			<5	0.8	0.6	0.05	0.20	2	60	19	3	18

MAPPING UNIT **SDb**

LOCATION Site A186; Cunningham Highway; 392 000 mE, 6 861 750 mN

SOIL PROFILE CLASS Grey, brown and dark cracking clays

PRINCIPAL PROFILE FORM Ug 5.13 or Ug 5.14

GREAT SOIL GROUP Black earth-brown clay intergrade

PARENT MATERIAL Marburg sandstone?

LANDFORM Undulating areas of moderate relief; saddle between two knolls

VEGETATION Cultivated sorghum

PROFILE

0-10 cm	brownish-black (10YR3/2)	light-clay	self-mulching, fine-crumb surface between large cracks; blocky; very firm
10-45 cm	brownish-black (10YR2/2)	medium-clay	coarse-blocky; very firm; moderate powdery lime
45-60 cm	dull-yellowish-brown (10YR5/4)	medium-clay	coarse-blocky; extremely firm; large amounts of powdery lime and concretionary lime
60-90+ cm	olive-brown (2.5Y4/3) grading to dark-brown (10YR3/4)	medium-clay	blocky; very firm; large amounts of powdery lime and concretionary lime

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
							Exchangeable Cations m equiv. per 100 g					Particle Size percent			
0-10	8.0	0.020	27	0.99	0.09	6	23	6.0	0.43	0.85	23	33	17	6	44
10-20	8.3	0.018	19			<2									
20-30	8.9	0.030	27			<2	20	11	0.18	3.2	28	26	16	8	50
30-45	9.1	0.051	83			<2									
45-60	9.1	0.068	199			<2	30	15	0.18	5.1	24	25	16	4	55
60-90	9.2	0.092	380			<2	>30	15	0.16	5.6	23	28	16	7	49

MAPPING UNIT **SDy-Db**

LOCATION Site A188; SW of Leyburn; 359 250 mE, 6 899 500 mN

SOIL PROFILE CLASS Yellow to brown, neutral and alkaline, texture contrast soils

PRINCIPAL PROFILE FORM Dy 3.43

GREAT SOIL GROUP Solodics or solodized solonetz

PARENT MATERIAL Marburg sandstone

LANDFORM Plains of moderate relief; lower slope

VEGETATION Mixed forest of narrow-leaf ironbark, bulloak, cypress pine and occasional rusty gum

PROFILE

0-10 cm	dark-brown (10YR3/3)	light-sandy-clay-loam	hardsetting surface; massive; friable; slight gravel (2-5 mm)
10-30 cm	dull-yellowish-brown (10YR5/4), bleach when dry	sandy-clay-loam	massive; friable; very gravelly (4-15 mm)
30-70 cm	dull-yellow-orange (10YR6/3) with bright-yellowish-brown (10YR6/6) mottle	medium-clay	blocky or columnar; extremely firm
70-90+ cm	dull-yellowish-brown (10YR5/4)	light-medium-clay	massive; friable; large angular gravel (20-30 mm)

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
							Exchangeable Cations m equiv. per 100 g					Particle Size percent			
0-10	5.8	0.007	18	0.54	0.04	<2	0.9	0.9	0.18	0.18	3	54	27	2	17
10-20	6.1	0.007	24			<2									
20-30	5.4	0.018	54			<2	0.4	1.4	0.03	0.70	3	42	32	9	17
30-40	6.0	0.084	489			<2									
40-60	6.7	0.113	543			<2	1.4	8.0	0.11	4.3	9	25	18	3	54
60-70	7.9	0.106	579			<2									
70-90	8.5	0.098	471			<2	1.3	8.0	0.11	4.6	8	32	22	4	42

MAPPING UNIT **TUm-D**

LOCATION Site A190; North of Gore; 350 250 mE, 6 870 500 mN

SOIL PROFILE CLASS Shallow gravelly loams

PRINCIPAL PROFILE FORM Um 2.12

GREAT SOIL GROUP Lithosols

PARENT MATERIAL Traprock

LANDFORM Hills; on interfluve

VEGETATION Cleared; forest of tumbledown gum, cypress pine, broad-leafed ironbark with an understorey of *Acacia* spp. and wild rosemary

PROFILE

0-10 cm	dark-brown (10YR3/3)	loam	hardsetting surface; weak sub-angular blocky; friable; very stony and gravelly (5-50 mm, 40%)
10-25 cm	dull-yellowish-brown (10YR5/4), bleach when dry	sandy-clay-loam	massive; friable; very gravelly (3-15 mm, 40%)
25+ cm	fragmented, weathered, parent rock		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
							Exchangeable Cations m equiv. per 100 g					Particle Size percent			
0-10	5.8	0.010	27	1.8	0.09	<2	4.5	1.9	0.35	0.35	8	27	30	18	25
10-20	5.0	0.009	27			<2									
20-25	5.2	0.008	22			<2	0.9	1.8	0.11	0.28	5	24	28	18	30

MAPPING UNIT **TUm-D**

LOCATION Site A199; North of Glenlyon; 349 500 mE, 6 810 000 mN

SOIL PROFILE CLASS Shallow, gravelly loams

PRINCIPAL PROFILE FORM Um 2.12

GREAT SOIL GROUP Lithosols

PARENT MATERIAL Traprock

LANDFORM Upper slope of hills

VEGETATION Cleared for native pasture; silver-leaf ironbark, brown box, and cypress pine

PROFILE

0-10 cm	brown (7.5YR4/4)	clay-loam	hardsetting surface; massive; friable; gravelly
10-20 cm	orange (7.5YR6/6) bleach when dry	clay-loam	massive; friable; gravelly
20-30 cm	bright-brown (7.5YR5/6), bleach when dry	clay-loam	massive; friable; gravelly

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
							Exchangeable Cations m equiv. per 100 g					Particle Size percent			
0-10	6.5	0.013	27	1.2	0.09	43	7.5	2.0	0.54	0.28	10	21	19	23	37
10-20	6.1	0.006	20			33									
20-30	6.3	0.006	20			37	5.0	2.2	0.18	0.4	8	24	15	21	40

MAPPING UNIT **TUm-D**

LOCATION Site A133; West of Pratten; 374 750 mE, 6 892 000 mN

SOIL PROFILE CLASS Shallow, gravelly, texture contrast soils

PRINCIPAL PROFILE FORM Dr 2.41

GREAT SOIL GROUP Soloths

PARENT MATERIAL Traprock

LANDFORM Midslope of hills

VEGETATION Open-forest of narrow-leaf ironbark and cypress pine

PROFILE

0-10 cm	dark-brown (7.5YR3/4)	sandy-clay-loam	hardsetting surface; massive; friable; gravelly
10-30 cm	brown (7.5YR4/4), bleach when dry	sandy-clay-loam	massive; friable; gravelly
30-50 cm	reddish-brown (5YR4/8)	medium-clay	coarse-columnar; extremely firm; gravelly
50-60 cm	bright-brown (7.5YR5/6)	medium-clay	massive; extremely firm; gravelly
60+ cm	fragmented, weathered, parent rock		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
							Exchangeable Cations m equiv. per 100 g					Particle Size percent			
0-10	5.7	0.008	25	2.1	0.11	<5	3.7	3.0	0.35	0.3	9	20	26	24	30
10-20	5.7	0.008	20			<5									
20-30	6.0	0.008	20			<5	1.4	6.4	0.07	1.1	16	28	16	23	33
30-50	5.9	0.023	58			<5									
50-60	5.8	0.050	181			<5	0.8	15	0.09	4.0	21	10	11	16	63

MAPPING UNIT **TUm-D**

LOCATION Site A191; near Macintyre Brook; 344 250 mE, 6 855 000 mN

SOIL PROFILE CLASS Shallow, gravelly, texture contrast soils

PRINCIPAL PROFILE FORM Db 1.43

GREAT SOIL GROUP Solodics

PARENT MATERIAL Traprock

LANDFORM Midslope of hills

VEGETATION Cleared for native pasture; white box and tumbledown gum

PROFILE

0-10 cm	dark-brown (7.5YR3/4)	light-sandy-clay-loam	hardsetting surface; massive; friable; slight gravel
10-30 cm	dull-brown (7.5YR5/4) bleach when dry	sandy-clay-loam	massive; friable; gravelly
30-45 cm	brown (7.5YR4/3-4/4)	light-medium clay	blocky; firm
45+ cm	fragmented, weathered, parent rock		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
							Exchangeable Cations m equiv. per 100 g					Particle Size percent			
0-10	5.8	0.006	<18	1.0	0.08	3	2.2	2.6	0.45	0.22	7	32	28	17	23
10-20	6.0	0.006	<18			< 2									
20-30	7.1	0.030	54			< 2	2.4	8.8	0.11	2.8	11	30	22	18	30
30-45	8.1	0.045	123			< 2									

MAPPING UNIT **TD**

LOCATION Site A146; South of Cement Mills, Gore; 374 570 mE, 6 892 000 mN

SOIL PROFILE CLASS Shallow, gravelly, texture contrast soils

PRINCIPAL PROFILE FORM Dr 2.42

GREAT SOIL GROUP Solodics

PARENT MATERIAL Traprock

LANDFORM Plains, undulating; on upper slope

VEGETATION Cleared; yellow box

PROFILE

0-10 cm	dark-brown (10YR3/3)	clay-loam (gravelly)	hardsetting surface; massive; friable; gravelly
10-25 cm	yellowish-brown (2.5Y5/4), bleach when dry	clay-loam	massive; friable; laminated gravel
25-35 cm	dull-reddish-brown (5YR4/4)	heavy-clay	blocky; extremely firm
35-40 cm	brown (10YR4/4)	heavy-clay	blocky; extremely firm
40+ cm	fragmented, weathered, parent rock		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
							Exchangeable Cations m equiv. per 100 g					Particle Size percent			
0-10	6.0	0.203	34	2.8	0.20	28	6.2	4.0	0.78	0.15	14	27	20	18	35
10-20	5.9	0.014	31			15									
20-25	5.9	0.007	24			6									
25-30	6.0	0.010	47			<5	4.0	10	0.35	1.9	19	15	10	8	67
30-35	6.2	0.019	74			<5									
35-40	6.8	0.022	71			72	4.5	12	0.38	2.2	19	20	7	6	67

MAPPING UNIT **TD**

LOCATION Site A130; East of Durikai; 366 250 mE, 6 880 250 mN

SOIL PROFILE CLASS Shallow, gravelly, texture contrast soils

PRINCIPAL PROFILE FORM Db 1.43

GREAT SOIL GROUP Solodized solonetz

PARENT MATERIAL Traprock

LANDFORM Plains, irregular; lower slope

VEGETATION Forest of narrow-leaf ironbark, broad-leaf ironbark with an understorey of *Acacia ixiophylla*

PROFILE

0-10 cm	brownish-black (10YR3/2)	loam (gravelly)	hardsetting surface; massive; friable; gravelly
10-30 cm	brown (10YR4/4), bleach when dry	sandy-clay-loam	massive; friable; gravelly
30-50 cm	brown (7.5YR4/4)	medium-clay	columnar; very firm; gravelly
50-80 cm	orange (7.5YR6/6)	medium-clay	massive; very firm; gravelly (shale)
80+ cm	fragmented, weathered shale		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
							Exchangeable Cations m equiv. per 100 g					Particle Size percent			
0-10	5.5	0.014	33	3.4	0.18	8	5.2	3.4	0.40	0.30	16	30	30	15	25
10-20	5.4	0.033	103			<5									
20-30	5.6	0.030	105			<5	0.9	4.2	0.18	0.80	8	26	23	16	35
30-50	6.4	0.101	416			<5									
50-60	7.3	0.173	670			<5	0.8	11	0.20	2.2	12	15	16	18	51
60-80	7.4	0.165	615			<5									

MAPPING UNIT **TDr - Db**

LOCATION Site A161; NW of Dalveen; 394 000 mE, 6 851 250 mN

SOIL PROFILE CLASS Shallow, gravelly, red-brown, acid and neutral texture contrast soils

PRINCIPAL PROFILE FORM Dr 2.11

GREAT SOIL GROUP Non-calcic brown soils

PARENT MATERIAL Traprock

LANDFORM Upper slope of hills

VEGETATION Open forest of yellow box and bluegum

PROFILE

0-5 cm	dark-brown (7.5YR3/3)	clay-loam	loose surface; granular; friable; gravelly
5-40 cm	dark-reddish-brown (2.5YR3/4)	heavy-clay	strong sub-angular-blocky; extremely firm
40-45 cm	brown (7.5YR4/4)	heavy-clay	blocky; extremely firm; very gravelly
45+ cm	fragmented, weathered, parent rock		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g					Particle Size percent			
							Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
0-5	5.7	0.010	<18	2.3	0.16	8	8.2	6.3	0.80	0.18	18	25	23	14	38
5-10	5.9	0.010	20			<5	11	13	0.38	0.58	23	6	10	17	67
10-20	6.0	0.008	20			<5									
20-30	5.9	0.015	<18			<5	11	15	0.33	0.93	24	5	8	12	75
30-40	6.2	0.011	<18			<5									
40-45	6.5	0.010	<18			<5									

MAPPING UNIT **TDr - Db**

LOCATION Site A160; NW of Dalveen; 394 250 mE, 6 849 500 mN

SOIL PROFILE CLASS Shallow, gravelly, red-brown, acid and neutral, texture contrast soils

PRINCIPAL PROFILE FORM Dr 2.41

GREAT SOIL GROUP Soloths

PARENT MATERIAL Traprock

LANDFORM Upper slope of hills

VEGETATION Open-forest, bluegum dominant

PROFILE

0-10 cm	brown (7.5YR4/3) thin bleach at 10 cm	sandy-clay-loam	hardsetting surface; massive; friable; gravelly
10-40 cm	reddish-brown (2.5YR4/7)	medium-clay	blocky; extremely firm
40-50 cm	brown (7.5YR4/6)	medium-clay	blocky; extremely firm
50+ cm	dull-yellowish-brown	clay	hardpan; weathered rock

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g					Particle Size percent			
							Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
0-10	5.9	0.011	<18	1.9	0.14	6	4.4	2.2	0.47	0.18	9	17	39	21	23
10-20	5.7	0.016	34			<5									
20-30	6.0	0.012	34			<5	4.6	7.8	0.43	0.83	16	6	16	14	64
30-40	5.4	0.010	29			<5									
40-50	5.4	0.009	<18			<5	4.4	7.4	0.28	0.82	16	6	16	14	64

MAPPING UNIT **MUg - D**

LOCATION Site A167; East of Mundoey; 314 000 mE, 6 812 500 mN

SOIL PROFILE CLASS Grey and brown, cracking clays

PRINCIPAL PROFILE FORM Ug 5.13

GREAT SOIL GROUP Brown clays

PARENT MATERIAL Colluvium of mixed origin

LANDFORM Plains of low relief; gilgai mound

VEGETATION Cleared; belah dominant with wilga and brigalow

PROFILE

0-20 cm	brownish-black (10YR3/2)	light-clay	self-mulching surface; fine-angular-blocky; firm
20-60 cm	brownish-black (10YR3/1)	medium-clay	blocky; extremely firm; lime concretions
60-90+ cm	dark-brown (10YR3/3)	medium-clay	blocky; extremely firm; lime concretions

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv per 100 g					Particle Size percent			
							Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
0-10	7.5	0.017	<18	1.0	0.07	17	17	7.2	0.35	0.92	26	4	39	15	42
10-20	8.0	0.024	31			7									
20-30	8.2	0.065	177			<5	20	13	0.23	5.1	34	4	20	15	61
30-60	8.9	0.109	398			<5									
60-90	8.9	0.173	615			<5	17	15	0.20	6.3	32	5	18	18	59

MAPPING UNIT **MUg - D**

LOCATION Site A147; East of Inglewood; 321 500 mE, 6 857 250 mN

SOIL PROFILE CLASS Grey and brown cracking clays

PRINCIPAL PROFILE FORM Ug 5.1

GREAT SOIL GROUP Grey clays

PARENT MATERIAL Mixed origin (basalt and sandstone)

LANDFORM Plains, undulating; midlower slope

VEGETATION Cleared for cultivation; belah dominant with wilga and occasional poplar box

PROFILE

0-2 cm	brownish-black (2.5Y3/1)	light-clay	self-mulching surface; fine angular blocky; firm; lime nodules and quartz gravel
2-15 cm	brownish-black (2.5Y3/1)	medium-clay	blocky; extremely firm
15-60 cm	yellowish-grey (2.5Y4/1)	heavy-clay	blocky; extremely firm
60-90+ cm	olive-black (5Y3/1)	heavy-clay	blocky; extremely firm; traces of lime

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g					Particle Size percent			
							Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
0-10	7.1	0.033	40	2.9	0.20	12	27	9.5	0.72	1.4	35	16	21	13	50
10-20	6.9	0.025	49			6									
20-30	6.0	0.045	235			<5	25	14	0.28	3.1	44	8	14	7	71
30-60	6.2	0.071	398			<5	26	16	0.26	3.6	44	8	14	7	71
60-90	7.9	0.064	398			<5	26	17	0.26	4.1	44	8	14	8	70

MAPPING UNIT MUg - D

LOCATION Site A168; West of Mundoey; 311 750 mE, 6 813 000 mN

SOIL PROFILE CLASS Alkaline texture contrast soils

PRINCIPAL PROFILE FORM Db 4.43

GREAT SOIL GROUP Solodized solonetz

PARENT MATERIAL Colluvium of mixed origin

LANDFORM Plains of low relief

VEGETATION Open forest of belah, wilga and brigalow

PROFILE

0-20 cm	dark-brown (7.5YR3/3), fine bleach at 20 cm	sandy-clay-loam	loose surface; massive; friable
20-35 cm	very-dark-brown (7.5YR2/3)	sandy-clay	columnar; firm
35-60 cm	brown (7.5YR4/3)	medium-clay (sandy)	columnar; very firm
60-75 cm	brown (7.5YR4/3)	light-medium-clay	columnar; very firm; lime
75-90+ cm	dull-yellowish-brown (10YR5/3) and dull-reddish-brown (5YR4/4)	sandy-clay	massive; firm; lime

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g: Ca	Mg	K	Na	CEC	Particle Size percent: CS	FS	Silt	Clay
0-10	5.5	0.026	49	1.7	.11	10	3.0	2.5	0.54	0.93	10	36	33	8	23
10-20	5.5	0.032	69			6									
20-30	5.7	0.047	136			<5	1.8	5.9	0.16	3.8	13	38	22	8	32
30-35	6.5	0.083	416			<5									
35-60	9.3	0.150	453			<5	15	11	0.13	6.8	18	28	26	5	41
60-75	9.4	0.158	507			<5									
75-90	9.4	0.180	507			<5	26	11	0.13	6.5	14	33	25	3	39

MAPPING UNIT MUg - D

LOCATION Site A145; near Mosquito Creek; 331 250 mE, 6 876 000 mN

SOIL PROFILE CLASS Alkaline texture contrast soils

PRINCIPAL PROFILE FORM Dr 2.43

GREAT SOIL GROUP Solodic

PARENT MATERIAL Pleistocene alluvium and colluvium

LANDFORM Flat plain

VEGETATION Cleared for cultivation (sorghum)

PROFILE

0-8 cm	brown (7.5 YR 4/4) thin bleach at 8 cm	clay-loam	hardsetting surface; weak sub-angular-blocky; friable
8-30 cm	dull-reddish-brown (5YR4/4)	medium-clay	coarse-blocky; extremely firm; rounded gravel
30-60 cm	bright-reddish-brown (5YR5/6)	medium-clay	coarse-blocky; extremely firm
60-90+ cm	bright-brown (7.5YR5/6)	medium-clay	coarse-blocky; extremely firm; lime

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g: Ca	Mg	K	Na	CEC	Particle Size percent: CS	FS	Silt	Clay
0-10	6.2	0.015	18	2.2	0.22	15	9.4	4.0	1.9	0.46	16	22	28	20	30
10-20	6.0	0.028	71			<5									
20-30	6.1	0.027	109			<5	7.2	9.6	0.31	3.2	21	18	18	15	49
30-60	8.1	0.011	416			<5	10	14	0.18	5.2	24	17	20	13	50
60-90	8.9	0.191	794			<5	19	15	0.16	5.7	20	17	20	13	50

MAPPING UNIT MDb - Dy

LOCATION Site A194; East of the Inglewood-Texas Road; 315 250 mE, 6 844 500 mN

SOIL PROFILE CLASS Gravelly, brown and yellowish-brown, alkaline texture contrast soils

PRINCIPAL PROFILE FORM Db 1.42

GREAT SOIL GROUP Solodized solonetz

PARENT MATERIAL Colluvium of mixed origin

LANDFORM Plains of moderate relief; midslope

VEGETATION Mixed forest of cypress pine, narrow-leaf ironbark, rusty gum and bulloak with an understorey of *Acacia ixiophylla* and *Melaleuca lanceolata*.

PROFILE

0-10 cm	brownish-black (10YR3/2)	loam	hardsetting surface; massive; friable
10-25 cm	dull-brown (10YR5/4), bleach when dry	sandy-loam	massive; very friable; very gravelly (rounded, 5-20 mm)
25-30 cm	brown (10YR4/3)	light-medium -clay	columnar; firm; gravelly
30-45 cm	dull-brown (10YR5/4)	light-medium -clay	massive; firm; very gravelly (5-20 mm)
45+ cm	dense rounded gravel		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g: Ca	Mg	K	Na	CEC	Particle Size percent: CS	FS	Silt	Clay
0-10	5.1	0.008	29	2.4	0.10	3	0.1	0.4	0.11	0.40	4	28	42	13	17
10-20	5.3	0.006	<18			2									
20-25	5.1	0.010	18			2									
25-30	7.0	0.031	80			<2	<0.1	6.3	0.09	3.4	7	20	30	10	40
30-45	8.1	0.047	109			3									

MAPPING UNIT MDy - Db

LOCATION Site A174; West of Inglewood-Texas Road; 313 250 mE, 6 839 000 mN

SOIL PROFILE CLASS Gravelly, brown and yellowish-brown, acid, texture contrast soils

PRINCIPAL PROFILE FORM Dy 2.42

GREAT SOIL GROUP Solodized solonetz-soloth intergrade

PARENT MATERIAL Mixed origin - colluvium and alluvium

LANDFORM Plains of low relief; mid-lower slope

VEGETATION Mixed forest of cypress pine, narrow-leaf ironbark and rusty gum with an understorey of *Acacia ixiophylla*

PROFILE

0-10 cm	greyish-yellow-brown (10YR4/2)	loam	hardsetting surface; massive; friable; angular gravel
10-35 cm	greyish-yellow-brown (10YR5/2), bleach when dry	loam, fine-sandy	massive; friable; very gravelly
35-60 cm	dull-brown (7.5YR5/4) grading to dull-yellowish-brown (10YR5/4)	light-clay	columnar; very firm; gravelly
60+ cm	weathered, angular gravel		

Depth cm	pH 1:5	TSS %	Cl ppm	Org. C %	N %	Avail. P ppm	Exchangeable Cations m equiv. per 100 g: Ca	Mg	K	Na	CEC	Particle Size percent: CS	FS	Silt	Clay
0-10	5.5	0.009	<18	1.4	0.06	<5	0.2	0.70	0.28	0.18	4	27	41	14	18
10-20	5.8	0.007	<18			<5									
20-30	5.6	0.015	38			<5	<0.1	1.2	0.23	0.43	3	26	40	15	19
30-35	5.7	0.039	132			<5									
35-60	6.2	0.078	308			<5	<0.1	9.3	0.72	3.2	10	14	29	15	42

8 VEGETATION OF THE GRANITE AND TRAPROCK AREA

by L. Pedley

TABLES

MAPS

The Granite and Traprock area of South-East Queensland - A Land Inventory and Land Utilisation Study, Division of Land Utilisation, Technical Bulletin No. 13, Queensland Department of Primary Industries, Brisbane, 1976.

8 VEGETATION OF THE GRANITE AND TRAPROCK AREA

by L. Pedley*

The vegetation of the granite and traprock area has not been mapped or described in any detail previously. In what was mainly a survey of soils, Isbell (1957) described and mapped vegetation in an area immediately to the west. Because of the preponderance of shallow soils derived from shists and shales of Devonian age (traprock) the vegetation is unlike that of any other area in Queensland, though the vegetation of the south-eastern elevated part is similar to that of the New England region to the south and that of the western margin is similar to large areas of inland Queensland.

8.1 Major Environmental Controls

8.1.1 Settlement

The area was first settled more than a century ago and the vegetation has been drastically affected by settlement. Clearing for cultivation of crops has resulted in the complete destruction of the natural vegetation particularly in the vicinities of Inglewood, Stanthorpe and Warwick. Partial clearing by the ring-barking of woody plants to encourage growth of grasses and the cutting of some species for timber have also affected the vegetation. It is often difficult to assess the effect of ring-barking, as species differ in their ability to regenerate after ringing. The extent of clearing may be gauged from the Land Use map (MAP 7).

8.1.2 Fire

Fire has been a significant part of the environment in all but the wettest parts of Australia since the continent was colonized by aborigines possibly 30,000 years ago. In the last century the frequency of burning has probably increased considerably. Since the advent of domesticated grazing animals, large areas are burnt regularly to control regrowth of woody vegetation and to remove unpalatable dry herbage. Fire with intensive grazing has probably eliminated the most palatable and fire-sensitive species, so that the ground cover is now poorer in species and more uniform in composition over wider areas than it was before white settlement.

As pointed out previously (Pedley 1974) *Callitris* spp. are susceptible to fire and the composition of some communities containing *Callitris* spp. has probably changed due to the effect of deliberate or accidental fires. The patchy occurrence of *Callitris columellaris* in some communities is almost certainly the result of fires.

8.1.3 Moisture Availability

In arid and semi-arid regions the distribution and availability of water determines the distribution of plants. In the granite

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and traprock area which is not arid or semi-arid, the effect of moisture is confounded by other climatic and edaphic factors, but it seems that, at least in areas of uniform climate and geomorphology the distribution of plants is greatly influenced by the availability of water. This is especially apparent in land systems in which traprock predominates. In such land systems there are usually rather simple catenary sequences - ironbarks (Series *Pruinosae* of Pryor and Johnson 1971), usually *Eucalyptus crebra* on the concave upper slopes with shallow soils, and boxes (mostly species of series *Moluccanae* of Pryor and Johnson) on the convex lower slopes where soils are deeper. The catenary sequence varies between land systems with similar geology, probably due to some variation in climatic factors, such as temperature, the amount of rain and its seasonality. *Eucalyptus melanophloia* is the commonest eucalypt in Bonshaw, Glenlyon and Arcot land systems but is absent from all but the southern part of Warroo land system, whereas *E. albens* is common in Warroo but absent from land systems to the south.

8.2 Classification and Mapping

The communities described and mapped correspond roughly to associations as defined by Beadle and Costin (1952) though in some cases they are probably closer to being alliances. Where the vegetation appears to be more or less intact some mention of the structure of the community is made (following Specht 1970) but in many places disturbance is so great that the structure of the original community cannot even be guessed at. The structure and floristics of communities within land systems is given in some detail in the description of land systems. Over large areas where climatically diverse or geographically widely separated areas are compared, a description of the physiognomy of the vegetation is essential, but in a relatively small area the floristic community is probably as informative as its physiognomy.

The vegetation of the area was probably once largely woodland, often layered, with relatively small areas of open forest in the wettest areas in the south-east. Species of *Eucalyptus* and *Angophora* form the tallest stratum and predominate in all communities described except for those with a dense stratum of *Callitris columellaris*. They form the tallest stratum and contribute most to the biomass of the communities, though in many cases they cannot be described as dominant in the sense of Beadle and Costin as they do not condition the habitats of other strata. There is some evidence that, as in other parts of Queensland (Perry and Lazarides 1964; Boyland 1975) different strata are distributed independently of each other. The description of the associations is a description of the predominant stratum and the synusiae associated with it irrespective of whether these extend to other associations.

As in most studies of vegetation outside of the arid parts of Australia problems associated with the identification, classification and nomenclature of eucalypts have arisen. Some species are readily identified even when the observer is moving rapidly through the area while others are difficult to identify both in the field and with complete herbarium material. Three species of the series *Capitellatae* of

Pryor and Johnson, *Eucalyptus laevopinea, E. youmanii* and *E. caliginosa,* occur in the area and are difficult to distinguish, and may even be confused at times with *E. andrewsii.* As an example of one pattern of variation in *Eucalyptus,* Pryor and Johnson cited *E. blakelyi, E. dealbata, E. tereticornis* and related species. *E. blakelyi* is a reasonably well marked species south of Stanthorpe and *E. tereticornis* is common in other parts of the area, but where the ranges of the two overlap many trees difficult to assign to either species occur. On the other hand *E. dealbata* is distinct and widespread throughout the area where it is known as 'mountain gum'. In habit and ecological requirements however it differs considerably from *E. dealbata* 'tumble-down gum' in other parts of Queensland. *E. albens, E. microcarpa* and *E. pilligaensis* are common in parts of the area and all three sometimes grow together without obvious intergrading as reported by Pryor and Johnson. From observations of both in Queensland it appears that *E. microcarpa* would probably be better treated as a subspecies of *E. moluccana* than of *E. woollsiana* as suggested by Pryor and Johnson.

I have followed Blake and Roff (1972) in using the names *E. siderophloia* and *E. nubila* despite the use of names *E. fibrosa* subsp. *fibrosa* and *E. fibrosa* subsp. *nubila* for the same taxa by Pryor and Johnson and by Johnston and Marryatt (1965).

8.3 Vegetation Subdivisions

On the basis of vegetation alone, the area can be divided into five well defined areas. The land systems comprising the areas are shown in Table 8.1 below.

TABLE 8.1 - VEGETATION SUBDIVISIONS RELATED TO LAND SYSTEMS

Vegetation Subdivisions	Land Systems
1. The elevated granite	Eukey, Magnus, Norman, Severnlea, Summit, Washpool
2. The elevated traprock	Jibbinbar, Roberts, Arcot
3. The lower granite	Evandale, Ironpot
4. The lower traprock	Arcot, Bonshaw, Canal (part), Glenlyon, Gore, Pikedale, Texas, Thane, Warroo
5. The sandstone and Cainozoic strew	Canal (part), Bundella, Devine, Leslie, Magee

8.3.1 The Elevated Granite

This area is known generally as the Granite Belt and is physically a northern extension of the New England Tableland. Its vegetation is unlike that of any other part of Queensland. Many eucalypts are at or near the northern limit of their ranges (e.g. *E. blakelyi, E. caliginosa, E. nova-anglica, E. youmanii*) and there is one endemic species *(E. scoparia).* There is a high degree of endemism in the species of the lower strata. The unusual composition of the flora causes difficulties in identification to workers who otherwise have a good knowledge of the plants of inland Queensland generally.

The communities are structurally more complex and floristically richer than those of other parts of the granite and traprock area. There is a gradation of structural forms from open-forest of *Eucalyptus andrewsii* along the eastern wet margin of Summit land system to rather open woodland of *E. laevopinea* and *E. dealbata* in Magnus land system. Most communities have dense low-tree and shrub layers rich in species.

Much of the vegetation has been cleared for cultivation and grazing but some areas of rugged country remain relatively undisturbed. A large part of the Norman LS is reserved as a National Park but the area reserved could well be extended in order to preserve more unusual species and a greater range of vegetation types.

Because of the large number of species, the many different combinations of eucalypts in the upper storey, the difficulty in identifying the eucalypts, and the disturbance of the vegetation in the less rugged parts of the area, the mapping of the vegetation of the elevated granite is less reliable than the mapping of other parts of the surveyed area. The description of the vegetation is also broad. Plant associations that would probably be recognised in a more detailed survey are aggregated. An accurate and detailed survey of the vegetation would entail the plotting of the distribution of the 25 species of *Eucalyptus* recorded from the area as well as major components of the lower strata.

8.3.2 The Elevated Traprock

Communities of the elevated traprock region have affinities with those of areas to the south and to parts of the less elevated traprock area. The area is much poorer in species and its communities are simpler than the elevated granite to the east. This can be partly attributed to the lower rainfall but the lithology and topography of the area are major factors determining the composition and distribution of the flora. On the steep, south-facing upper slopes of the Roberts Range where precipitation is high and evaporation low, however, *Eucalyptus radiata* and *E. dunnii* form open-forest communities unlike any other in the surveyed area.

The elevated traprock region is extremely rugged and only the eastern margin is easily accessible. Consequently the composition of the vegetation is not known in detail. In the eastern part of Jibbinbar land system *Eucalyptus caleyi*, which occurs only sporadically in the southern part of the traprock area elsewhere, is common and predominates over a wide area. In the western part of the land system it is replaced by *E. melanophloia*.

Though it lacks the spectacular inselbergs and tors and many of the attractive plants of the elevated granite area, the elevated traprock is an unusual part of Queensland. Some portions should be conserved while the vegetation is still relatively undisturbed.

8.3.3 The Lower Granite

The vegetation of the lower granite is not particularly striking when compared to that of the high granite and traprock areas. Largely because of the low relief and gentle slopes of the area it has been extensively cleared, and little of its vegetation is undisturbed. There are also fewer species and most communities do not have a shrubby understorey. A feature of the area is the large areas of the *Eucalyptus crebra-E. tereticornis* association, often with dense patches of *Casuarina luehmannii*. *E. conica* occurs only in the southern part of Washpool LS where it is common.

8.3.4 The Lower Traprock

The largest area recognised is the lower traprock area. It has been cleared for grazing to such an extent that it is now difficult to determine the structure and floristics of the undisturbed communities. There are striking discontinuities in the ranges of some conspicuous canopy species which suggest that climatic factors (perhaps incidence of winter rain or winter temperature) which vary from south to north may have a strong effect. *E. melanophloia* does not occur in the northern half of the area although outside of the area it extends into wetter and drier areas and far into tropical Queensland. *E. albens* is found in Queensland only in the study area, where it is more or less confined to Warroo, Arcot and parts of Pikedale land systems.

Cadellia pentastylis ('Ooline') which belongs to a family with Indo-Malesian affinities, Simarubaceae, and which is sometimes regarded as a relict of more mesic vegetation, is found on slopes in Bonshaw LS. Farther west in Queensland it occurs sporadically on scarps in weathered sandstone, often with *Acacia catenulata* (Pedley 1974).

8.3.5 The Sandstone and Cainozoic Strew

The vegetation of the sandstone and areas of Cainozoic strew are similar to large areas of southern Queensland extending to the north and westward (see Dawson 1972, Pedley 1974). It is characterised by dense stands of *Callitris columellaris* and the presence of *Angophora costata* and the bloods, *Eucalyptus polycarpa* and *E. trachyphloia*. In the east the sandstone area is noteworthy for the occurrence of both heath and 'softwood' scrub in woodland of *E. crebra*. In the western part of the area *E. pilligaensis* is common alone or in association with *E. populnea*, a species common in Leslie LS but extending to both low level traprock and granite areas. South of Inglewood the mallees *E. bakeria* and *E. viridis* occur in heath-like vegetation which occupies only a small area not warranting treatment as a distinct land unit.

8.4 Vegetation Associations

The descriptions of associations that follow are less detailed than the descriptions of vegetation in the land units. The land units are based on differences in topography and soils rather than on vegetation types. Consequently more than one of the associations described may occur in a land unit. The vegetation map is based on a map of land units within the land systems. Where unit and vegetation boundaries do not correspond there will be some inaccuracies in the map; but, and because the associations described are rather broad, the map is adequate for a report of this nature and comparable to others of inland Queensland (Pedley 1967, 1974). It is least satisfactory in the elevated granite where the vegetation is a complex multi-speciеd continuum which is probably best mapped by plotting individual species of eucalypts.

8.4.1 *Eucalyptus microcarpa-E. melliodora*

Much of the community has been either removed or greatly modified by clearing, grazing and burning and most of the data have been derived from small relict patches on roadsides.

The upper layer, 10-20 m tall, consists of either *E. microcarpa* alone or of *E. microcarpa* with occasional *E. melliodora*. There are 90-200 trees per hectare. In some places, particularly in Gore and Warroo land systems *E. melliodora* forms extensive pure stands. In Leslie and Evandale LSs *E. tereticornis* and *Angophora floribunda* are occasional components of the community, and in Pikedale LS *E. albens* is significant in places.

The community usually lacks a well developed lower layer but in Canal, Thane and the norther part of Warroo LSs *Acacia ixiophylla* and/or *Cassinia laevis* sometimes form a dense shrub layer 1-2 m tall. In most places there are only scattered low trees and shrubs, mostly *Acacia* spp.

The ground cover is moderately dense and fairly uniform in composition throughout the study area. The most conspicuous species are probably *Bothriochloa decipiens, Cymbopogon refractus, Danthonia linkii, Dichelachne micrantha, Stipa verticillata* and *Aristida ramosa*.

8.4.2 *Eucalyptus populnea* and/or *E. pilligaensis*

This is structurally and floristically similar to the *E. microcarpa-E. melliodora* community and often grades into it. It has also been greatly modified.

The upper stratum is usually 16-18 m tall with *E. populnea* predominating and occasional *E. pilligaensis,* though in places there are pure stands of the latter. *Geijera parviflora* and, in Devine LS, *Callitris columellaris* occur, but lower layers are not well developed.

The community is not extensive and is best developed in Texas, Devine, Evandale and Leslie LSs, on lower slopes. The ground cover is similar to that of the *E. microcarpa-E. melliodora* community though *Enneapogon* spp. are common in places.

8.4.3 *Eucalyptus albens*

E. albens occurs on traprock throughout the area, but only in Texas, Pikedale and especially Warroo LSs does it form distinct communities. Elsewhere it is only a minor component of the vegetation. In Warroo LS *E. albens* extends from the alluvium where *E. microcarpa* predominates to the tops of hills where it grows with *E. crebra*. On the lower and intermediate slopes, however, it predominates.

E. albens, 12-18 m tall, forms a woodland (about 120-180 trees per hectare) usually with only scattered subshrubs of *Pimelea pauciflora* and *Olearia elliptica* with a moderately dense ground cover similar to that of the two communities described previously.

In Arcot LS *E. albens* and *E. melanophloia* occur together in a community described under *E. melanophloia*.

8.4.4 *Eucalyptus tereticornis-Angophora floribunda*

This community occurs throughout the area on lower slopes in many land systems but is usually limited in extent, intergrades with other communities and is therefore rarely large enough to map. Only small areas remain undisturbed.

E. tereticornis and *Angophora floribunda* usually occur in about equal proportions. *E. blakelyi* replaces *E. tereticornis* in the southern part of Severnlea LS. Other eucalypts are not common except in the northern part of Washpool LS where the community covers a large area and where *E. melliodora* is often common. The upper layer varies from 18 to 30 m in height, with a mean of 20 m. *Acacia neriifolia* and *Banksia integrifolia* occur in Magnus and Severnlea LSs and *Cassinia* spp. sometimes form a patchy shrub layer, but lower strata are not well developed. *Aristida ramosa, Cymbopogon refractus, Bothriochloa decipiens* and *Themeda australis* are the commonest species in the moderately dense ground layer.

8.4.5 *Eucalyptus tereticornis-Eucalyptus crebra*

This community is extensive in Evandale and Ironpot LSs, on upper and lower slopes and on plains.

The upper tree layer, 13-18 m tall, consists of *E. crebra, E. tereticornis* and occasional *Angophora floribunda*. Dense patches of *Casuarina luehmannii* up to 10 m tall occur in Ironpot LS but otherwise lower trees and shrubs are restricted to scattered *Acacia implexa* and occasional dense stands of *Cassinia laevis*. The ground layer consists mainly of *Enteropogon acicularis, Bothriochloa decipiens, Aristida ramosa, Cymbopogon refractus* and *Dichelachne micrantha*.

8.4.6 *Eucalyptus tereticornis-Eucalyptus caliginosa*

This is usually a layered woodland 12-20 m tall consisting of many species in the tree and shrub layers. The commonest tree is usually *E. caliginosa*, usually associated with at least three of the following species - *E. blakelyi, E. tereticornis, E. deanei, E. nova-anglicae, Angophora floribunda*, and rarely *E. laevopinea*. The lower tree layer which is usually not well developed consists mainly of *Callitris columellaris* and *Banksia integrifolia*. The shrub layer is often dense. *Daviesia mimosoides* is usually common, but in places *Jacksonia scoparia* and *Exocarpos cupressiformis* are prominent. The density of the ground cover is generally low but depends on the density of the shrub layer. *Dichelachne micrantha* and *Cymbopogon refractus* are the most constant species.

8.4.7 *Eucalyptus crebra-E. dealbata*

This woodland association predominates, usually on upper slopes of the lower granite, lower traprock and sandstone areas. It is best developed in Gore, Texas and Thane LSs. The upper stratum of about equal proportions of *E. dealbata* and *E. crebra* is 10-15 m tall. Occasionally on gentler slopes the upper stratum reaches 25 m with *E. crebra* predominating. *E. crebra* is sometimes replaced by *E. sideroxylon* and *E. exserta* var. *parvula* may also occur. In parts of Canal LS *E. dealbata* forms a woodland with occasional trees of *E. trachyphloia* and a moderate lower layer of *Casuarina inophloia*.

Lower woody layers are usually open but there may be a lower layer of *Callitris columellaris* or *Acacia sparsiflora* (in Magee LS) or a well developed shrub layer of mixtures of *Jacksonia scoparia, Olearia elliptica* and *Acacia* spp., especially *A. leiocalyx, A. ixiophylla* and *A. semilunata*.

Ground cover is usually low though dependent on the density of the woody strata. *Aristida ramosa* or *A. caput-medusae* is most common.

8.4.8 *Eucalyptus crebra-Angophora costata*

This is usually a distinctly layered woodland. The upper stratum 20-25 m tall consists of equal numbers of *E. crebra* and *A. costata* with occasional *E. tereticornis*. *Casuarina luehmannii* almost invariably predominates in the patchy lower tree layer about 10 m tall. The shrub layer which is most dense in places where the upper layers are open is rich in species, *Acacia* spp. (particularly *A. deanei, A. ixiophylla* and *A. semilunata*), *Daviesia* spp. and *Leucopogon* spp. being most common. Ground cover is extremely low.

The community covers large areas of Devine and Magee LSs and extends to Canal. A similar community occupies small areas on upper slopes of Thane and Pikedale LSs; *E. maculata* replacing *A. costata* and *Casuarina luehmannii* is rare. There is however a rich shrub layer.

8.4.9 *Eucalyptus caleyi*

On rugged hills in Jibbinbar and Washpool LSs *E. caleyi* forms a woodland 10-15 m tall with a patchy shrub layer of *Acacia* spp., *Cassinia laevis* and *Olearia elliptica* and extremely sparse ground cover. *E. albens, E. sideroxylon* and emergent *Acacia neriifolia* also occur occasionally, but because of the inaccessibility of the area where it is best developed, little is known of community.

8.4.10 *Eucalyptus caleyi-E. dealbata*

On hills in Roberts and the southern part of Washpool LSs, a woodland of *E. caleyi* and *E. dealbata* occurs. Structurally and floristically it is similar to the *Eucalyptus caleyi* woodland of Jibbinbar LS to the west. It is accessible in only a few places and the following description is not at all precise.

There is an upper layer usually 10-12 m tall of the two species of eucalypts and lower layers, rather dense in places of *Acacia pubifolia* and *Leptospermum attenuatum*. Patches of *Callitris* sp. occur. Ground cover is low, consisting usually of *Dichelachne micrantha*, *Cymbopogon refractus* and *Danthonia* spp.

8.4.11 *Eucalyptus melanophloia*

Woodland 12-18 m tall of *E. melanophloia* and occasional *Angophora floribunda* is widespread in Bonshaw, Glenlyon and Texas LSs, usually on intermediate slopes. *Callitris columellaris* forms a slightly lower patchy tree layer. Shrubs are not common except in a small area in Bonshaw LS where *Cadellia pentastylis*, *Geijera parviflora* and *Carissa ovata*, all of which are characteristic of communities farther inland, form moderately dense lower layers. Ground cover, mainly *Bothriochloa decipiens*, is not dense.

In the lower traprock areas *E. melanophloia* grades into *E. melanophloia-E. dealbata* communities on the upper slopes (the two communities are mapped together), and into *E. microcarpa-E. melliodora* communities on lower slopes. *E. melliodora* may sometimes be a significant component of the community even on intermediate slopes, particularly in Glenlyon LS.

On basalt hills east of Inglewood in Devine LS a small area of *E. melanophloia-Callitris columellaris* with a dense shrub layer of *Geijera parviflora* and a dense ground cover of *Dichanthium sericeum* occurs.

E. melanophloia is the commonest tree species over much of the southern part of the area. Communities with it as a major element correspond to *E. crebra* communities widespread in the north. The two species rarely grow together.

8.4.12 *Eucalyptus melanophloia-E. dealbata*

The two species form a woodland only 10-12 m tall on upper slopes in Bonshaw and Glenlyon LSs. There are usually scattered lower trees of *Callitris columellaris* and sometimes shrubs of *Olearia elliptica* and *Cassinia laevis*, but on the whole lower layers are not well developed. Ground cover of *Aristida ramosa*, *Cymbopogon refractus* and *Bothriochloa decipiens* is rather sparse.

In Arcot LS *Eucalyptus albens* occurs with *E. melanophloia* and *E. dealbata* and there is also a dense shrub layer with *Acacia leiocalyx*, *Cassinia quinquefaria*, *Dodonaea attenuata* and *Olearia elliptica* most common.

8.4.13 *E. dealbata-E. laevopinea*

This community consists of an upper layer 10-15 m tall of *Eucalyptus dealbata* and *E. laevopinea*, occasionally with some *Angophora floribunda*, *Callitris* spp. (commonly *C. endlicheri*) forms a dense lower tree layer up to 8 m tall in most places and there is a varied shrub layer. *Jacksonia scoparia*, *Acacia* spp., *Leptospermum attenuatum* and *Leucopogon* spp. are the commonest species. Ground cover is low, *Dichelachne micrantha* and *Danthonia racemosa* being the commonest species.

The community is best developed on the hills of Magnus and Severnlea LSs but extends to Roberts LS where *Acacia pubifolia* is conspicuous in the lower tree layer.

8.4.14 *E. andrewsii-E. tereticornis*

This woodland association may prove to be only equivalent to one of the components of the *E. andrewsii* complex discussed below, but because it has a distinctive appearance due to the presence of *E. tereticornis* and can be mapped, it is described separately.

The upper layer consists of *E. andrewsii* and *E. tereticornis* 14-15 m tall. *Angophora floribunda, E. punctata* and *E. microcarpa* occur only occasionally. A moderately dense lower tree layer 5-8 m tall is developed consistently. It consists of species of *Acacia*, usually *A. implexa* often with *A. irrorata* or *A. leucoclada*.

8.4.15 *Eucalyptus andrewsii* Complex

This is a complex of related communities rather than a single community, and, using more refined survey techniques than those employed, it is likely that it could be broken down into several less heterogeneous components. It is floristically rich with the composition and density of the lower layers altering greatly from place to place.

The upper layer of this woodland is 15-20 m tall (up to 25 m on the eastern edge) and consists usually of *E. andrewsii* with *E. laevopinea, E. dealbata, E. microcarpa, E. deanei* and *Angophora floribunda* in smaller numbers and varying considerably from site to site. The lower tree layers vary in composition and height. Where *Callistris columellaris* occurs other species are not conspicuous, but in places *Acacia filicifolia, A. adunca, A. implexa* or *Exocarpos cupressiformis* may form dense stands. Conspicuous shrubs are *Jacksonia scoparia, Acacia betchei, Daviesia latifolia* and *Leucopogon* spp. The ground cover is low. *Danthonia racemosa* and *Dichelachne micrantha* are probably the commonest species in most places.

The *Eucalyptus andrewsii* complex is restricted to the elevated granite area particularly in Eukey and Norman LSs.

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8.5 List of Species mentioned in the Text and in Section 3

DICOTYLEDONS

Apocynaceae	
Carissa ovata R.Br.	Currant Bush
Casuarinaceae	
Casuarina cristata Miq.	Belah
C. inophloia (F.Muell.) F.M. Bailey	Thready-bark Oak
C. luehmannii R.T. Baker	Bull Oak
Compositae	
Cassinia laevis R.Br.	Wild Rosemary or Cough Bush
C. quinquefaria R.Br.	Wild Rosemary or Cough Bush
Helichrysum diosmifolium (Vent.) Sweet	
Olearia elliptica DC.	Peach Bush or Sticky Daisy Bush
Epacridaceae	
Leucopogon melaleucoides A. Cunn. ex DC.	a Beard Heath
Euphorbiaceae	
Petalostigma pubescens Domin	Quinine Bush
Flindersiaceae	
Flindersia collina F.M. Bailey	Broad-leaf Leopard Tree
Leguminosae	
Acacia adunca A. Cunn. ex G. Don	
A. betchei Maiden & Blakely	
A. crassa Pedley	
A. deanei (R.T. Baker) Welch et al.	Green Wattle
A. decora Reichenb.	Pretty Wattle
A falcata Willd.	
A. filicifolia Cheel & Welch	
A. fimbriata A. Cunn. ex G. Don	Brisbane Golden Wattle
A. harpophylla F.Muell.	Brigalow
A. implexa Benth.	Lightwood
A. irrorata Sieb. ex Spreng.	
A. ixiophylla Benth	
A. leiocalyx (Domin) Pedley	
A. leucoclada Tindale	
A. neriifolia A. Cunn. ex Benth.	
A. pubifolia Pedley	
A. semilunata Maiden & Blakely	
A. sparsiflora Maiden	Currawong
Daviesia mimosoides R.Br.	
D. squarrosa Smith	
Jacksonia scoparia R.Br.	Dogwood
Moraceae	
Ficus platypoda A. Cunn. ex Miq.	Small-leaf Moreton Bay Fig
Myoporaceae	
Eremophila mitchellii Benth.	Budda or Bastard Sandalwood
Myoporum deserti A. Cunn. ex Benth.	Ellangowan Poison Bush
Myrtaceae	
Angophora costata (Gaertn.) J. Britten	Rusty Gum
A. floribunda (Smith) Domin	Rough-barked Apple

DICOTYLEDONS (continued)

Myrtaceae (continued)

Angophora subvelutina F. Muell.	Broad-leaved Apple
Eucalyptus albens Benth.	White Box
E. andrewsii Maiden	New England Blackbutt
E. bakeri Maiden	Baker's Mallee
E. blakelyi Maiden	Blakely's Red Gum
E. bridgesiana R.T. Baker	
E. caleyi Maiden	Caley's Ironbark
E. caliginosa Blakely & McKie	Broad-leaved Stringybark
E. camaldulensis Dehn.	River Red Gum
E. conica Deane & Maiden	Fuzzy Box
E. crebra F. Muell.	Narrow-leaved Ironbark
E. dealbata A. Cunn. ex Schau.	Tumble-down Gum, Hill Gum or Mountain Gum
E. deanei Maiden	Deane's Gum
E. dunnii Maiden	Dunn's White Gum
E. exserta F. Muell.	Bendo or Queensland Peppermint
E. exserta F. Muell. var. *parvula* Blakely	
E. laevopinea R.T. Baker	Silver-top Stringybark
E. maculata Hook.	Spotted Gum
E. melanophloia F. Muell.	Silver-leaved Ironbark
E. melliodora A. Cunn. ex Schau.	Yellow Box
E. microcarpa Maiden	Brown Box
E. nova-anglica Deane & Maiden	New England Peppermint
E. nubila Maiden & Blakely	Dusky-leaved Ironbark
E. panda S.T. Blake	Tumble-down Ironbark
E. pilligaensis Maiden	Mallee Box
E. polycarpa F. Muell.	Long-fruited Bloodwood
E. populnea F. Muell.	Poplar Box
E. punctata DC.	Grey Gum
E. radiata Sieb. ex DC.	Narrow-leaved Peppermint
E. scoparia Maiden	Wallangarra White Gum
E. siderophloia Benth.	Broad-leaved ironbark
E. sideroxylon A. Cunn. ex Woolls	Mugga
E. tereticornis Smith	Blue Gum
E. trachyphloia F. Muell.	Brown Bloodwood
E. viridis R.T. Baker	Green Mallee
E. youmanii Blakely & McKie	Youman's Stringybark

DICOTYLEDONS (continued)

Myrtaceae (continued)	
Leptospermum arachnoides Gaertn.	
L. attenuatum Smith	Slender Tea-tree
L. flavescens Smith	Common Tea-tree
Oleaceae	
Notelaea microcarpa R.Br.	Native Olive
Pittosporaceae	
Citriobatus spinescens (F. Muell.) Druce	Wallaby Apple
Proteaceae	
Banksia integrifolia L.f.	Banksia or Honeysuckle Oak
Rhamnaceae	
Alphitonia excelsa (Fenzl.) Benth.	Red Ash
Rutaceae	
Geijera parviflora Lindl.	Wilga
Santalaceae	
Choretrum candollei F. Muell. ex Benth.	
Exocarpos cupressiformis Labill.	Native Cherry
Santalum lanceolatum R.Br.	Plumwood
Sapindaceae	
Dodonaea attenuata A. Cunn.	Hop Bush
Heterodendrum diversifolium F. Muell.	Scrub Boonaree
Simaroubaceae	
Cadellia pentastylis F. Muell.	Ooline
Thymeliaceae	
Pimelea pauciflora R. Br.	Poison Pimelea

MONOCOTYLEDONS

Cyperaceae	
Cyperus spp.	Sedges
Gramineae	
Ancistrachne uncinulata (R.Br.) S.T. Blake	Hooky Grass
Aristida caput-medusae Domin	Many-headed Wire Grass
A. ramosa R.Br.	
Bothriochloa decipiens (Hack.) C.E. Hubbard	Pitted Blue Grass
Chloris ventricosa R.Br.	Tall Chloris
Danthonia linkii Kunth	Wallaby Grass
D. racemosa R.Br.	
Dichanthium sericeum (R.Br.) A. Camus	Queensland Blue Grass
Dichelachne micrantha (Cav.) Domin	Short-hair Plume Grass
Enneapogon spp.	Bottle-Washer Grasses
Enteropogon acicularis (Lind.) Lazarides	Curly Windmill Grass
Eragrostis spp.	Love Grasses
Imperata cylindrica (L.) Beauv. var. *major* (Nees) C.E. Hubbard	Blady Grass
Paspalidium spp.	
Paspalum dilatatum Poir.	Paspalum
Stipa scabra Lindl.	Rough Spear Grass
S. verticillata Nees	Slender Bamboo Grass

MONOCOTYLEDONS (continued)

Gramineae (continued)	
Themeda australis (R.Br.) Stapf	Kangaroo Grass
Juncaceae	
Juncus spp.	Reeds
Xanthorrhoeaceae	
Xanthorrhoea australis R.Br.	Grass-tree

CONIFERS

Cupressaceae	
Callitris columellaris F. Muell.	White Cypress Pine
C. endlicheri (Parl.) F.M. Bailey	Black Cypress Pine

9 FAUNA OF THE GRANITE AND TRAPROCK AREA

by T.H. Kirkpatrick

APPENDICES

The Granite and Traprock Area of South-East Queensland - A Land Inventory and Land Utilisation Study, Division of Land Utilisation, Technical Bulletin No. 13, Queensland Department of Primary Industries, Brisbane, 1976.

9 FAUNA OF THE GRANITE AND TRAPROCK AREA

by T.H. Kirkpatrick*

For the purposes of this report, the mammal and bird fauna of the region is divided into the following two groups:

'A' species which are widely distributed and found virtually throughout the entire region.

'B' species which are of restricted distribution, found only in some small part of the region.

For fauna classification purposes this division is appropriate because the habitat of the region is fairly uniform. Apart from wetland species, which of course require water, the distribution of most species is governed primarily by vegetation and to a much lesser extent soils and topography. The vegetation of practically the entire region is either an open eucalypt forest or a grassland resulting from clearing of the open forest. In the following list (Appendix 9.1), species present are given the appropriate A or B rating, and distribution of the B labelled species is given in the notes on each land system (Appendix 9.2).

9.1 Mammals and Birds

The fauna of the region is typical of that found in southern subcoastal Queensland. Most species occur throughout the region, wherever suitable living conditions occur. A few species are of particular interest - the attractive turquoise parrot, commonly considered a scarce species in Queensland, occurs throughout the district and is in places quite common. The only occurrence of the superb lyrebird in Queensland is in the south-eastern corner of the region, similarly for the common wombat. The introduced fallow deer is widespread in Pikedale LS, with some spread into the adjacent Jibbinbar LS and Glenlyon LS. The caves of the Glenlyon LS harbour large numbers of the bent-winged bat.

The presence of the introduced rabbit has undoubtedly had an effect on the small ground-living mammals of the region. At least two species have suffered - the rufous rat-kangaroo which seems to be no longer present, and the brush-tailed rock wallaby which has been dramatically reduced in numbers.

The flying fox and some birds, including the silver eye and the eastern rosella are regarded as serious pests by orchardists of the district. No really satisfactory methods of control are available. However as damage is normally confined to ripe or ripening fruit, and much of the fruit is picked while still unripe, orchardists generally are able to live with the pest problem.

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* Queensland National Parks and Wildlife Service. Text prepared when author was a member of Fauna Conservation Branch, Department of Primary Industries.

Occasionally, damage is caused by wallabies gnawing at the bark of fruit trees during winter. Adequate fencing to exclude the animals is probably the best method of control.

Two far western species, the emu and the red kangarco are known to extend into the western edge of the region, but only the emu has been found in recent surveys. However there is no reason to believe that the red kangaroo will not reappear in the Texas LS, Magee LS, Bundella LS and Devine LS in suitable years. This is certainly only the fringe of the range of this species.

Although the waterbirds are all listed as occurring throughout the region, the waders, particularly, are seldom found away from large bodies of water with shallow margins.

The only such bodies of water in the district are the artificially-created lakes of Leslie Dam (Ironpot LS), Coolmunda Dam (Devine LS and Warroo LS) and Storm King Dam (Eukey LS). Especially in dry times these lakes become centres of concentration for all wetland species.

APPENDIX 9.1

LIST OF MAMMALS PRESENT

Bat, Bent-winged	*Miniopterus schreibersii*	(OF) (B)*
Bat, Grey's	*Nycticeius greyi*	(OF) (A)
Bat, Horseshoe	*Rhinolophus megaphyllus*	(OF) (B)
Bat, Little Brown	*Eptesicus pumilis*	(OF) (A)
Bat, Little Red Fruit	*Pteropus seapulatus*	(OF) (A)
Cat	*Felis catus*	(OF,G) (A)
Cat, Tiger	*Dasyurops maculatus*	(OF) (A)
Deer, Fallow	*Cervus dama*	(OF,G) (A)
Dingo	*Canis dingo*	(OF) (A)
Echidna	*Tachyglossus aculeatus*	(OF) (A)
Fox	*Vulpes vulpes*	(OF,G) (A)
Glider, Greater	*Schoinobates volans*	(OF) (B)
Glider, Pigmy	*Acrobates pygmaeus*	(OF) (A)
Goat	*Capra hircus*	(OF) (A)
Hare	*Lepus europaeus*	(OF,G) (A)
Kangaroo, Grey	*Macropus gigantus*	(OF) (A)
Koala	*Phascolarctos cinereus*	(OF) (A)
Mouse, Marsupial	*Antechinus flavipes*	(OF) (A)
Phascogale	*Phascogale tapoatafa*	(OF) (A)
Pig	*Sus scrofa*	(OF) (A)
Pipistrel	*Pipistrellus tasmaniensis*	(OF) (A)
Platypus	*Ornithorhynchus anatinus*	(W) (A)
Possum, Grey Brush-tailed	*Trichosurus vulpecula*	(OF) (A)
Rabbit	*Oryclotagus cuniculus*	(OF,G) (B)
Rat, Ship	*Rattus rattus*	(OF,G) (A)
Rat, Water	*Hydromys chrysogaster*	(W) (A)
Ringtail, Grey	*Pseudocheirus peregrinus*	(OF) (B)
Sminthopsis	*Sminthopsis murina*	(OF) (A)
Wallaby, Red-necked	*Macropus rufogrisea*	(OF) (A)
Wallaby, Rock	*Petrogale penicillata*	(OF) (B)
Wallaby, Swamp	*Wallabia bicolor*	(OF) (A)
Wallaby, Whiptail	*Macropus parryi*	(OF) (B)
Wallaroo	*Macropus robustus*	(OF) (A)
Wombat, Common	*Vombatus hirsutus*	(OF) (B)

* Key to Abbreviations

A - widely distributed.

B - of restricted distribution.

OF - open forest.

G - grassland/cultivation.

U - urban.

W - water.

APPENDIX 9.2

LIST OF BIRDS PRESENT

Avocet	*Recurvirostra novaehollandiae*	(W) (A)
Babbler, Grey-crowned	*Pomatostomus temporalis*	(OF) (A)
Babbler, White-crowned	*Pomatostomus superciliosus*	(OF) (B)
Bird, Apostle	*Struthidea cinerea*	(OF) (A)
Bird, Little Friar	*Phileman citreogularis*	(OF) (A)
Bird, Mistletoe	*Dicaeum hirundinaceum*	(OF) (A)
Bird, Noisy Friar	*Philemon corniculatus*	(OF) (A)
Bird, Rainbow	*Merops ornatus*	(OF) (G) (A)
Bronzewing, Common	*Phaps chalcoptera*	(OF) (A)
Budgerigar	*Melopsittacus undulatus*	(G) (B)
Bushlark, Singing	*Mirafra javanica*	(OF) (G) (A)
Butcher-bird, Grey	*Cracticus torquatus*	(OF) (A)
Butcher-bird, Pied	*Cracticus nigrogularis*	(OF) (A)
Chough, White-winged	*Corcorax melanorhamphos*	(OF) (A)
Cockatiel	*Nymphicus hollandicus*	(OF) (G) (A)
Cockatoo, Glossy Black	*Calyptorhynchus lathami*	(OF) (B)
Cockatoo, Sulphur-crested	*Cacatua galerita*	(OF) (G) (A)
Cockatoo, Yellow-tailed Black	*Calyptorhynchus funereus*	(OF) (A)
Coot	*Fulica atra*	(W) (A)
Corella, Little	*Cacatua sanguinea*	(G) (B)
Cormorant, Black	*Phalacrocorax carbo*	(W) (A)
Cormorant, Little Black	*Phalacrocorax sulcirostris*	(W) (A)
Cormorant, Little Pied	*Phalacrocorax melanoleucos*	(W) (A)
Cormorant, Pied	*Phalacrocorax varius*	(W) (A)
Crow, Australian	*Corvus orru*	(OF) (A)
Cuckoo, Channel-billed	*Scythrops novaehollandiae*	(OF) (A)
Cuckoo, Fan-tailed	*Cacomantis pyrrhophanus*	(OF) (A)
Cuckoo, Horsfield Bronze	*Chrysococcyx basalis*	(OF) (G) (A)
Cuckoo, Pallid	*Cuculus pallidus*	(OF) (A)
Cuckoo-shrike, Black Faced	*Coracina novaehollandiae*	(OF) (A)
Cuckoo-shrike, Ground	*Pteropodocys maxima*	(G) (A)
Curlew, Southern Stone	*Burhinus magnirostris*	(OF) (A)
Currawong, Pied	*Strepera graculina*	(OF) (A)
Darter	*Anhinga anhinga*	(W) (A)
Dotterel, Black-fronted	*Charadrius melanops*	(W) (A)
Dove, Bar-shouldered	*Geopelia humeralis*	(OF) (B)
Dove, Diamond	*Geopelia cuneata*	(OF) (A)
Dove, Indian Spotted	*Streptopelia chinensis*	(U) (B)
Dove, Peaceful	*Geopelia striata*	(OF) (A)
Drongo, Spangled	*Dicrurus hottentottus*	(OF) (A)
Duck, Black	*Anas superciliosa*	(W) (A)
Duck, Musk	*Biziura lobata*	(W) (A)
Duck, Pink-eared	*Malacorhynchus membranaceus*	(W) (A)
Duck, Water Whistling	*Dendrocygma arcuata*	(W) (A)
Duck, White-eared	*Aythya australis*	(W) (A)
Eagle, Australian Little	*Hieraaetus morphnoides*	(OF) (G) (A)
Eagle, Wedge-tailed	*Aquila audax*	(OF) (G) (A)
Eagle, Whistling	*Haliastur sphenurus*	(OF) (G) (W) (A)
Egret, Little	*Egretta garzetta*	(W) (A)
Emu	*Dromaius novaehollandiae*	(OF) (G) (B)
Falcon, Little	*Falco longipennis*	(OF) (G) (A)
Falcon, Peregrine	*Falco peregrinus*	(OF) (A)
Fantail, Grey	*Rhipidura fuliginosa*	(OF) (A)
Fantail, Rufous	*Rhipidura rufifrons*	(OF) (B)
Finch, Banded	*Stizoptera bichenovii*	(OF) (A)
Finch, Plum-headed	*Aidemosyne modesta*	(OF) (G) (A)
Finch, Red-browed	*Aegintha temporalis*	(OF) (B)
Finch, Zebra	*Taeniopygia guttata*	(OF) (G) (A)

LIST OF BIRDS PRESENT (Continued)

Firetail, Diamond	*Zonaeginthus guttatus*	(OF)(G)(A)
Flycatcher, Leaden	*Myiagra rubecula*	(OF)(A)
Flycatcher, Restless	*Seisura inquieta*	(OF)(A)
Frogmouth, Tawny	*Podargus strigoides*	(OF)(A)
Galah	*Cacatua roseicapilla*	(OF)(G)(A)
Goldfinch	*Carduelis carduelis*	(G)(B)
Goshawk, Australian	*Accipiter fasciatus*	(OF)(A)
Grassbird, Tawny	*Megalurus timoriensis*	(OF)(G)(A)
Grebe, Crested	*Podiceps cristatus*	(W)(A)
Grebe, Little	*Podiceps ruficollis*	(W)(A)
Gull, Silver	*Larus novaehollandiae*	(W)(A)
Harrier, Spotted	*Circus assimilis*	(G)(A)
Hawk, Brown	*Falco berigora*	(OF)(G)(A)
Hen, Black-tailed Native	*Tribonyx ventralis*	(W)(A)
Heron, Nankeen Night	*Nycticorax caledonicus*	(OF)(W)(A)
Heron, White-faced	*Ardea novaehollandiae*	(W)(G)(A)
Heron, White-necked	*Ardea pacifica*	(G)(W)(A)
Honeyeater, Black-chinned	*Melithreptus gularis*	(OF)(A)
Honeyeater, Blue-faced	*Entomyzon cyanotis*	(OF)(A)
Honeyeater, Brown	*Lichmera indistincta*	(OF)(A)
Honeyeater, Brown-headed	*Melithreptus brevirostris*	(OF)(A)
Honeyeater, Fuscous	*Melpihaga fusca*	(OF)(A)
Honeyeater, Regent	*Xanthomyza phrygia*	(OF)(A)
Honeyeater, Spiny-cheeked	*Acanthagenys rufogularis*	(OF)(A)
Honeyeater, White-eared	*Meliphaga leucotis*	(OF)(A)
Honeyeater, White-fronted	*Phylidonyris albifrons*	(OF)(A)
Honeyeater, White-naped	*Melithreptus lunatus*	(OF)(A)
Honeyeater, Yellow-faced	*Meliphaga novaehollandiae*	(OF)(A)
Honeyeater, Yellow-tufted	*Meliphaga melanops*	(OF)(A)
Ibis, Australian White	*Threskiornis molucca*	(G)(A)
Ibis, Straw Necked	*Threskiornis spinicollis*	(OF)(G)(A)
Kestrel, Nankeen	*Falco cenchroides*	(OF)(G)(A)
Kingfisher, Azure	*Alcyone azurea*	(W)(A)
Kingfisher, Forest	*Halcyon macleayii*	(OF)(A)
Kingfisher, Sacred	*Halcyon australasiae*	(OF)(A)
Kite, Black-shouldered	*Elanus notatus*	(OF)(G)(A)
Kite, Square-tailed	*Lophoictinia isura*	(OF)(G)(B)
Kookaburra, Laughing	*Dacelo novaeguineae*	(OF)(A)
Lark, Magpie	*Grallina cyanoleuca*	(OF)(A)
Lorikeet, Little	*Glossopsitta pusilla*	(OF)(A)
Lorikeet, Musk	*Glossopsitta concinna*	(OF)(B)
Lorikeet, Rainbow	*Trichoglossus haematodus*	(OF)(A)
Lorikeet, Scaly-breasted	*Trichoglossus chlorolepidotus*	(OF)(A)
Lyrebird, Superb	*Menura superba*	(OF)(B)
Magpie, Black-backed	*Gymnorhina tibicen*	(OF)(A)
Martin, Fairy	*Petrochelidon ariel*	(OF)(G)(A)
Martin, Tree	*Petrochelidon nigricans*	(OF)(A)
Miner, Noisy	*Myzantha melanocephala*	(OF)(A)
Moorhen, Dusky	*Gallinula tenebrosa*	(W)(A)
Nightjar, Spotted	*Eurostopodus guttatus*	(OF)(A)
Oriole, Olive-backed	*Oriolus sagittatus*	(OF)(B)
Owl, Barn	*Tyto alba*	(OF)(G)(A)
Owl, Boobook	*Ninox novaeseelandiae*	(OF)(G)(A)
Owlet-Nightjar	*Aegotheles cristatus*	(OF)(A)
Pardalote, Black-headed	*Pardalotus melanocephalus*	(OF)(A)
Pardalote, Spotted	*Pardalotus punctatus*	(OF)(A)
Pardalote, Striated	*Pardalotus substriatus*	(OF)(A)
Parrot, King	*Alisterus scapularis*	(OF)(G)(A)
Parrot, Red-winged	*Aprosmictus erythropterus*	(OF)(G)(B)
Parrot, Turquoise	*Neophema pulchella*	(OF)(A)
Pelican	*Pelecanus conspicillatus*	(W)(A)
Pigeon, Crested	*Ocyphaps lophotes*	(OF)(G)(A)
Pigeon, Feral	*Columba livia*	(U)(G)(A)
Pigeon, Wonga	*Leucosarcia melanoleuca*	(OF)(B)

LIST OF BIRDS PRESENT (Continued)

Pipit, Australian	*Anthus novaeseelandiae*	(G)(A)
Plover, Banded	*Vanellus tricolor*	(OF)(G)(A)
Plover, Spur-winged	*Vanellus novaehollandiae*	(G)(W)(A)
Quail, Brown	*Coturnix ypsilophorus*	(G)(A)
Quail, Painted Button	*Turnix varia*	(OF)(G)(A)
Quail, Stubble	*Coturnix pectoralis*	(G)(A)
Quail-thrush, Spotted	*Cinclosoma punctatum*	(OF)(B)
Raven, Australian	*Corvus coronoides*	(OF)(A)
Robin, Hooded	*Petroica cucullata*	(OF)(A)
Robin, Scarlet	*Petroica multicolor*	(OF)(A)
Robin, Yellow	*Eopsaltria australis*	(OF)(B)
Roller, Eastern Broad-billed	*Eurystomus orientalis*	(OF)(G)(A)
Rosella, Crimson ·	*Platycercus elegans*	(OF)(G)(A)
Rosella, Eastern	*Platycercus eximius*	(OF)(G)(A)
Rosella, Pale-headed	*Platycercus adscitus*	(OF)(G)(A)
Scrub-wren, White-browed	*Sericornis frontalis*	(OF)(B)
Silvereye, Grey-breasted	*Zosterops lateralis*	(OF)(B)
Sitella, Orange-winged	*Neositta chrysoptera*	(OF)(A)
Snipe, Australian Painted	*Rostratula bengalensis*	(W)(A)
Songlark, Rufous	*Cincloramphus mathewsi*	(G)(A)
Sparrow, House	*Passer domesticus*	Towns only
Sparrowhawk, Collared	*Accipiter cirrhocephalus*	(OF)(A)
Squatter	*Geophaps scripta*	(OF)(A)
Starling	*Sturnus vulgaris*	(OF)(A)
Stilt, White-headed	*Himantopus himantopus*	(W)(A)
Swallow, Welcome	*Hirundo tahitica*	(OF)(A)
Swamphen	*Porphyrio porphyrio*	(W)(A)
Swan, Black	*Cygnus atratus*	(W)(A)
Swift, Spine-tailed	*Chaetura caudacuta*	(OF)(A)
Teal, Grey	*Anas gibberifrons*	(W)(A)
Tern, Marsh	*Chlidenias hybrida*	(W)(A)
Thornbill, Buff-tailed	*Acanthiza reguloides*	(OF)(A)
Thornbill, Brown	*Acanthiza pusilla*	(OF)(A)
Thornbill, Little	*Acanthiza nana*	(OF)(A)
Thornbill, Striated	*Acanthiza lineata*	(OF)(A)
Thornbill, Yellow-tailed	*Acanthiza chrysorrhoa*	(OF)(A)
Tit, Shrike	*Falcunculus frontatus*	(OF)(A)
Tree-creeper, Brown	*Climacteris picumnus*	(OF)(A)
Tree-creeper, White-throated	*Climacteris leucophaea*	(OF)(A)
Triller, Jardine	*Coracina tenuirostris*	(OF)(A)
Triller, Varied	*Lalage leucomela*	(OF)(A)
Triller, White-winged	*Lalage sueurii*	(OF)(A)
Turkey, Brush	*Alectura lathami*	(OF)(A)
Wagtail, Willie	*Rhipidura leucophrys*	(OF)(A)
Warbler, Brown	*Gerygone igata*	(OF)(A)
Warbler, Reed	*Acrocephalus stentoreus*	(OF)(G)(A)
Warbler, Speckled	*Chthonicola sagittata*	(OF)(A)
Warbler, White-throated	*Gerygone olivacea*	(OF)(A)
Wattle-bird, Little	*Anthochaera chrysoptera*	(OF)(B)
Wattle-bird, Red	*Anthochaera carunculata*	(OF)(B)
Weebill	*Smicrornis brevirostris*	(OF)(A)
Whistler, Golden	*Pachycephala pectoralis*	(OF)(B)
Whistler, Rufous	*Pachycephala rufiventris*	(OF)(A)
Whiteface	*Aphelocephala leucopsis*	(OF)(B)
Winter, Jacky	*Microeca leucophaea*	(OF)(A)
Wood-swallow, Black-faced	*Artamus cinereus*	(OF)(A)
Wood-swallow, Dusky	*Artamus cyanopterus*	(OF)(A)
Wood-swallow, Little	*Artamus minor*	(OF)(A)
Wood-swallow, Masked	*Artamus personatus*	(OF)(A)
Wood-swallow, White-breasted	*Artamus leucorhynchus*	(OF)(A)
Wood-swallow, White-browed	*Artamus superciliosus*	(OF)(A)
Wren, Superb Blue	*Malurus cyaneus*	(OF)(A)

APPENDIX 9.3

DISTRIBUTION OF SPECIES

Land Systems	Species
Roberts Norman Eukey Washpool	Most A species, all B species except fallow deer, the goldfinch and those species found in western land systems.
Severnlea	Most A species, all B species except fallow deer and those species found in western land systems.
Summit Magnus Arcot Bonshaw	Most A species and rabbits.
Jibbinbar Pikedale	Most A species, rabbits and fallow deer.
Glenlyon	Most A species, rabbits and bats listed as B species, which occur in the Glenlyon cave system.
Ironpot	Most A species, no rabbits.
Canal	Most A species and emus.
Thane	Most A species, B species include yellow robin, white-browed babbler, whiteface, emus in the north-west corner. No rabbits.
Evandale	Most A species.
Gore	Most A species. B species include rabbit, corella and red-winged parrot.
Warroo	Most A species. B species include rabbit, emu and possibly fallow deer.
Texas Magee Bundella Devine	Most A species. B species include rabbit, emu, corella, red-winged parrot and red kangaroo in some years.

ALPHABETIC INDEX TO LAND SYSTEMS

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