Biodiversity Conservation at the Bioregional Level

a case study from the Burt Plain Bioregion of Central Australia

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DECLARATION

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program.

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ABSTRACT

This thesis considers ways to improve biodiversity conservation at the bioregional level in Australia through the use of geospatial science technologies and biological modelling techniques. Following a review of approaches to biodiversity conservation at the bioregional level, including the roles and potential of geospatial science technologies in this regard, I consider biodiversity modelling using a case study of the Burt Plain bioregion in central Australia that focuses on selected taxa, ecosystems and landscapes. The Burt Plain bioregion was chosen since it is one of 19 bioregions nationally that has been given a 'very high' priority status for biological survey, assessment and potential reservation of land for conservation purposes.

The specific research objectives for the Burt Plain bioregion study were to:

- describe the species composition, distribution and nature of the dominant vegetation communities within the bioregion;
- characterise environmental niche of communities with respect to selected environmental and management variables – latitude, longitude, climate, land systems and land units, geology, hydrography, topography, and tenure;
- analyse how well or otherwise taxa have been sampled (during previous ground surveys) with respect to geographical and environmental variables;

- develop and compare quantitative habitat models of the potential distribution of selected species based on presence-only distributional data; and
- examine the significance of radiometric data as a potential correlate and predictor of the distribution of those selected species.

National conservation initiatives such as the bioregional approach and international initiatives such as the biosphere reserves program to support the planning and management of biodiversity conservation are discussed in chapter two. The scientific and related processes underpinning the development of bioregions and strategies across the Australian states and territories are then considered. An important finding arising from this review is the need to improve biological information, especially through systematic surveys and on-going monitoring of ecosystems and populations of species, at the bioregional level to inform land use allocation and management. This finding is consistent with one of the general aims of the thesis to improve the spatial modelling techniques available for bioregional assessment and biodiversity conservation.

In chapter three I review the role and limitations of geospatial technologies currently employed for biodiversity conservation management. Current developments and applications of GIS and remote sensing to wildlife research, conservation gap analysis and conservation reserve design are considered. Geographic information systems (GIS) are now routinely used by ecologists to

analyse spatial data. Although various forms of GIS have been available for 15 to 25 years, the biological applications of GIS have figured most prominently in the ecological literature only in the past 15 years. The use of computer-generated models to simulate environmental events can provide a greater understanding of ecosystems, and offers improved predictive powers to conservation and land managers. The decision support offered by computer-based modelling techniques appears likely to underpin conservation and management decisions much more into the future providing that adequate biological and other datasets are available for this purpose.

Dominant vegetation communities and various environmental gradients were analysed to characterise environmental niches at the bioregional scale for the Burt Plain bioregion (Chapter 4) and more locally at the catchment scale for the Upper Todd River Catchment (Chapter 5). In Chapters four and five I describe in detail the land tenure and use, land systems, climate soil, geology, topography, hydrology, vegetation and biodiversity of the Burt Plain bioregion and Upper Todd River Catchment. The bioregion contains some ephemeral watercourses, which are generally in fair to good condition, but are afforded little protection from a range of threatening processes, including grazing and trampling by feral animals and livestock and weed infestation. The major river systems occurring in the bioregion include parts of the Plenty, Hanson, Sandover and Lander Rivers. In the Upper Todd River Catchment the major watercourses

are the Todd River and Station Creek, which exit the area via two narrow gaps in the low rocky hills on the southern boundary of the bioregion. The dominant geology can be summarised as plains and low rocky ranges of Pre-Cambrian granites on red earths. The bioregion has approximately 200 - 250 mm of summer rainfall, with rainfall occurring on 20 - 30 days per year. There is a high variability and range of temperatures, with an annual mean temperature of approximately 22-23°C.

In Chapter six I consider a range of species found within the Burt Plain bioregion using existing survey data and techniques that enables the prediction of the spatial distribution of taxa. Using GLM and GAM models, Black-footed Rock-Wallaby *(Petrogale lateralis),* Spinifex Hopping Mouse *(Notomys alexis)* and Spencers Frog *(Limnodynastes spenceri)* were chosen for a more in-depth analysis. Environmental variables correlated with the presence of each species are then described and prediction maps showing the probability or likelihood of the presence of the species within the bioregion developed.

In Chapter seven I examine the utility of radiometric data for wildlife habitat modelling. Statistical relationships are tested between the concentrations of the elements uranium, thorium and potassium and terrain characteristics such as position in the landscape, slope and aspect as well as other climatic variables. Radiometric data were found to be useful for developing statistical predictive

models of six species: Red Kangaroo (*Macropus rufus),* Desert Dunnart *(Sminthopsis youngsoni),* Rabbit *(Orcytolagus cuniculus),* Brown Honeyeater *(Lichmera indistincta),* Little Spotted Snake *(Suda punctata)* and Southern Boobook *(Ninox novaeseelandiae).* I suggest that the utility of radiometric data for wildlife habitat modelling would appear significant and should be explored further using alternative quantitative modelling techniques and presence/ absence records for target faunal species. Predictions of species distributions may be useful for prioritising land acquisitions for reservation as well as in the future design of biological surveys.

The thesis concludes with a synthesis of the major research findings, discussion of the limitations of the datasets available for the study, perspectives on management issues in the Burt Plain bioregion, and possible future research directions. It is important that purposefully-designed biological survey research be undertaken across the bioregions of the arid zone of Australia to enhance basic understanding of biodiversity patterns and their relationships to environmental heterogeneity and site-landscape level processes. Geospatial modelling techniques can assist such biodiversity survey and evaluation and make their conduct more cost-efficient and the inferences drawn from subsequent data analyses more powerful. This knowledge is required to contribute to the emergent concepts and theory of ecosystem dynamics and associated biodiversity patterns in arid Australia and, most significantly, to

enhance the conservation and management of the unique biological complement and systems found in this region.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ACT	Australian Capital Territory
AMG	Australian Map Grid
ANCA	Australian Nature Conservation Agency
ANZECC	Australian and New Zealand Environment Conservation Council
ASCII	American Standard Code for Information Interchange
AUSLIG	Australasian Surveying & Land Information Group
AVHRR	Advanced Very High Resolution Radiometer
AVIRIS	Airborne Visible/Infrared Imaging Spectrometer
BRS	Biological Records Scheme
CAR	Comprehensive, Adequacy and Representativeness
CANRI	Community Access to Natural Resources Information
CORINE	CoORdination of Information on the Environment
CRA	Comprehensive Regional Assessment
CRES	Centre Resource and Environment Studies
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CZAR	Centre for Arid Zone Research
DD	Decimal degrees
DEH	Department of Environment and Heritage
DEM	Digital Elevation Model
DLPE	Department of Lands, Planning & Environment, Northern Territory
DOLA	Department of Land Administration, Western Australia
DTM	Digital Terrain Model
EPBC	Environment Protection and Biodiversity Conservation
ERIN	Environmental Resources Information Network
ESOCLIM	Estimation of Climate
ESRI	Environmental Systems Research Institute

GAM	Generalised Additive Model
GARP	Genetic Algorithms for Rule Production
GIS	Geographic Information System
GLM	Generalised Linear Model
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation of Australia
ICM	Integrated Catchment Management
IUCN	International Union for the Conservation of Nature and Natural Resources
IMCRA	Interim Marine and Coastal Regionalisation of Australian
IPA	Indigenous Protected Areas
MA	Millennium Ecosystem Assessment
MAB	Man and Biosphere
NOAA	National Oceanic and Atmospheric Adminstration
NDVI	Normalised Different Vegetation Index
NP	National Park
NRIC	National Resource Information Centre
NRSCP	National Reserves System Cooperative Program
NRSMPA	National Representative System of Marine Protected Areas
NRSP	National Reserve System Program
NSCABD	National Strategy for Conservation of Australia's Biological Diversity
NSW	New South Wales
NT	Northern Territory
PWCNT	Parks and Wildlife Commission, Northern Territory
RFA	Regional Forest Agreement
ROTAP	Rare or Threatened Australian Plants
RMIT	Royal Melbourne Institute of Technology

SRS	Specimen Records Scheme
TIN	Triangular Irregular Network
TM	Thematic Mapper
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America
WRI	World Resources Institute

CHAPTER 1 - INTRODUCTION

1.1 INTRODUCTION

The Millennium Ecosystem Assessment (MA) was established in 2002 with the involvement of governments, the private sector, nongovernmental organisations, and scientists to provide an integrated global assessment of the consequences of ecosystem change for human well-being and to analyse options available to enhance the conservation of ecosystems and their contributions to meeting human needs (Reid *et al.* 2002). In 2005 the MA released a landmark scientific consensus report entitled *Ecosystems and Human Well-Being: Biodiversity Synthesis* that outlined the extent of human impacts on Earth's ecosystems and some of the key challenges for the conservation of biological diversity over the next 50-100 years (Millenium Ecosystem Assessment 2005). The report states that virtually all of Earth's ecosystems have been significantly transformed through human actions, and that changes have been particularly rapid in the last 50 years – especially in developing countries. Many animal and plant populations have declined in numbers, geographical distribution, or both. For instance, a quarter of mammal species world-wide are currently threatened by extinction, and it is estimated that human activity has caused between 50 and 1000 times more extinctions in the last 100 years than would have happened due to natural processes (Millenium Ecosystem Assessment 2005). Reversing the degradation

of ecosystems while meeting increasing human demand for their ecosystem services is a key challenge recognised in the report:

"An unprecedented effort would be needed to achieve by 2010 a significant reduction in the rate of biodiversity loss at all levels. Short-term goals and targets are not sufficient for the conservation and sustainable use of biodiversity and ecosystems. Given the characteristic response times for political, socioeconomic, and ecological systems, longer-term goals and targets are needed to guide policy and actions. Improved capability to predict the consequences of changes in drivers for biodiversity, ecosystem functioning, and ecosystem services, together with improved measures of biodiversity, would aid decision-making at all levels. Science can help ensure that decisions are made with the best available information, but ultimately the future of biodiversity will be determined by society." (Millenium Ecosystem Assessment 2005)

The MA report suggested that the challenge to conserve biological diversity can be partially met in the future given significant changes to policies, institutions, and practices including the acquisition of comprehensive biological data through new and additional biological survey. However, these required actions will have to be substantial when compared to the actions currently taken. My thesis aims to contribute to the body of knowledge and techniques underpinning biological survey and conservation evaluation using a case study from a biologically-significant, but poorly studied region of Australia.

Many approaches have been used to describe and map biological diversity (e.g. (Beardsley & Stoms 1993; Desgranges & Jobin 2003; Gould 2000; McKendry & Machlis 1993; Nohr & Jorgensen 1997; Oindo *et al.* 2003; Roy 2003) during the past decade or so. Olson (2001), for example, subdivided the terrestrial world

into 14 biomes and eight biogeographic realms. Nested within the biogeographic realms are 867 ecoregions. These ecoregions were defined by Olson & Dinerstein (2002) as mapped continental-scale units of biodiversity that cover a relatively large area of land or water containing a characteristic set of natural communities that share a large majority of species, other environmental conditions and processes. Ecoregions function effectively as coarse-scale conservation units because they encompass similar biological communities, and their extent roughly coincides with the area over which key ecological processes interact most strongly (Orians 1993). Consequently, many scientists (Arvidson 2005; Fu *et al.* 2004; Jepson & Whittaker 2002; Loveland & Merchant 2004; McDonald *et al.* 2005; Olson *et al.* 2001; Ricketts & Imhoff 2003) have argued that ecoregions are likely to reflect the distribution of species and communities more accurately than do units based on global and regional models derived from gross biophysical features such as rainfall and temperature (Schulz 1995), vegetation structure, or spectral signatures from remote-sensing data (DeFries *et al.* 1995; Loveland & Belward 1997). None of these other approaches emphasises the importance of endemic genera and families (higher taxa), distinct assemblages of species, or the imprint of geological history (Olson *et al.* 2001). The ecoregion map developed by (Olson *et al.* 2001) complements global priority-setting analyses, such as 'Global 200' (Olson & Dinerstein 1998) and 'Hotspots' (Myers *et al.* 2000), by providing an even finer level of resolution to describe and assess biodiversity.

The conservation of biological diversity in Australia is a high priority for government at both State and Commonwealth level (Australian Department of Environment and Heritage 2001). In Australia, State of the Environment (SoE) reporting occurs at regular levels at all levels of government (Australian Department of Environment and Heritage 2001). National SoE Reports provide information about environmental and heritage conditions, trends and pressures for the Australian continent, surrounding seas and Australia's external territories (Australian Department of Environment and Heritage 2001). The reports are based on data and information gathered and interpreted against environmental indicators. For convenience environmental indicators have been grouped into environmental themes (Australian Department of Environment and Heritage 2001). Australia was a founding signatory to the UN Convention on Biological Diversity (Commonwealth of Australia 1996) and has developed a National Strategy for the Conservation of Biological Diversity (Commonwealth of Australia 1996). However, at present, major gaps in biological data and information limit the effectiveness of conservation, planning and management activities against these commitments (Ferrier *et al.* 2004).

This thesis considers ways to improve biodiversity conservation at the bioregional level in Australia through the use of geospatial science technologies and biological modeling techniques. Modeling techniques are illustrated using a case study of the Burt Plain bioregion in central Australia that focuses on target

taxa, ecosystems and landscapes. I investigate the dominant vegetation communities and their distribution and various environmental gradients. I argue that modern geospatial technologies can make a valuable contribution to the management, manipulation and analysis of spatial information, and discuss these techniques further in detail as they underpin much of the new analysis presented in the thesis.

1.2 BIOREGIONALISM IN AUSTRALIA

The Australian environment is unique, characterised by a prevalence of stochastic climatic and hydrological regimes. Australia has a relatively sparse human population density and this pattern restricts opportunities for strong local ownership of regional resource management, at the scale of bioregions. Although Australia has scarcely more than two persons per square kilometre of total land area, this raw figure is highly misleading: most of the continent is desert or semi-desert and of limited agricultural value. In consequence, Australia is one of the world's most urbanized countries: 91% of Australia's population lives in urban areas predominantly along the east coast (Australian Bureau of Statistics 2006).

Catchment management in Australia has been vested historically in State and Territory governments, while the Commonwealth sets a broader policy agenda

that may be implemented through joint Federal/State funding arrangements such as the National Action Plan for Salinity and Water Quality (Commonwealth of Australia 2000). However, there is an emerging trend to recognise the importance of regionalism as greater statutory powers and responsibility are devolved to regional authorities and local governments.

Across Australia, natural resource managers and the community have increasingly recognised Integrated Catchment Management (ICM) as an effective means of dealing with environmental issues (Bellamy *et al.* 2002; Environment ACT 2000). ICM involves managing natural resources within a 'whole of system' approach and avoids dealing with issues in isolation (Environment ACT 2000). It also implies the integration of natural resource management across the whole of government and the many sectors of the community that use and manage these resources (Environment ACT 2000).

River basins[1] or catchments and bioregions have formed the more recent context for natural resource management in Australia. Catchment management can be conceptualised as a subset of river basin management. The nature of hydrological linkages suggests a river basin or a catchment forms a natural unit of management. These units have been used to establish the management boundaries for major environmental funding processes such as the Natural

Heritage Trust (Australian Department of Agriculture, Forests and Fisheries 2005). On the other hand, bioregionalisations of Australia have been developed to support conservation evaluation and to monitor environmental management using processes such as national state-of-the-environment (SoE) reporting (Department for Environment Heritage and Aboriginal Affairs 1998).

A bioregion is an area which is defined by various biological and geographic components, unlike areas defined by political or other anthropogenically-defined boundaries. Bioregions are relatively uniform tracts of land of similar climatic pattern, with recurring patterns of land types and vegetation communities. Bioregions are natural assemblages of plants and animals with discernible, but dynamic boundaries existing simultaneously in space and time. Bioregions are defined by physiographic and climatic limits that define the natural communities of organisms in space and time through interactions with the physiological and behavioural capabilities of these organisms (Welsh 1994).

Thackway (1995b) designed a preliminary bioregionalisation of Australia, known as the Interim Biogeographic Regionalisation of Australia (IBRA) and updated versions of this approach have been developed as improved data have become available (Figure 1.1). The bioregionalisation framework has been used to

[1] River basin management is the planned management of land and water resources of a major river valley for many purposes, including the conservation of land and water resources and a range of human uses.

identify gaps in biological survey and priorities for conservation reservation at a national level (Thackway & Cresswell 1995a); see Figure 1.2. I have used this bioregionalisation framework as the basis for the quantitative analyses undertaken in my research.

Integrated Resources Management (IRM) is the term used to describe management of bioregions undertaken on an integrated basis (Bellamy & Johnson 2000; Lal *et al.* 2001). The Central Australian Arid Tourist Region is one such example (Costelloe *et al.* 2005; Smyth & James 2004; Tooth & Nanson 2000). IRM aims to manage bioregions as an entity, with the objective of maintaining the overall productivity on long-term sustained yield basis in each region (Hopper 1995).

1.3 BIOLOGICAL SURVEYS AT THE REGIONAL LEVEL

Australian science is recognized as a leader in the development of some of the elements required for species and ecosystem assessment (Adam 2001). Techniques for evaluating the adequacy of existing data sets, characterising environmental variation at the landscape level, designing biological surveys, and the spatial extension of biological and ecological patterns such as the distribution of species continued to be refined. Depending on the form and quality of the available data sets, a number of computer-based techniques can be used to

develop inferences about the biological significance and conservation value of different parts of a bioregion.

The National Land and Water Resources Audit sponsored a national terrestrial biodiversity audit in 2000 that used a range of data sets to assess the status of biological diversity (Australian Terrestrial Biodiversity Audit, 2002). As part of this activity, McKenzie *et al.* (2002) reviewed the nature conservation issues that each of Western Australia's 53 biogeographical subregions faced in 2002. Their report provides a detailed, systematic basis for assessing conservation priorities among different parts of Western Australia; however no information was included for regions that are predominantly in the Northern Territory or South Australia. Biological data for these areas are limited and governments are supporting new biological surveys to redress this situation.

In a national context, the bioregions of the Northern Territory are notable for the:

- relatively limited extent of conservation reserves;
- high proportion of land that is owned or managed by Aboriginal people;
- relatively low land (market) value;
- limited areas of vacant crown land;
- the lack of habitat fragmentation caused by clearing; and
- relatively low level of threat from extensive landscape modification.

Unfortunately, the availability of survey-based distributional data on biodiversity is very limited and the conservation status of the biodiversity of these regions is uncertain. It is recognized that biodiversity values may be extensively threatened by inappropriate fire management, spread of weeds and impact of livestock and feral animals (Connors *et al.* 1996). These factors and concerns have been used to help establish priorities for conservation planning in the Northern Territory relative to the rest of the nation (Scott 2004).

1.4 OBJECTIVES OF THESIS

The objective of my thesis was to examine the efficacy of selected geospatial modelling techniques to support biodiversity assessment at a bioregional level in central Australia. The objective of my research is to contribute to an improved understanding of biodiversity conservation at the bioregional level. In order to attain to this objective I review bioregional planning and management for biodiversity conservation as well as the role and limitations of geospatial technologies currently employed for biodiversity conservation and management. The Burt Plain bioregion was chosen as a case study area to explore these issues. As a result of my reviews and the 'high priority' status given to the area by the Australia Government Department of Environment and Heritage for developing the National Reserve System

The specific research objectives of the thesis set for the Burt Plain bioregion study were to:

- describe the species composition, distribution and nature of the dominant vegetation communities within the Burt Plain bioregion;
- characterise environmental niche of communities with respect to selected environmental and management variables – latitude, longitude, climate, land systems and land units, geology, hydrography, topography, and tenure;
- analyse how taxa have been sampled with respect to geographical and environmental variables;
- develop and compare the predictive output of habitat models of the potential distribution of selected species based on presence-only distributional data; and
- examine the significance of radiometric data as a potential correlate and predictor of wildlife distribution.

For this thesis the primary emphasis has been given to developing and comparing Generalised Linear Models (GLMs) and Generalised Additive Models (GAMs) and their predictive outputs produced by the software SPMODEL, and based on presence-only wildlife distributional data. The software SPMODEL was initially developed by Environment Australia (Bennett *et al*. 1997). The basis of this modelling focus is considered further later in the thesis.

1.5 LAYOUT OF THESIS

In Chapter two I review published literature on approaches to bioregional planning and management techniques used for biodiversity conservation in Australia and overseas, as well as summarise past and present approaches to reserve system development, and the formation of IBRA boundaries. I also document progress with implementation of the Interim Biogeographic Regionalisation of Australia. This review suggests, that critical to the conservation of biological diversity is the need to manage for whole functioning ecological systems at the bioregional scale.

In Chapter three I review published literature on the role and current limitations of geospatial science technologies currently used for establishling biodiversity conservation measures at the regional level in Australia. I consider the applications of GIS to wildlife research and management, and discuss developments in geographic information systems that allow managers to better understand landscape-scale dynamics.

In Chapter four I introduce the Burt Plain bioregion of central Australia which is used as a case study in the thesis. I discuss the distribution of dominant vegetation communities and various environmental gradients in the Burt Plain bioregion and analyse selected data sets to characterise the environmental niche of vegetation communities. The distribution of rainfall and nutrients in the arid

region of Australia results in dramatic differences in floristic composition and productivity in different parts of landscape at different times of the year.

The purpose of Chapter five is to analyse the distribution of mulga (*Acacia aneura*) communities and various environmental gradients in the Burt Plain bioregion to best quantify environmental relationships at the landscape level. Mulga vegetation communities within the Upper Todd River catchment, which is located within the Burt Plain bioregion, were selected for more detailed study. The variation in selected environmental and management variables in this catchment was characterised with respect to latitude, longitude, climate, land systems and land units, geology, hydrography, topography, and tenure. The floristics and structure of mulga were examined in relation to the above variables as well as fire, grazing and the presence of weeds. I discuss the nature of major landscape processes operating in this catchment.

In Chapter six I assess the potential for modelling species spatial distributions on a bioregional scale using presence data only. Appropriate management strategies must be based on detailed geographical and ecological understanding of species and their habitats. They must also draw on an assessment of a species status and conservation value, for which faunal surveys provide an important source of information. This chapter aims to contribute to an improved understanding of the distribution of selected taxa and their habitats. This

research may aid the design of more systematic faunal surveys through analysis of existing data from a bioregional perspective.

In Chapter seven I introduce a study investigating the utility of radiometric data for predicting vegetation community patterns and areas of higher probability of the occurrence of selected fauna species in the arid zone. Statistical relationships are tested between the concentrations of the elements uranium, thorium and potassium and terrain characteristics such as position in landscape, slope and aspect and other environmental variables.

In Chapter eight I review and synthesise the major results of the earlier research chapters and discuss ways to improve bioregion surveys and biological modelling in the Burt Plain bioregion and comparable settings. Several limitations to current modeling approaches are considered as are some priorities for future research.

This thesis represents a compilation and collation of diverse data sets within a bioregional context. It is not meant to provide detailed land use plans for every, or any bioregion. Rather, the information assembled here may be useful for helping set strategic priorities for future conservation planning and surveys within and between bioregions.

Figure 1.1 Australia's Bioregions (Source: Australian Government Department of the Environment and Heritage) with the Burt Plain bioregion study area highlighted in yellow.

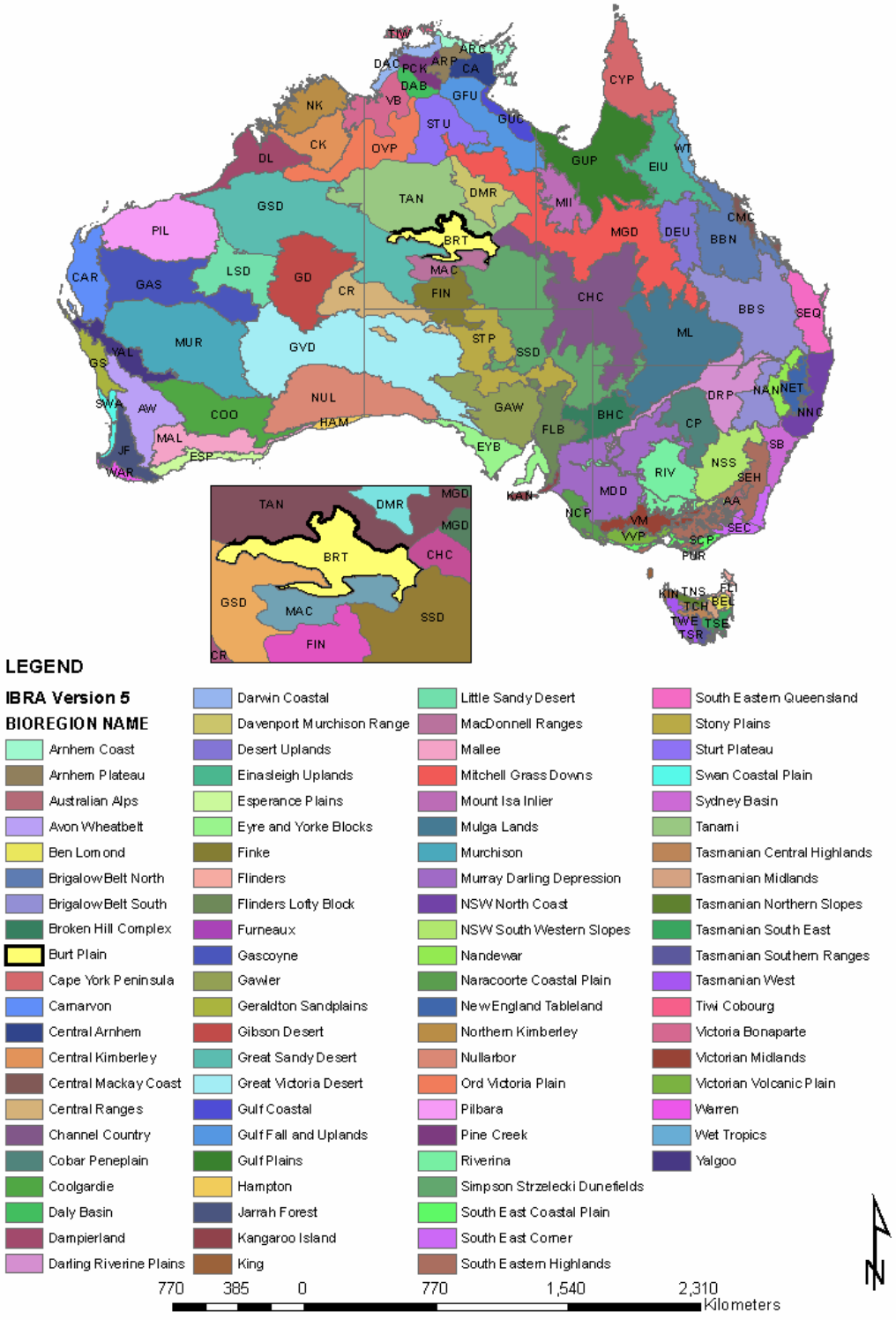
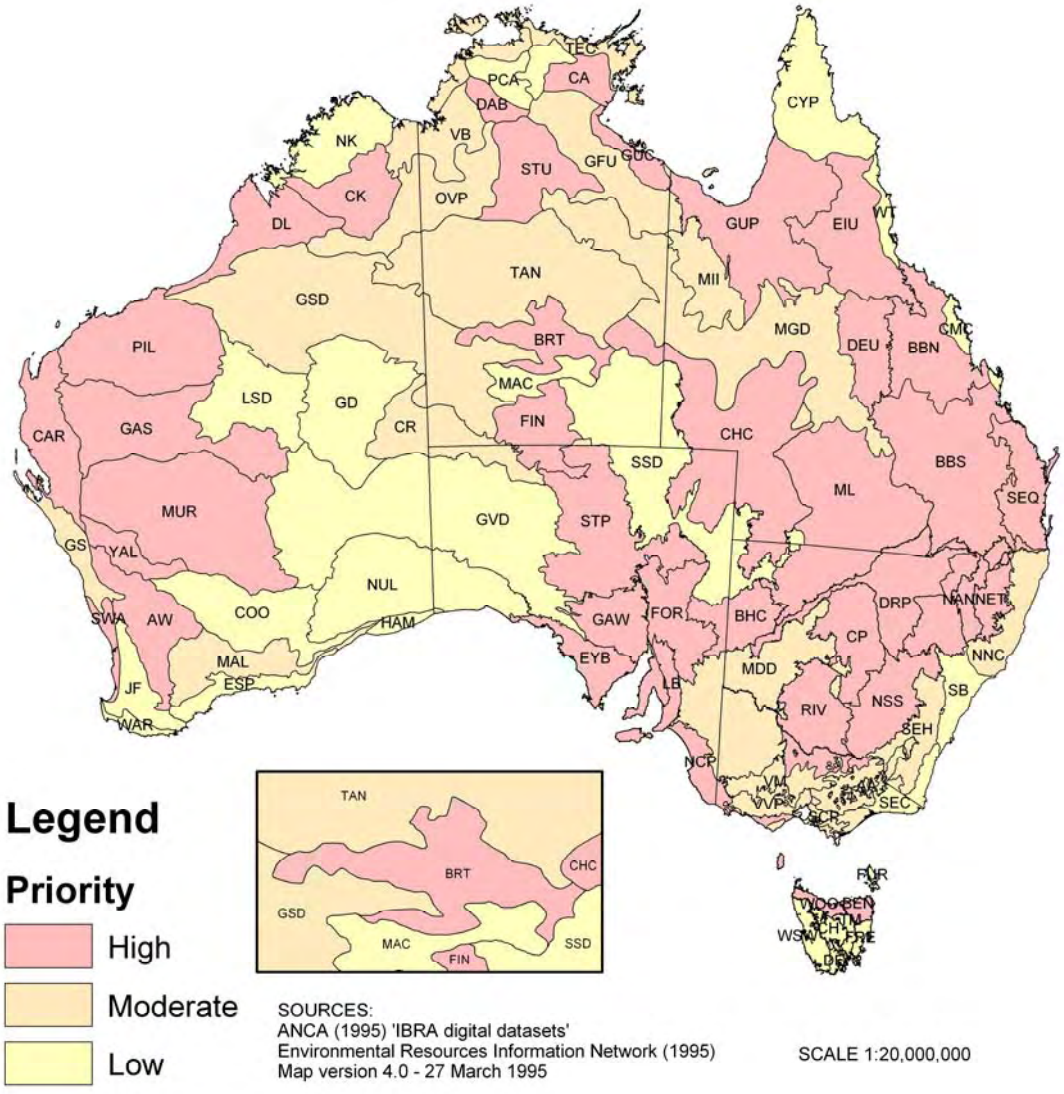


Figure 1.2 Australia's priority bioregions for developing the National Reserve System based on the IBRA bioregions (Source: Australian Government Department of the Environment and Heritage).



CHAPTER 2 - BIOREGIONAL PLANNING AND MANAGEMENT FOR BIODIVERSITY CONSERVATION

2.1 INTRODUCTION

This literature review synthesises approaches to the bioregional planning and management techniques used for establishing biodiversity conservation initiatives in Australia and the rest of the world. It summarises past and present approaches to reserve system development, and in Australia the formation of IBRA boundaries. Finally, I also document progress with implementation of the IBRA since its inception in 1995.

2.2 PROTECTED AREA SYSTEMS

The maintenance of ecological processes and biological diversity is an issue of great importance both internationally and nationally (Commonwealth of Australia 1996b; Myers *et al.* 2000; Reid 1995; Rhind 1993). Maintaining biodiversity will depend largely on the success of a variety of measures to protect and manage, in an ecologically sustainable way, habitats and species that exist outside of formal conservation reserves (Brunckhorst *et al.* 1998). A significant feature of any strategy to maintain biodiversity, however, is a system of protected areas. Such a system should be designed and managed to represent and protect the diversity of gene pools, species, and ecosystems (Courrier 1992).

Many species use more than one vegetation or habitat type and individuals may use more than one patch in any landscape (Kirby 1996). Globally, there is a tendency to place more value on the conservation of species that are restricted to the 'core' of a patch because these may be rarer, less mobile and have more restricted requirements than those found at the 'edge' (Kirby 1996). However, 'edge' species also need to be conserved (Kirby 1996). Concentrating on habitat patches rather than on the whole landscape also limits the scope for conservation at a wider scale. There is now recognition of the need to look beyond the habitat level and examine biological inter-relationships at the landscape level (Kirby 1996).

Although Australia's first national park was declared in 1879, recognition of the need for a representative system of protected areas in Australia dates back only about 30 years (Brunckhorst *et al.* 1998). During the 1970s and 1980s there was considerable expansion in the area encompassed by Australia's protected areas. However, much of this growth was not systematic in that there was no attempt to represent the full array of ecosystems known to occur within each jurisdiction (Bedward *et al.* 1992; Bridgewater *et al.* 1992).

In order to minimise potential land-use conflicts, reserve planning should occur within the broader context of comprehensive land and water use planning, zoning and regulatory activities (Davis *et al.* 1999). Unfortunately, this has generally not been the case in Australia. Historically, national parks and conservation reserves were established to protect scenic or popular recreational locations, geological oddities and historical sites – occasionally reserves would be established to preserve favoured or huntable species (Pressey 1996; Scott *et al.* 1993). Other parcels of land which were added to the national reserve system included land not suitable for primary production and usually less fertile or less valuable than the surrounding lands. Biological reserves are often created on a case-by-case basis in response to the imminent threat of development, at which time the political and financial will is generated for direct conservation intervention (Davis *et al.* 1999). These approaches have produced a collection of protected areas that are neither biotically representative nor economically cost-effective (Bedward *et al.* 1992; Benson 1990; Margules *et al.* 1988).

Approximately 6% of the Australian continent is reserved for conservation, though mostly this comprises many small protected areas (Brunckhorst *et al.* 1998). The arid zone of Australia was no different in the process of setting aside land for conservation with only about 3% of Australia's arid zone dedicated for that purpose.

Australia has nine human-derived jurisdictions, including federal, state, and territory based governments, each of which is responsible for planning and management independent protected area systems (Thackway & Cresswell 1997). Each system has developed in a different way, with a variety of operational goals and terminology. With a few notable exceptions, "national" parks in Australia are not federal parks but declared and managed under state law with state funding. Each state and territory has its own system of protected areas, with its own legislation. The independent approaches and legislation of the states have led to inconsistencies. For example, (Brunckhorst *et al.* 1998) described how although all jurisdictions have "national parks", the term is applied to many different types of areas. Although the term "national park" might now be associated with large, relatively undisturbed areas, there are many small national parks, and one state has 23 national parks of 4 ha or less (Brunckhorst *et al.* 1998). In contrast the biggest national park in Australia, Kakadu, covers almost two million hectares (Brunckhorst *et al.* 1998).

As each state has taken a different approach in developing its systems of protected areas and associated legislation, it is not practical to succinctly describe here the various methods used. One approach, however, is noteworthy as an

example. The state of Victoria enacted specific legislation[1] and created a body, called the Land Conservation Council in 1970 to provide a comprehensive process for systematically evaluating and making recommendations on the use of public land for conservation purposes. The process followed by the Council provided for comprehensive data gathering and publication, before informed assessment of needs and solutions, and two formal stages for public input. As a result, Victoria is considered to have the most representative system of protected areas of any Australian state (Brunckhorst *et al.* 1998).

At the national level Australia is a signatory to the UN Convention on Biological Diversity which obliges countries to establish a system of protected areas to conserve biodiversity; develop guidelines for the selection, establishment and management of protected areas; and promote the protection of ecosystems, natural habitats and the maintenance of viable population of species (Commonwealth of Australia 1999). Also, at the national level the goal of a 'Comprehensive, Adequate and Representative System of Reserves' for Australia is endorsed by the Commonwealth and State and Territory Governments, as signatories to the National Strategy for Conservation of Australia's Biological Diversity (NSCABD) and the National Forest Policy Statement (Commonwealth of Australia 1999).

[1] Land Conservation Act of 1970, No. 8008/1970 Victoria Parliament.

Successive Governments have supported three main processes to work towards a comprehensive, adequate and representative (CAR) system of reserves – the National Reserve System Program (NRSP)[2], the Regional Forest Agreement (RFA)[3] process and the National Representative System of Marine Protected Areas (NRSMPA)[4] (Commonwealth of Australia 1999).

In response to several national and international inquiries and commitments that called for the development of a national reserve system (NRS), the Australian federal government in 1992 established the National Reserve System Program (NRSP), administered by the Australian Nature Conservation Agency (ANCA)[5]. The goal of that program was to establish the NRS in cooperation with the state and territorial nature conservation agencies (Keating 1992). The biogeographic approach to regionalisation, which comprises primarily state and territory data and information, was selected as the preferred regionalisation for implementing the NRS (Thackway & Cresswell 1995a) and (Thackway & Cresswell 1995b). The NRS employs a bioregional approach – that is, protected areas are identified,

[2] The NRSP focuses on ensuring rapid and significant improvements in the terrestrial reserve system. Its main priority addresses the key gaps in comprehensiveness at the national scale, using the IBRA as its regional planning framework (Commonwealth of Australia 1999).
[3] The RFA process focussed on specific forest and woodland ecosystems in specific forested regions. RFAs are integrated strategies for establishing forest reserves and ecologically sustainable forest management that aims to achieve resource security for resource utilisation industries (Commonwealth of Australia 1999).
[4] The NRSMPA is being developed cooperatively by the Commonwealth, State and Northern Territory agencies responsible for the conservation, protection and management of marine environments (Commonwealth of Australia 1999).
[5] The Australian Nature Conservation Agency (ANCA) is now called Department of Environment and Heritage (DEH).

selected, and managed as part of the wider ecological, social and economic landscape.

Thackway (1997) argued that the establishment of a comprehensive, adequate, and representative system of protected areas is the most effective mechanism for the conservation and maintenance of ecological functions and services across entire landscapes. Thackway (1997) also described nature conservation as a land use that seeks to conserve and maintain biodiversity; that is, *in situ* ecological functions and services.

2.2.1 CAR – Comprehensive, Adequacy and Representativeness

An important function of management in largely natural landscapes is to provide the 'backbone' of a 'comprehensive, adequate and representative' (CAR) system of terrestrial areas as part of a national reserve system (Commonwealth of Australia 1996b). Comprehensiveness requires that the full range of natural communities and species is conserved; adequacy requires the maintenance of ecological viability and integrity of populations, species and communities; and representativeness should ensure that the full biotic diversity, including genetic diversity, is included (Crown State of Victoria 1997a, b, c). These requirements are articulated in the Scientific Guidelines for establishing the National Reserve System (1997) - *Nationally agreed criteria for the establishment of a comprehensive,*

adequate and representative reserve system for forests in Australia, which include the nationally agreed biodiversity criteria for the CAR system developed for the National Forest Policy (JANIS 1996).

Comprehensiveness refers to the degree to which the protected area system encompasses the entire variety of biological species and communities, ecological attributes, and physical features on a nationwide basis, as evaluated against national criteria (after Brunckhorst in HoRSCERA 1993; (Brunckhorst 2000)).

Adequacy refers to the capacity of a protected area system to maintain biological diversity and ecological processes. Adequacy will depend on the regional setting and variety of ecological processes involved. Management considerations may include temporal and spatial perturbations, both natural and human induced; population viability of biota; size and design of individual reserves; and the ability to maintain ecosystem services at a quality that meets present and future needs of native species and local human communities criteria (after Brunckhorst in HoRSCERA 1993; (Brunckhorst 2000)).

Representativeness refers to the extent that sites identified for, or already declared as, protected areas sample known biological diversity, environmental and ecological patterns and processes, and physical features at various scales

(after Brunckhorst in HoRSCERA 1993; (Brunckhorst 2000)). While the goal of representativeness is considered vital for the conservation of biodiversity, Pressey (1996) indicated that there are some problems with its implementation. For example, elements of biodiversity are being progressively lost from the world before they can be protected and, very often, before they can even be described. Representing all species, including the undescribed ones, presents obvious difficulties. The same problem of lack of knowledge applies to the goal of representing all biological variation at the level of separate populations and genes.

2.2.2 What are protected areas and what are they for?

A 'protected area' is defined in the UN Convention on Biological Diversity as 'a geographically defined area, which is designated or regulated and managed to achieve specific conservation objectives' (see Article 2 – Use of Terms pg 5 - http://www.biodiv.org/doc/handbook/cbd-hb-01-en.pdf). The terminology that applies to protected areas varies from country to country. In Australia, there are some 40 different categories of reserves. These categories include specific-purpose areas such as scientific reserves and very large areas such as the Great Barrier Reef Marine Park, which has zones ranging from multiple use to restricted areas (Commonwealth of Australia 1996a).

The basic underlying purpose of protected areas is to separate the components of biodiversity from the things that threaten their persistence. Threats to biodiversity can be grouped under the term 'threatening processes'. Pressey (1996) outlined how the term 'protected areas' is more than just a fashionable descriptor for nature reserves. Pressey (1996) stated that the term is deliberately broad because not all protected areas are dedicated only for nature conservation. The establishment and management of protected areas covers a spectrum of arrangements from strict reservation solely for nature conservation to various combinations of conservation and extractive use such as logging or grazing by domestic stock (Soulé 1991).

The IUCN categorisation system defines a protected areas as "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means" (Commission on National Parks and Protected Areas and World Conservation Monitoring Center 1994). In addition, this approach defines protected areas by management objectives, thus strengthening the role protected areas can play in the bioregional approach (Bridgewater *et al.* 1996). The spectrum of protection measures is formally recognised in the IUCN classification of protected areas (Table 2.1). One of the aims of this new classification is to reduce confusion over the many different terms used

internationally to describe types of protected areas. For example, (Pressey 1996) reported that Australia uses 45 different names compared to the United States National Parks Service which is responsible for 18 different types of areas.

Table 2.1 IUCN protected area categories

Category	Description
Ia	Strict Nature Reserve: Protected Area managed mainly for science
Ib	Wilderness Area: Protected Area: managed mainly for wilderness protection
II	National Park: Protected Area managed mainly for ecosystem conservation and recreation
III	Natural Monument: Protected Area managed mainly for conservation of specific natural features
IV	Habitat/Species Management Area: Protected Area managed mainly for conservation through management intervention
V	Protected Landscape/Seascape: Protected Area managed mainly for landscape or seascape conservation and recreation
VI	Managed Resource Protected Areas: Protected Area managed mainly for the sustainable use of natural ecosystems

Source: (IUCN The World Conservation Union 2002)

The conservation of biodiversity also is reliant upon the 'unreserved matrix' (Franklin 1993), all the pieces of natural and semi-natural habitat that occur outside formally declared protected areas. These range from large tracts of intact vegetation in private and public ownership to small patches of habitat, which may even occur along roadsides and railways. The idea of regional-scale

planning or ecosystem management (Noss & Cooperrider 1994) concerns an overall conservation strategy that integrates the management of all natural and semi-natural areas, whether or not they are formally listed and categorised as protected areas.

Areas do not necessarily have to be made into reserves or National Parks to achieve conservation outcomes. In inland Australia, it is may be more practicable to develop a system where there are many small areas across the vast landscapes, that are managed for conservation by people who use the land e.g. pastoralists, tourism operators, aboriginal traditional owners, or mining companies. Brunckhorst (2000) discussed how protected natural areas and other reserves are a necessary element, but not necessarily the complete solution for maintaining biodiversity.

2.2.3 Identification and selection of candidate protected areas

Within the protected area system, land designated as wilderness may be of particular importance for biological diversity conservation (Commonwealth of Australia 1996a). Areas designated as wilderness must be of sufficient size and undisturbed, with core areas remote from mechanical access and edge effects (Commonwealth of Australia 1996a).

Systematic approaches for identifying representative reserve systems in Australia have been advocated for more than two decades (Kirkpatrick 1983). In the United States, the adoption of systematic conservation planning approaches has varied which (Davis *et al.* 1999) explained is partly due to planners' lack of familiarity with reserve design theory and tools. In the experience of Davis *et al*. (1999), initial systematic approaches may not be well received by conservation practitioners. There is rarely consensus on what should be protected (e.g. species versus ecosystems) or on what level of protection is desirable. A common concern is that existing biological survey data are too incomplete or biased to support systematic site selection approaches (Davis *et al.* 1999). Selection models are viewed as data-driven and unable to capture in-depth personal experience and expertise of the ecosystems and biota of interest (Davis *et al.* 1999). Another complaint is that reserve selection models are too simplistic to deal with the complex biological, socio-political, institutional and economic realities of site planning and acquisition (Davis *et al.* 1999). Pressey (1995) stated that the theory and methods of conservation planning will advance more rapidly and become more useful through concerted efforts by researchers to collaborate with practitioners in applying systematic approaches to real planning exercises.

Until relatively recently reserve selection was not directed towards preserving biodiversity. Historically, areas selected as national parks and similar reserves

tended to be chosen for their spectacular scenery, value for recreation, special features or, because they consisted of very steep terrain which could not be developed for some other land use. Often, reserves have been chosen purely on the basis of *ad hoc* political reasons rather than conservation merit (Pressey 1994).

Existing systems of protected areas, terrestrial or marine, do not adequately represent the diversity of ecosystems and species assemblages and many are unsustainable for protecting biodiversity in the longer term because of their size, shape, landscape connectivity (Brunckhorst 2000) and inconsistent application of management principles. Brunckhorst (2000) described how protected areas may function as reference sites. In this case, protected areas may essentially function as 'measuring sticks' for landscape-wide conservation and sustainability.

2.2.4 Effectiveness of protected areas

Scientific research in many countries has revealed that the effectiveness of protected areas is dependent not only upon the general management techniques applied, but also the regional context and the connectivity (i.e. the design of the linkages and corridors) between areas (Commonwealth of Australia 1992). This points to the need for management of biodiversity on a regional scale, involving all landscape elements, not just within protected areas and their immediate

surroundings. The system of protected areas can and should be set within the framework of a national development plan (Walton *et al.* 1997).

Readers interested in the details of specific techniques on reserve identification and selection are referred to the many published papers (e.g., Margules & Austin 1994; Margules & Redhead 1995; Margules *et al.* 1988; Pressey *et al.* 1993; Bedward et al. 1992; Pressey et al. 1994a; Belbin 1995; Woinarski *et al.* 1996; Brunckhorst *et al.* 1998; Church *et al.* 1996; Davis *et al.* 1999; Diamond 1975; Ferrier *et al.* 2000; Kiester *et al.* 1996; Kirkpatrick 1983; Nicholls & Margules 1993; Pressey & Nicholls 1989; Pressey & Logan 1994; Pressey *et al.* 1994a; Pressey 1994; Pressey *et al.* 1994b; Rebelo & Siegfried 1992; Saetersdal *et al.* 1993; Scott *et al.* 1991; Scott *et al.* 1993; Soule & Simberloff 1986). The only published paper relating to reserve design in the Northern Territory is (Woinarski *et al.* 1992), who argued that protection of the still extensive natural vegetation outside the reserve system will be vital for the persistence of mobile-species in this landscape. Mobility and massive population fluctuations in response to a highly variable climate are pervasive features of both the monsoonal and arid parts of the Northern Territory (Woinarski *et al.* 1992). These characteristics defy the adequate conservation of these species in a conventional system of formal reserves, and pose substantial problems for reserve design (Woinarski *et al.* 1992).

Further commentary on protected area conservation and reserve design issues is provided by Soule (1986), Soule (1987), Wilson (1992), Noss & Cooperrider (1994), Grumbine (1994), and Forey *et al.* (1994).

2.2.5 A bioregional approach to reserve selection

The idea that it is possible to recognise biogeographic regions or natural ecological regions within Australia and/or overseas, or groups of organisms with particular geographical affinities, has existed since the time of the earliest biological explorations of the continents. A range of schemes to formally describe these regions has been proposed over the years which fall loosely into three streams; botanical, zoological and physical/biophysical aspects of the environment.

By comparing the proportional area of each bioregion currently represented in protected areas and the bias in the representation of ecosystems within that system of reserves (Figure 2.1) an assessment of comprehensiveness of biodiversity protection through reservation can be attained (Brunckhorst *et al.* 1998; Thackway & Cresswell 1995b). Figure 2.2 displays the nature conservation reserves currently found within IBRA regions.

Figure 2.1 Bias in the representation of biodiversity in protected areas within the IBRA (Source: Australian Government Department of the Environment and Heritage).

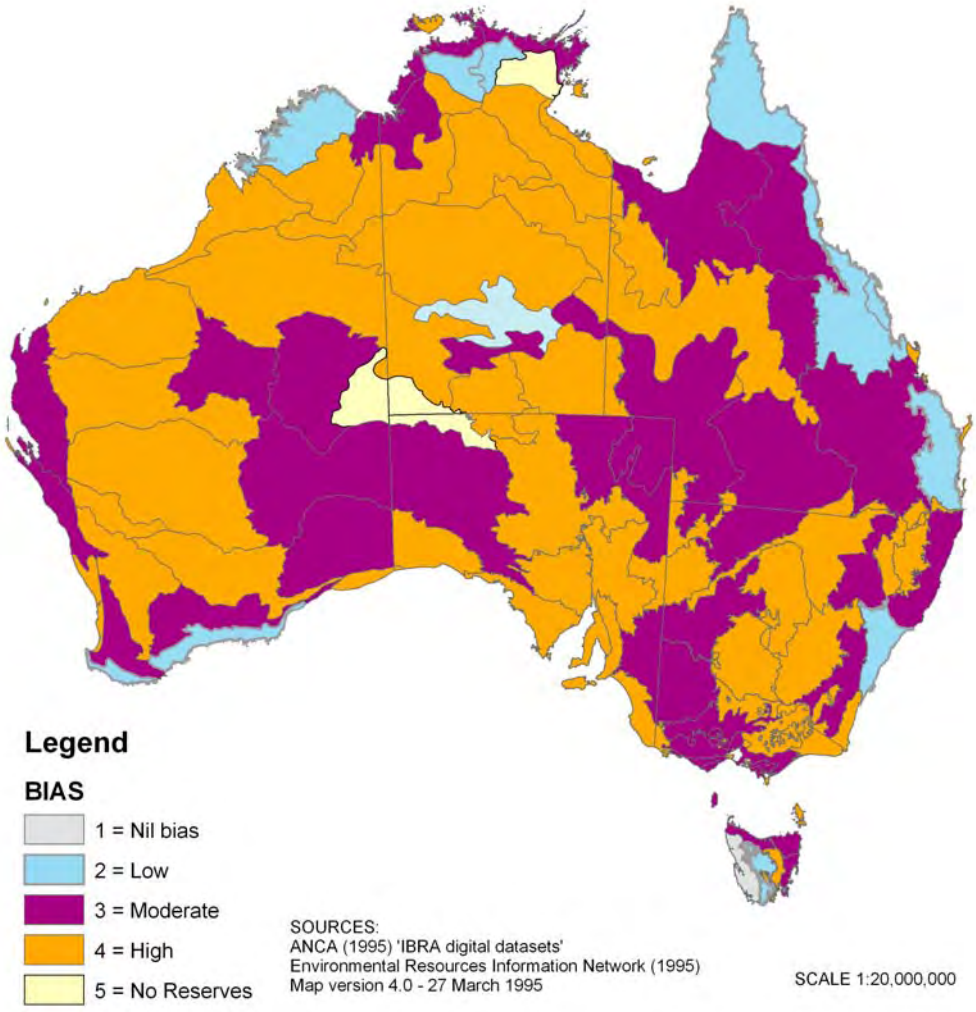
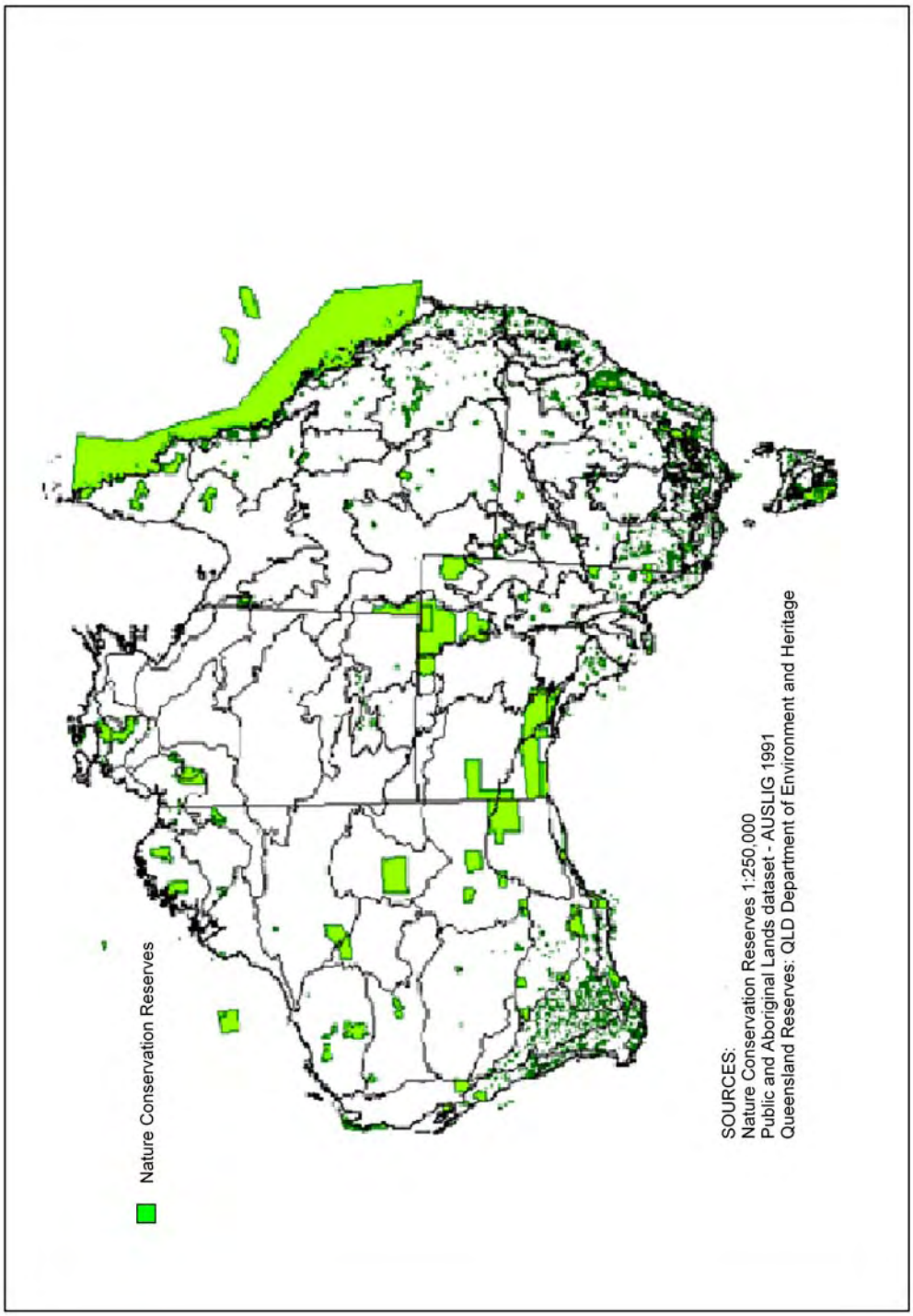


Figure 2.2 Nature conservation reserves within IBRA regions (Source: Australian Government Department of the Environment and Heritage).



2.2.6 Biosphere reserves – one model of the bioregional approach

The idea of setting up biosphere reserves resulted in large part from the 1968 UNESCO Conference on Rational Use and Conservation of the Resources of the Biosphere (Batisse 1993). The Man and Biosphere (MAB) Program, which was also derived directly from the Biosphere Conference, was aimed directly at reconciling resource utilisation with long-term protection through an interdisciplinary research approach. In today's terminology, MAB was therefore the first deliberate international effort to identify ways and means of achieving the sustainable development of terrestrial ecosystems (Batisse 1993).

The Biosphere Reserve concept, formulated to wed conservation and sustainable development, has been developed and championed under the UNESCO Man and the Biosphere Program (MAB) (Bridgewater *et al.* 1996). Biosphere reserves are recognised areas of representative environments which have been internationally designated within the framework of UNESCO's MAB Program for their value to conservation through providing scientific knowledge, skills and values to support sustainable development (Bridgewater *et al.* 1996).

Biosphere Reserves are nominated by national governments, but must meet agreed criteria and adhere to a minimum set of agreements before being ratified and admitted to the worldwide network. In particular, each Biosphere Reserve

should perform three complementary functions: a biodiversity conservation function (with a focus on conserving a representative sample of major ecosystems); a development function (with a focus on humans in the biosphere, emphasising an integrative role for local communities); and a logistical function (combining conservation research, education, training and monitoring) (Bridgewater *et al.* 1996).

Biosphere Reserves are a special kind of conservation area – traditionally a nested series of zones with differing management intensities (core area, buffer zone and transition area), designed to include people within an overall conservation framework (Bridgewater *et al.* 1996). In practice, however, biosphere reserves were not always fully recognised as tools for sustainable development. About 90 per cent of all Biosphere Reserves are covered by some form of designated Protected Area (e.g. national park, nature reserve), although eight per cent have no nationally designated areas associated with them (Bridgewater *et al.* 1996). All of Australia's Biosphere Reserves are designated protected areas (Bridgewater *et al.* 1996).

The MAB Program provides an integrative tool for managing whole landscape systems, including socio-economic features (Brunckhorst 2000). It unites conservation and sustainable development across the landscape; provides a

potential strategic framework for land use management across jurisdictions – coupled to monitoring sites across the landscape and, globally, to the international network of biosphere reserves (Brunckhorst 2000).

There are over 425 Biosphere Reserves in 95 participating countries (Brunckhorst 2000). Australia has 13 Biosphere Reserves (UNESCO 2006) with only one occurring in the Northern Territory, namely: Uluru (Ayers Rock-Mount Olga) National Park (Table 2.2). Mornington Peninsula and Western Port Bay were more recently added to the Biosphere Reserve register in 2002, and Barkindji Biosphere Reserve in 2005.

Table 2.2 – List of Australian Biosphere Reserves

	Biosphere Reserve	Date of approval	Extension
1	Croajingolong National Park, Victoria	1977	
2	Kosciusko National Park	1977	
3	Macquarie Island	1977	
4	Prince Regent River	1977	
5	Unnamed	1977	
6	Uluru (Ayers Rock – Mount Olga)	1977	
7	Yathong Nature Reserve	1977	
8	Fitzgerald River National Park, W.A.	1978	
9	Hattah-Kulkyne & Murray-Kulkyne National Park	1981	
10	Wilsons Promontory National Park, Victoria	1981	

11	Riverland Biosphere Reserve (originally Bookmark Biosphere Reserve)	1977	1995
12	Mornington Peninsula and Western Port, Victoria	2002	
13	Barkindji Biosphere Reserve	2005	

2.3 BIOREGIONS

While there is no internationally agreed definition of a bioregion, Miller (1996) offered the following:

'A geographic space that contains one whole or several nested ecosystems, characterised by its landforms, vegetative cover, human culture, and history, as identified by local communities, government agencies, and scientists.'

Thackway (1997) and Brunckhorst *et al.* (1998) defined a bioregion as an area of land and/or water whose limits are defined not by political boundaries but by the geographical distribution of biophysical attributes, ecological systems, and human communities. The definition reflects internal environmental and biological homogeneity, but must also reflect the aspirations and identity that human communities have for and with their environment.

The Global Biodiversity Strategy (Courrier 1992) summarised the description of a 'bioregion' as:

- large enough to maintain the integrity of its biological communities, habitats and ecosystems;
- having cultural identity and a sense of home to its local residents;
- containing a mosaic of land uses; and
- having components, which are dynamic and interactive.

Brunckhorst (2000) referred to the concept of a bioregion as a regional-landscape scale of matching social and ecological functions as a unit of governance for future sustainability that can be flexible and congruent still with various forms of government found around the world. A bioregion is more likely than most to be a region defined by its essence, including what people identify with it (Aberley 1993). The notion of a bioregion is good because of its breadth and link to local people and culture (Slocombe 1998).

2.3.1 Bioregionalism and bioregional planning

Slocombe (1993) argued that bioregionalism is a concept with roots in environmentalism, 1930s regionalism, and much older philosophical and political economic theory. Bioregionalism focuses on regions and communities, defined ecologically, culturally, and historically (Slocombe 1993). Dodge (1988) defined "Bioregionalism" as being from the Greek *bios* (life) and the French *region*

(region), itself from the Latin *regia* (territory), and earlier, *regere* (to rule or govern). Etymologically, then, bioregionalism means life territory, place of life, or perhaps by reckless extension, government by life.

Thackway (1997) and Brunckhorst *et al.* (1998) defined bioregional planning as a planning framework that allows for the variously defined and tenured areas of land or sea within a bioregion to be managed in a complementary way to achieve long-term nature conservation and human lifestyle objectives.

Although bioregional planning lacks an agreed definition, Miller (1996) suggested it to be:

> 'an organisational process that enables people to work together, acquire information, think carefully about the potential and problems of their region, set goals and objectives, define activities, implement projects, take actions agreed upon by the community, evaluate progress and refine their approach.'

One of the determinants of the success of bioregional planning will be the extent to which all levels of government cooperate and coordinate their activities. For this to occur, a concerted nationwide effort is necessary to establish better lines of

communication and coordination mechanisms (Commonwealth of Australia 1996b).

Land use planning in the arid lands has tended to be highly centralised and driven by the collection of data which is then under-utilised (CSIRO 2000a, b). It has often been uni-sectoral rather than integrated across sectors. Implementation has been confused by conflict between regional and central government policies and is often not supported by institutional arrangements (CSIRO 2000a, b). From 1995, a project entitled Rangeways was developed in the Western Australian Goldfields, collaboratively amongst a number of organisations and agencies including CSIRO's Centre for Arid Zone Research, and drew the involvement of all sectorial interests in the regional community as well as further agencies as it progressed (CSIRO 2000a, b). The project sought ways to identify and reconcile opportunities for different land uses while protecting biological sensitive areas within the framework of community-based regional planning and Ecologically Sustainable Development policy (CSIRO 2000a, b).

One of the major determinants of the success of bioregional planning will be the extent to which all levels of government cooperate and coordinate their activities (Parliament of the Commonwealth of Australia 1993). For this to occur a concerted nationwide effort will be required to establish better lines of

communication and coordination mechanisms which can be activated as soon as appropriate bioregional boundaries have been determined and accepted (Parliament of the Commonwealth of Australia 1993).

2.3.2 National conservation initiatives

Thackway (1997) reported the main advantages of adopting a system of bioregions for planning of protected areas and implementation of national conservation initiatives are:

- That such regions foster an ecologically meaningful understanding of complex landscapes and provide culturally relevant identities for integrating and communicating data and information, and for setting priorities;
- A planning instrument for developing regional scale programs for ecological restoration, ecological research, and monitoring, and for evaluating the effectiveness of adaptive management;
- A strategic platform for coordinating environmental audits and reporting, including assessment of ecological sustainability of human activity, and identification of threatening processes;
- A valuable contextual framework for surveying, analysing, and understanding dynamic landscape processes;

- Methodology for developing regional conservation strategies that integrate a representative reserve system with off-reserve measures and ecologically sustainable development; and
- Useful for identifying priorities and developing and undertaking preliminary gap analyses for protected areas.

In Australia, a national classification of ecosystems or environments, termed the Interim Bioregional Regionalisation for Australia (IBRA) brings together jurisdictions/states and acts as a top layer in a bioregional framework (Thackway & Cresswell 1997). Australia's bioregional planning framework is used for assessing the relative distribution of conservation values and priorities within each region (Thackway & Cresswell 1997). It has also provided a basis for assessment of more pragmatic bioregional frameworks for local communities to integrate restoration, catchment management and sustainable land use planning together with local authorities (Brunckhorst 2000).

2.3.3 Bioregional mapping

The idea that land could be mapped into natural units and described, based on the integration of climatic, topographic, vegetation and soil characteristics was established in Britain and the USA by the early 1930's (Margules & Scott 1984). The Commonwealth Scientific and Industrial Research Organisation (CSIRO) Division of Land Research pioneered resource surveys in Australia (Neave *et al.*

1996a, b, c). The surveys known as "land system surveys" were designed to rapidly provide information at regional scales for the initial evaluation of land use potential (Austin & Basinksi 1978) by classifying land characteristics (biotic and abiotic) into less-complex functional units (Christian & Stewart 1953). A land system was defined by (Christian & Stewart 1953) as an area, or group of areas, throughout which can be identified a recurring pattern of topography (landforms), soils and vegetation which are termed land units.

The U.S. Forest Service's ECOMAP program currently delineates the U.S. into ecoregions (Bailey 1995; ECOMAP 1993). The division of regional units is widely used both by federal agencies and The Nature Conservancy (The Nature Conservancy 1997) as the basis for resource assessments. The framework subdivides the Earth's surface into successively smaller, more homogeneous land units. The highest level, called the *domain*, is associated with broad climatic regimes and gross physiography. Domains are split into *divisions* based on vegetational affinities. *Provinces* are subdivisions of a division corresponding to continental weather patterns, soil orders, and potential natural vegetation. Domains, divisions, and provinces are all categorised at the ecoregional level in the framework. Provinces can be progressively subdivided into *subregions, landscapes*, and ultimately *land units* at the project planning level.

Loomis and Echohawk (1999) reported that 23 of the 35 ecoregions in the U.S. have less than 1% of their land area protected as Wilderness[6], and 7 out of 35 have no land protected as Wilderness whatsoever. While much of the land with little protection is in areas dominated by private land ownership, a surprisingly large amount of land in the Intermountain states of Nevada and Utah is publicly owned.

The work of Loomis and Echohawk (1999) represented the first comprehensive, national analysis of Wilderness representation of all four federal land management agencies in the Lower 48 states in the USA. Combining Geographic Information System (GIS) data from the four federal agencies and several non-governmental entities, they were able to identify ecosystems that were under-represented in the NPWS and should therefore become priorities for Wilderness preservation recommendations and designations. Loomis and Echohawk (1999) also illustrated an approach which can be used by conservation agencies worldwide as part of any systematic process of protected area design to conserve the full range of ecosystem diversity within their countries.

Numerous efforts are underway by public and private groups to assess the status

[6] In the USA, Wilderness is one protected area designation for conserving selected portions of the natural landscape. Wilderness designation provides the strictest protection from development because it prohibits roads, logging, mechanised access and construction of permanent structures (Loomis & Echohawk 1999).

of biodiversity in the United States, with most being conducted at local to subregional scales, and many focused on species or communities of special concern (Davis 1994). Currently lacking is an overview of the protection status of species and communities both statewide and in the western U.S. as a whole. Davis (1994) described how by compiling a statewide, albeit low resolution digital database, GIS capabilities can be used to identify and map landscape in California that contain large numbers of potentially unprotected vegetation types and vertebrate species of interest. The evaluation of the protection status of plant communities, animal species and vertebrate species richness by GIS overlay of biological distribution data on a map of existing biological reserves has been termed "gap analysis". Areas can then be identified and then be studied in more detail as candidates for additional preservation and protection efforts to fill existing "gaps" in the protection network. This approach allows conservationists to be proactive rather than reactive in their efforts to preserve biodiversity (for example, Funk *et al.* 2005; Rey Benayas and de la Montana 2003; Pearlstine *et al.* 2002).

Research expeditions into remote areas to collect biological specimens provide vital information for understanding biodiversity. However, major expeditions to little-known areas can be expensive and time consuming. In order to get the maximum return for the investment, Funk *et al.* (2005) in their recent study used environmental variables and information on existing collecting localities to help

determine the sites of future expeditions. A survey gap analysis tool based on 'ED complementarity' was employed to select the sites that would most likely contribute the most new taxa.

A conservation gap analysis was conducted for the Intermountain Semi-Desert (ISD) ecoregion to assess the representation of land-cover types within areas managed primarily for biodiversity objectives. Stoms *et al.* (1998) reported the results of the nation's first multistate gap analysis of plant communities. The ecoregion was selected for the prototype regional gap analysis for both practical and conservation reasons. The ISD ecoregion makes a representative case study that could be applied to other regions throughout the westerns U.S. (Stoms *et al.* 1998). GAP projects are now underway in almost every state in the nation, which will support other regional analyses (Stoms *et al.* 1998).

Studies of bioregions in the United States include Black *et al.* (1998) who investigated the Palouse bioregion[7] so as to understand land use history at multiple scales and the biophysical changes that have occurred. This research provided a useful starting point for outlining future research needs, establishing conservation goals and targeting ecological restoration efforts and can also be used immediately in local land use planning efforts.

[7] The Palouse bioregion covers 16 000 sq km in westcentral Idaho, southeastern Washington and northeastern Oregon, between the western edge of the Rocky Mountains and the Columbia River Basin of the United States.

Another example where a bioregional management approach has been taken is by the United States Army. Legislatively, the United States Army is required to manage natural resources and conserve listed threatened and endangered species on Department of Defence land. In order to retain use of sufficient training lands while complying with these basic legal requirements, the Army has chosen to pursue a bioregional management approach to sustain ecosystems on a long-term basis. Getlein (1997) discussed how bioregional planning[8] offers the US Army an opportunity to use the natural resources of its installations' neighbours to solve common conservation problems.

Yaffee (1999) discussed how ecoregional management adopts many of the principles identified in the ecosystem-based approaches but emphasises landscape-scale management as a fundamental goal. Landscape ecosystems are seen as real geographic units defined as much by their abiotic and floristic components as by the species and communities of animals that associate with them. Success comes through maintenance or restoration of ecological functions associated with those landscape units. Ecoregions have been defined and mapped in a number of ways. Omernik (1995) defined ecoregions as "regions of

[8] Bioregional planning is defined by Getlein *et al.* (1997) here as planning that considers the natural boundaries of the studied area – watershed, climatic, altitudinal, and so on – as well as political boundaries.

relative homogeneity with respect to ecological systems involving interrelationships among organisms and their environment" and distinguishes between single-purpose and multi-factor mapping approaches.

Some in the bioregional movement have argued for redefining political boundaries to conform to large-scale ecological boundaries and for developing sustainable economies within these regions e.g. (Sale 1985) and (Meeker-Lowry 1990). An array of efforts to map ecoregions and landscape ecosystems (Albert 1993); (Omernik 1995); (Luoma 1997); (Ricketts *et al.* 1997); (The Nature Conservancy 1997) has narrowed the debate about boundaries, and landscape ecosystems are being used as management units (Barnes 1993).

Moss & Milne (1998) described how planning and management strategies in Canada are developed for the present and based upon data collected, and observations made at the time of the collection, without reference to the fact that any one point in time is but one stage in a sequence of events. Moss & Milne (1998) stated that it is necessary to strengthen understanding of those ecosystem processes that are relevant to planning goals, and that these must be defined in terms of both their spatial and temporal dimensions. In the Niagara Escarpment

of southern Ontario, Canada[9], these have been determined to be land surface features and forest cover, and, in particular, the processes that operate within these ecosystems. This IUCN web site explains bioregions in general, and explores the nine bioregions it has identified in the South American realm.

2.4 THE BIOREGIONAL FRAMEWORK IN AUSTRALIA

Whitehead *et al.* (1992) stated that the existing network of protected areas in the Northern Territory does not offer comprehensive protection of the avifaunal or floristic diversity present. Distribution of reserves is heavily biased to the Top End, and in particular to the Wet Tropical Zone[10] which is more than 19% reserved. The Dry Grassland Zone is virtually unrepresented and the Central Arid Zone is less than 1% represented (Whitehead *et al.* 1992). Protected areas are also spatially clumped at either end of the north-south ecological gradient so that the maximum distance along the gradient between significant 'neighbouring' reserves exceeds 800 km (Whitehead *et al.* 1992). Clearly the current reserve system does not satisfactorily sample the biological continuum in the Northern Territory, as elsewhere in Australia.

[9] The Niagara Escarpment is the dominant landscape feature of Southern Ontario and has been designated an UNESCO World Biosphere Reserve.
[10] This zone as defined by Whitehead *et al.* (1992) includes the huge Kakadu National Park, which represents approximately 45% of the total protected area in the Northern Territory.

At the end of 1998, New South Wales (NSW) had a reserve system occupying about 6.6% of its area, developed over more than a century (Pressey *et al.* 2000). Extensive reviews which have assessed the representativeness of part or all of the reserve system in relation to biogeographic regions (Environment Protection Authority 1997), and environmental sub-regions (Denny 1998) have confronted the lack of consistent, detailed data on biophysical variation across the State. The only review that have been based on maps on natural variation have been at the very broad scales of biogeographic regions, sub-regions and environmental domains (Pressey *et al.* 2000).

The use of management boundaries that make geographic sense has been the norm of watershed managers for many decades. But these ideals have not been achieved in practice and, as a result, get lumped and transformed into a new definition of appropriate management. The idea of bioregional management may have sounded new in the early 1990's, but in fact two clear examples already existed in Australia: the Australian Alps National Park and the Great Barrier Reef Marine Park. Although differing in management structure, both were attempts to plan, execute and evaluate integrated management over broad regions, each of which has distinguishing human, biological and physiographic attributes, across Federal and State jurisdictions with both local government and communities playing a critical role in the final implementation of management options.

The bioregional management approach focuses upon the political means to promote restoration and maintenance of the natural systems that ultimately support the people and nature in each area (World Resources Institute 2000). It rests on:

- a commitment to the health of natural systems;
- a spiritual and cultural affinity to community, the land, and ecological processes; and
- the goals of political decentralisation, self-determination, and social equity (World Resources Institute 2000).

Drawing upon the elements and experience of bioregionalism (World Resources Institute 2000), has identified an idealised set of characteristics for increasing the conservation, study, and sustainable use of biodiversity as below:

1) Large, biotically viable regions;
2) Leadership and management ;
3) A structure of cores, corridors and matrices;
4) Economic sustainability;
5) Full involvement of stakeholders;
6) Social acceptance;

7) Solids and comprehensive information;

8) Research and monitoring;

9) Use of knowledge;

10) Adaptive management;

11) Restoration;

12) Cooperative skills development;

13) Institutional integration; and

14) International cooperation.

The purposes of a bioregional or regional framework as described by (Parliament of the Commonwealth of Australia 1993) is to:

- Develop a systematic basis for understanding and recognising inherent biodiversity in each region;
- To enable environmental auditing of each region to determine the conservation status of biodiversity threatening processes, sustainability of landuse and socio-economic issues, so as to focus and prioritise conservation planning in this country; and

- To develop regional conservation strategies that integrates a representative reserve system with off reserve measures and ecologically sustainable development.

The IBRA provides a broad-level break up of the Australian landmass into eighty biogeographic regions (Chapter 1 - Figure 1.1) (Commonwealth of Australia 1999). The IBRA regions were derived by compiling climate, lithology/geology, landform, vegetation, flora and fauna, land use, and other attributes as needed (Commonwealth of Australia 1999). The most accessible robust data and information available at the time for each State and Territory was used including field knowledge, published resource and environmental reports, continental data sets, and existing biogeographic regionalisations (Commonwealth of Australia 1999). The IBRA regions can then progressively be subdivided into smaller scale (i.e. hierarchal) regional frameworks (Brunckhorst *et al.* 1998).

In order to provide a systematic framework for identifying the deficiencies in the existing system of protected areas, four conservation attributes were developed based on IBRA. The attributes were:

- reservation status of ecosystems and the percent area reservation in each IBRA region;

- the extent to which the existing system of protected area fails to include examples of the broad (vegetation types) ecosystems within an IBRA region;
- dominant land use and/or threatening processes within each IBRA region which places constraints and limitations to planning the NRS; and
- alternative conservation management measures.

The first three attributes have been used to derive draft priority IBRA regions for funding under the NRSP (Commonwealth of Australia 1999).

In Australia, the IBRA (compiled by Thackway & Creswell 1995a) was, at first, mistakenly considered a single scale, single use regionalisation intended only for conservation reserve assessment because it was initially developed for that single purpose. However, it actually incorporated multiple data sets of ecosystem and landscape characteristics and a combination of quantitative and qualitative synthesis, across scales (Brunckhorst 2000). Through its development in partnership with a variety of State and local resource management agencies it gained broad acceptance through several levels of government and some community groups (Brunckhorst 2000). Subsequently, it has become of wider interest to many public and private resource and land management agencies.

The following five steps outlined by Bridgewater *et al.* (1996) characterise the approach taken by all state and territorial nature conservation agencies in developing their respective contributions to the NRS:

- Step 1: Identify gaps in the current system of protected areas and setting priorities using a bioregional planning framework;
- Step 2: Identify representative ecosystem areas to fill the identified gaps (i.e. sites of key conservation significance);
- Step 3: Select potential reserve areas (i.e. potential candidate protected areas);
- Step 4: Assess the feasibility of potential reserve areas and negotiate new protected areas; and
- Step 5: Establish reserves and implement management.

These five steps are not always performed sequentially, and they usually involve varying degrees of analysis and feedback to the previous step(s), depending on data and information available, the involvement and support of interest groups, political willingness, and economic situations (Brunckhorst *et al.* 1998).

The IBRA is being used in Step 1 to assist in the identification of gaps in the current system of protected areas and to set priorities for filling these gaps. The former ANCA (or DEH) and the state and territorial nature conservation

agencies have developed a set of three conservation planning attributes for each IBRA region: reservation status, bias in the degree of comprehensiveness of ecosystem represented in protected areas, and constraints and limitations to planning the NRS (i.e. threatening processes) (Brunckhorst *et al.* 1998). These attributes were integrated by (the then) ANCA (see Thackway (1997)) for each IBRA region to establish national priorities (i.e. high, medium, and low) for allocation resources under the NRSP (see Chapter 1 - Figure 1.2). High priority bioregions (of which the Burt Plain is one) were defined as those with no reserves or that have a small proportion of the region in reserves, those that show substantial bias in proportion of reserves, and those with exceptional circumstances regarding long-term viability of the region's biodiversity due to threatening processes. Steps 2 through 5 are now being addressed by a scientific panel that will report to the ANZECC (Brunckhorst *et al.* 1998).

2.4.1 Development of bioregions across the States and Territories

There are currently 85 IBRA regions Australia wide, and 404 sub-regions that have now been defined based on major geomorphic features in each bioregion (Version 6.1). The bioregions and sub-regions are the reporting unit for assessing the status of native ecosystems, their protection in the national reserve system and for use in monitoring and evaluation framework in the Australian Government's current Natural Resource Management initiatives.

Tasmania

By 1994, the Tasmanian Parks and Wildlife Service had identified eight IBRA regions for Tasmania (Peters & Thackway 1998). These were derived from the *Nature Conservation Regions* (NCRs) by a process of aggregation and boundary refinement based on specialist knowledge. Currently there are nine IBRA regions for Tasmania. Edgar *et al.* (1997) described how quantitative surveys of plants and animals were made at over 150 shallow rocky reef sites around the Tasmanian coastline and Bass Strait islands in order to maximise the conservation value of sites within a proposed system of representative marine protected areas (MPAs). Data were analysed using several different methods (overlap of species ranges, multidimensional scaling and ecotone analysis) to produce a state bioregionalisation and identification of appropriate MPA sites (Edgar *et al.* 1997).

Queensland

Queensland's bioregions as described by Stanton & Morgan (1977) represent the primary level of biodiversity classification at a scale of approximately 1:1 000 000 – 1: 2 500 000. These regions are based on broad landscape patterns that reflect the major structural geologies and climate as well as major changes in floristic and faunistic assemblages (Sattler & Williams 1999). The bioregions of

Queensland have been the fundamental framework used in planning the expansion of the National Park estate over the past decade, and have focused on sampling biodiversity comprehensively across all bioregions. Importantly, this bioregional approach has enabled public recognition of the need to protect biodiversity in all parts of the State, as distinct from the readily accessible or 'charismatic' environments (Sattler & Williams 1999).

In total, 19 bioregions have now been recognised as occurring in Queensland in whole or part (Sattler & Williams 1999). Those parts of bioregions that overlap with adjoining States and the Northern Territory are recognised as distinct provinces within the 13 Queensland bioregions. Queensland's bioregions contain a further level called 'provinces' which provide a framework for the future description of detailed land types nested within regional ecosystems at a scale of 1:50 000 – 1:100 000. These provinces delineate significant differences in landscape pattern usually associated with geology and geomorphology or finer climatic differences. The provinces therefore have a characteristic pattern of landform and vegetation, and generally indicate major differences in land processes and energy budgets, and species distributions and patterns of movements (Davie *et al*. 1994).

Wilson *et al.* (2002) summarised: (i) the Queensland Herbarium survey and mapping methods and land classification system and its role in vegetation management legislation and, (ii) the current extent and rate of vegetation clearing by bioregion, sub-region and Broad Vegetation Group; (iii) and the amount of vegetation protected under legislated statewide bioregional and regional ecosystem thresholds. Information also is provided on the pre-clearing and current extent by 18 Broad Vegetation Groups and the area of non-remnant woody vegetation by bioregion. For bioregions and regional ecosystems where past clearing has been extensive, a substantial proportion (50-91%) of the remaining vegetation is protected by bioregional and regional ecosystem thresholds prescribed under statewide legislation and associated policies. For other bioregions and regional ecosystems, other factors such as rainfall, soil and areas of high conservation value are likely to play a larger role in determining the amount of vegetation protected. However, the effectiveness of the Queensland legislation cannot be assessed until regional planning, processes have been completed and all criteria addressed.

Northern Territory

There are currently 23 bioregions in the Northern Territory. Connors *et al.* (1996) presented an information base for the 20 nationally defined bioregions which occur in the Northern Territory. The report lists each bioregion and includes

information about the extent of reservation (and other land tenure), land values, the reservation bias, known conservation values or other reservation priorities (including lists of threatened and unreserved plants and animals, species recorded mostly from the bioregion, tables of the extent and reservation status of every vegetation type present in the bioregion, refugial values and wetland values), lists of weed species recorded, amount of distributional data available, and list of relevant references (including wildlife survey, land system mapping and resource appraisal surveys for pastoral properties). Bioregional planning has been accepted by the Department of Infrastructure, Planning and Environment, and detailed planning for one bioregion has now been commenced (Connors *et al.* 1996).

Western Australia

In total, 25 bioregions have now been recognised as occurring in Western Australia in whole or part and within those 53 biogeographical subregions (McKenzie *et al.* 2002). The Western Australian input to the national scheme is based on Beard's Phytogeographic Regions (Beard 1980), with minor changes derived from new knowledge. The scheme resulting from this second approach has been used as the basis for an assessment of conservation status (Hopkins *et al.* 1996). Hopkins (1996) found a number of vegetation types inadequately reserved and high number of vegetation types that were not in reserves at all. In

2001-02, the Department of Conservation and Land Management undertook an extensive audit of the State's terrestrial biodiversity as part of the National Land and Water Resources Audit Biodiversity Assessment. McKenzie *et al.* (2002) provides a summary of those findings for each of the biogeographic regions and summarises the nature conservation issues faced in 2002.

New South Wales (NSW)

Seventeen of the 80 Australian biogeographic regions delineated by Thackway & Cresswell (1995b) occur partly or wholly within NSW. The regions have been identified mainly according to geology and relief (see Morgan & Terrey (1990) for descriptions and rationale for most of the regions in the State). Pressey *et al.* (2000) used a regionalisation approach to reflect broad patterns of land use and biodiversity in NSW. This showed within-State variation in reservation and quantitative reservation bias.

Morgan and Terrey (1992) subdivided the eleven biogeographic regions in western NSW into subregions and provinces, based mainly on geology, relief, soils and vegetation. The six eastern regions have also been divided into subregions by Denny (1998) according to variation in relief, altitude, geology, soils and climate. Pressey *et al.* (2000) then matched the boundaries of the two

subdivisions to produce a layer of 104 subregions and provinces across the State, all nested within biogeographic regions.

Pressey *et al.* (2000) tabulated remaining native vegetation, reservation, reservation bias, and extent of high-priority landscapes in subdivisions of New South Wales including biogeographic regions. Few biogeographic regions have extensive areas of well-reserved landscapes and most regions are dominated by poorly reserved landscapes.

South Australia

In total, 11 bioregions have now been recognised as occurring in South Australia in whole or part. The only published information regarding bioregions in South Australia occurs in the State of the Environment Report for South Australia (Department for Environment Heritage and Aboriginal Affairs 1998). Here a summary of the area of remnant vegetation by IBRA is given for South Australian bioregions[11], as well as a figure[12] showing the percentage of IBRA in South Australia, percentage of conserved in protected areas, and the percentage of environmental associations conserved.

[11] Table 12.1 (Department for Environment Heritage and Aboriginal Affairs 1998) page 195
[12] Figure 12.2 (Department for Environment Heritage and Aboriginal Affairs 1998) page 196

Victoria

Bioregions identified in Victoria form part of national frameworks for terrestrial and marine environments, the IBRA and IMCRA. Of the 80 IBRA regions delineated across Australia, eleven occur in Victoria with eight of these shared with adjacent States. Of the 60 IMCRA regions delineated around Australia, five occur in Victorian waters with three of these shared with adjacent States (Crown State of Victoria 1997a, b, c). The broad scale that is appropriate for national purposes was not able to discriminate adequately between areas with meaningful differences at the state-wide scale. Therefore a further refinement delineated 21 Victorian bioregions and described them in a Victoria context (Crown State of Victoria 1997a, b, c). The National Strategy for the Conservation of Australia's Biological Diversity, the National Strategy for Ecologically

Sustainable Development and the Victorian *Flora and Fauna Guarantee Act* 1988 all provide overarching objectives for the conservation and management of biodiversity in Victoria (Crown State of Victoria 1997a, b, c).

Crown State of Victoria (1997a; 1997b; 1997c) described and discussed each Victorian bioregion, detailing biodiversity condition and management responses. It also provided maps, tables and charts illustrating comparative data relating to flora and fauna information. Bioregional networks have been established to facilitate partnerships between the wide range of land managers who share

responsibilities for biodiversity conservation in Victoria (Crown State of Victoria 1997a, b, c).

2.4.2 The role of off-reserve biodiversity conservation

Pence *et al.* (2003) investigated the practical and financial implications of alternative strategies for meeting explicit conservation goals on the Agulhas Plain, South Africa. In addition to traditional on-reserve protection, they identified two types of property-rights agreements (conservation easements and management agreements) and two types of financial incentives (land management assistance and tax relief) as appropriate for encouraging off-reserve conservation on targeted lands in the area. The conservation costs, to both the public and private sector (including expanded obligations from new legislation), were first modelled and then analysed in a Geographic Information System (GIS). Australia's biological diversity and the threats to it extend across tenure and administrative boundaries (Commonwealth of Australia 1996b). Achieving off-reserve conservation goals is discussed by Fisher (1998) for the Barkly Tableland. James *et al.* (2000) also describe off-reserve conservation of native species with animal production in Australian rangelands. Hoffmann (2003) describes how it is envisaged that ants will have an important role to play in the sustainable management of Australia's rangelands aiding the off-reserve conservation of biodiversity.

2.4.3 Native Forests as a special case

Australia's National Forest Policy of 1992 (Commonwealth of Australia 1992) sets out broad conservation and industry goals for the management of Australia's forests agreed between the Commonwealth, State and Territory Governments. To implement this national policy, governments agreed to:

- Provide interim protection to forest areas which may be required for a Comprehensive, Adequate and Representative (CAR) forest reserve system;
- Undertake Comprehensive Regional Assessments (CRAs) of environment, heritage, economic and social values of forests; and
- Negotiate Regional Forest Agreements (RFAs) between the Commonwealth and State governments about the long-term management and use of forests in a particular region.

Regional Forest Agreements (RFAs) are agreements between the Commonwealth and State governments which provide a blueprint for the future management of the forests, and the basis for an internationally competitive and ecologically sustainable forest products industry (Environment Australia 2000). The 20-year agreements aim to establish:

- A world class Comprehensive, Adequate and Representative (CAR) forest reserve system;

- Certainty for industries and regional communities, enabling the development of internationally competitive and ecologically sustainable industries; and
- Ecologically sustainable management of the whole forest estate, both on and off reserves.

The relationship between the IBRA and the Regional Forest Agreement process is important. The IBRA is the instrument for determining bioregional targets for the forest CAR reserve system (JANIS 1996), including the private land component.

2.4.4 The Indigenous Context and Indigenous Protected Areas

Terrestrial and marine areas within the Aboriginal domain in Australia lie both within and outside Aboriginal jurisdictions and as a result fall under a variety of tenures and statutes which apply a range of restrictions on land use, access to outsiders and dealings in land (Langton 1996). Aboriginal communities and regions have developed environmental protection plans (Langton 1996). These developments, following successful Aboriginal management of national parks at Uluru-Kata Tjuta, Kakadu and Nitmuluk are evidence of Aboriginal concern to be involved in planning the various uses of human and non-human environments at a local and regional level.

For bioregional planning to have any relevance to Indigenous communities Fourmile (1996) suggested that they must be involved in the determination of not only what constitutes a bioregion in terms of both cultural and natural criteria, but also in the determination of the boundaries of bioregions. Indigenous communities must be treated as stakeholders who have an equal right to be involved in bioregional planning and biodiversity conservation and therefore all planning groups associated with a bioregion are obligated to involve the local indigenous communities in all activities incorporating these processes and their implementation (Fourmile 1996). Planners must respect the fact that in any one bioregion there will be a number of local Indigenous communities involving a number of clans, families and other land affiliated groups (Fourmile 1996). Bioregional planning and biodiversity conservation must also accommodate indigenous subsistence rights.

2.5 CONCLUSIONS

The IBRA is now firmly established as a conservation-planning tool at both national and regional levels and its further refinement and application will continue to be important components of Australia's conservation efforts. Use of the IBRA bioregions will assist in the assessment of the conservation status of regional ecosystems on a national basis.

It is extremely difficult to abolish existing administrative boundaries and management units, but as shown in this literature review, it is not impossible to transcend them. Today, many different sciences contribute to understanding ecosystem structure and dynamics. Regional planning in which environmental characteristics are a principal determinant of boundaries is considered to be of major importance if conservation of biodiversity is to succeed (Commonwealth of Australia 1996b).

Several state and Territory governments are also beginning to plan and manage on a bioregional basis as part of their land management responsibilities. Actions such as this are needed elsewhere in Australia; they must be based on ecological parameters, vegetation types, catchment areas and climatic factors, combined with the interests of those living and working in the area (Commonwealth of Australia 1996b).

CHAPTER 3 - A REVIEW OF THE ROLE AND LIMITATIONS OF GEOSPATIAL TECHNOLOGIES CURRENTLY EMPLOYED FOR BIODIVERSITY CONSERVATION AND MANAGEMENT

3.1 INTRODUCTION

In this chapter I review the role and limitations of geospatial science technologies currently employed for biodiversity conservation at the regional level in Australia. I consider the applications of Geographic Information Systems (GIS) to wildlife research and management, and discuss developments in GIS that allow managers to better understand landscape-scale dynamics (Sessions *et al.* 1997).

Many questions posed by biodiversity researchers and managers relate to the interactions between species and environmental factors that are inherently spatial such as climate, vegetation, soils, topography and human disturbance. GIS provide a capability to study ecological interactions over large areas because of their capacity to store, display, manipulate and analyse spatial data (Johnson 1990; Shaw & Atkinson 1990). GIS vary enormously in their implementation capabilities of visualisation, organisation and analysis of spatial and temporal data (Walker 1996). Although various forms of GIS have been available for over

20 years, the use of GIS has figured most prominently in the ecological literature in the past decade. Given further reductions in cost of computing facilities, and greater access to ecological data in the future, GIS technology is likely to figure prominently in the methods used by ecologists in the future (Klomp & Lunt 1997).

Researchers are looking to newer tools with which they can process and display the results of their field work. The development of these tools is in direct response to a need to estimate species distributions and abundances, and to predict the responses of these species to different management alternatives (Burgman 1994).

Johnson (1990) published a review of the use of GIS in ecological applications. She found the GIS operations most frequently used were: the derivation of area and length measures; the spatial intersection of features by merging data sets for analysing coincidence and the detection of temporal change; proximity analyses; and, the derivation of data for input to models. In landscape ecology GIS are a fundamental tool, especially as a platform to analyse data and examine models (Farina 1998). GIS can be indispensable for landscape investigations, such as:

- Land use change;
- Vegetation patterning;
- Animal distribution across the landscape;

- Linking remote sensing with topography; and
- Modelling processes across the landscape.

GIS have also been used extensively in biodiversity management and research for the following applications:

- Mapping distribution of species and habitats;
- Analysis of movements;
- Monitoring temporal change;
- Management of species;
- Assessment of biological diversity;
- Selection of survey sites;
- Assessment of impacts and hazards;
- Linkages to models;
- Habitat restoration; and
- Reserve design and selection.

More recent publications include Millington *et al.* (2001) who review a representative set of exam ples from the many varied spatial techniques and analytical approaches being used today by geographers, ecologists, and biogeographers to study plant and animal distributions. Vogiatzakis (2003) discusses the role of GIS-based modelling in nature conservation focusing on the predictive models for species occurrence, plant community occurrence and

habitat suitability as well as looking at the importance of Digital Elevation Models and their derived properties in ecological studies.

3.2 APPLICATIONS OF GEOSPATIAL TECHNOLOGIES

3.2.1 Mapping distribution and habitats

The following review of applications of geospatial technologies is not exhaustive bur rather focussed on examples of work relevant to the current thesis. These applications are discussed below with Australian examples given where they exist. The literature on mapping of distributions and habitats of biota in a GIS framework is extremely broad and covering all aspects of it would be beyond the scope of this thesis. Digital image analysis of remotely sensed data has proved to be an effective and cost efficient method for mapping habitat of plant and animal species in large areas (Aspinall 1992; Aspinall & Veitch 1993; Kautz 1992; Kirby *et al.* 1996; Matthews 1991; Miller 1994; Mumby *et al.* 1997; Van Manen & Pelton 1997). Habitat maps appear most capable of providing information on the distributions of large numbers of species in a wider variety of habitats (Nagendra 2001). With the launch of new satellites such as IKONOS, satellite imagery and remotely sensed data have also been used for coastal and marine habitat and environment mapping (Capolsini *et al.* 2003; Gaines *et al.* 1998; Long & Skewes 1996; Mumby & Edwards 2002; Mumby *et al.* 1997; Pausas *et al.* 1995; Riegl &

Purkis 2005; Sanderson 2001; Stathopoulou *et al.* 2004). Accuracy of maps are improved by using existing spatial ecological information and also collecting ground data (Matthews 1991).

Various satellites regularly record land cover data using a range of wavelengths within the electromagnetic spectrum, which can be translated into visual images. The size and type of habitat patch that can be distinguished depends on the spatial resolution of the satellite system and also on the degree to which different habitats can be unambiguously separated according to their reflectance of different types of radiation (Kirby *et al.* 1996). Discrimination between habitats can be improved by comparing areas of known land cover with their satellite images and then searching for other areas with a comparable signal. Nevertheless there remain difficulties in reconciling estimates of the extent of and change in land cover types from different surveys because of differences in cover type and definition and recognition (Kirby *et al.* 1996).

GIS has been applied to a great number of endangered species protection projects. Most involve the determination of suitable habitat areas, which then becomes the basis for management plans and protection strategies. GIS enables the development of predictive relationships between environmental factors and the distribution of species. GIS has been used for mapping of habitat and

prediction of distribution of many species, especially those that are rare or restricted in range or habitat (Table 3.1).

Most studies have used the capabilities of GIS to overlay several layers of data and create new layers identifying areas of coincidence of specific attributes. A few studies have taken advantage of the spatial attributes inherent to GIS, such as measuring size of habitat patch, proximity to edge of patch or spatial arrangement of habitat patches to incorporate into definitions of habitat suitability (Hodgson *et al.* 1987, 1988; Palmeirum 1988; Shaw & Atkinson 1988; van Horne 1990). These studies suggest that adding spatially explicit requirements to models removes one of the largest sources of error in existing modelling procedures.

Palmeirum (1988) used satellite imagery to generate a potential distribution map for birds based on land cover. Spatial factors such as minimum size of forest patch and proximity to edge of forest were used with the type of land cover to produce maps showing the probability of occurrence of species. An algorithm was applied to these probability maps to produce maps of density of a species throughout the study area and estimate the total number of individuals of a particular bird species in the study area.

Shaw & Atkinson (1990) used an evaluation of the size distribution of patches of habitat, the relationship between size of patch and distance between adjacent patches, and the proportional amount of edge in a patch (i.e. deviation from a circular patch) to describe the spatial characteristics of habitat for Golden-cheeked Warbler *Dendroica chrysoparia*. Measures of shape and size of polygons were used to evaluate suitability of habitat for land birds in the southern Cook Islands (Franklin & Steadman 1991). However, the measures used (size of the largest polygon, a perimeter-area index, fractal dimension) did not add to the description of habitat in their study. They concluded this was because the systems were small, spatially simple and had limited flora and fauna.

Table 3.1: Global and Australian (*) examples of individual wildlife species applications of GIS.

REPTILES	
Gopher Tortoise *(Gopherus polyphemus)*	(Mead *et al.* 1988)
Elapid Snakes	(Nix 1986)
LIZARDS	(James & Shine 2000)
BIRDS	
	(Neave 1993; Neave *et al.* 1996a; Neave *et al.* 1996b, c) (van Horne 1990); (Schuster 1990); (Saetersdal *et al.* 1993); (Franklin & Steadman 1991)
Antarctic seabirds	(McCormick 1994)
Black Tern (*Chlidonias niger)*	(Naugle *et al.* 2000)
California Condor (*Gymnogyps californianus)*	(Scepan *et al.* 1987); (Stoms *et al.* 1990)
Spotted Owl *(Strix occidentalis)*	(Glenn & Ripple 2004; Young *et al.* 1987); (Davis & DeLain 1986); (Laymon & Barrett 1986; Laymon & Reid 1986); (Verner *et al.* 1992); (Lehmkuhl & Raphael 1993); (Specht 1995)
Large owls	(Loyn *et al.* 2000)
Bald Eagle (*Haliaeetus leucocephalus)*	(Chandler *et al.* 1990)
Golden-cheeked Warbler *(Dendroica chrysoparia)*	(Shaw & Atkinson 1988)
Wood Stork (*Mycteria Americana)*	(Hodgson *et al.* 1987, 1988); (Gaines *et al.* 2000; Gaines *et al.* 1998)
Red-cockaded woodpecker *(Picoides borealis)*	(Azevedo *et al.* 2000)
White-breasted Nuthatch *(Sitta carolinensis)*	(Palmeirum 1988)
Red-eyed Vireo (*Vireo olivaceus)*	(Palmeirum 1988)
Indigo Bunting (*Passerina cyanea)*	(Palmeirum 1988)
American White Pelican *(Pelecanus erythrorhynchos)*	(Anderson & Anderson 1990)
Cook Is. land birds	(Franklin & Steadman 1991)
* Helmeted Honeyeater *(Lichenostomus melanops cassidix)*	(McCarthy 1994); (Akcakaya *et al.* 1995)
Tanzania rare birds	(Miller *et al.* 1989)
Sandbill crane *(Grus Canadensis)*	(Pearlstine *et al.* 1995); (Baker *et al.* 1995)
Wading birds	(Pearlstine *et al.* 1995)
Frugivorous birds	(Price *et al.* 1999)
Bioko Is. Endemic birds	(Lenton *et al.* 2000)
Neotropical migratory birds	(Penhollow & Stauffer 2000)
Grouse	(Kurki *et al.* 2000)

Namibian endemic birds	(Jarvis & Robertson 1999)
Waterfowl	(Jr. *et al.* 1995a; Jr. *et al.* 1995b)
Shorebirds	(Taft *et al.* 2003)
MAMMALS	
* Arboreal & Ground Dwelling	(Norton & Briggs 1993)
	(Cork & Catling 1996); (Catling *et al.* 1998; Catling & Coops 1999); (Pausas *et al.* 1997; Pausas *et al.* 1995)
* Forest fauna	(Ferrier 1991, 1993); (Neave & Norton 1991; Neave *et al.* 1993)
Black Bear *(Ursus americanus)*	(Van Manen & Pelton 1997); (Holt 1991)
Grizzly Bear (*Ursus arctos)*	(Franklin *et al.* 2002; Rounds & Shovic 2000); (Peterso 1996)
Giant Panda *(Ailuropoda melanoleuca)*	(Chen & Fu 1999)
Marten *(Martes spp.)*	(Kurki *et al.* 1998); (Schulz & Joyce 1992)
Beaver *(Castor spp.)*	(Johnston & Naiman 1990)
Cougar (*Puma concolor)*	(Gagliuso 1991)
Jaguar (*Panthera onca*)	(Ortega-Huerta & Medley 1999)
Cheetah (*Acinonyx jubatus*)	(Gros & Rejmanek 1999)
Panther *(Panthera spp.)*	(Pearlstine *et al.* 1995)
Mountain Lion (*Puma concolor*)	(Pike *et al.* 1999)
Gray Wolf (*Canis lupus*	(Mladenoff & Sickley 1998)
Red Fox (*Vulpes vulpes)*	(Kurki *et al.* 1998); (Haslett 1990)
White-tailed Deer (*Odocoileus virginianus)*	(Foster *et al.* 1997); (Ormsby & Lunetta 1987); (Tomlin *et al.* 1987)
Tehama Deer *(Odocoileus hemionus)*	(Stenback *et al.* 1987)
Red deer (*Cervus elaphus)*	(Palmer & Hester 2000)
Mule deer and Elk (*Odocoileus hemionus)*	(Johnson *et al.* 2000); (Cooper & Millspaugh 1999); (Ling & West 1997)
Roe deer (*Capreolus capreolus)*	(Radeloff *et al.* 1999)
Antelope (Bovidae)	(Perrin & Taolo 1999)
Caribou *(Rangifer spp.)*	(Bechtel *et al.* 2004)
Muskox (*Ovibos moschatus)*	(Ferguson 1991)
Bison *(Bison spp.)*	(Matthews 1991)
Sheep (*Ovis aries)*	(Palmer & Hester 2000)
Wild pigs *(Sus spp.)*	(Waitham *et al.* 1999); (O'Brien 1991)
Pygmy rabbit (*Brachylagus idahoensis*)	(Gabler *et al.* 2000)
Black-tailed jackrabbit (*Lepus californicus)*	(Knick & Dyer 1997)
Northern bobwhite (*Colinus virginianus)*	(Dixon *et al.* 1996)
Tiger (*Panthera tigris)*	(Seidensticker 1997); (Worah *et al.* 1989); (Wikramanayake *et al.* 1998)
Spotted Deer *(Axis axis)*	(Worah *et al.* 1989)
Rustyspotted Cat *(Felis rubiginosa)*	(Worah *et al.* 1989)

Giant Squirrel *(Ratufa spp.)*	(Worah *et al.* 1989)
Elephant *(Pachyderm spp.)*	(Barnes *et al.* 1997)
* Macropods	(Skidmore *et al.* 1996); (McAlpine 1994, 1995; Walker & Cocks 1991); (Buchanan & Wardell-Johnson 1990; Walker 1990)
* Leadbeater's Possum (*Gymnobelideus leadbeateri)*	(Lindenmayer *et al.* 1991; Lindenmayer *et al.* 1990; Lindenmayer & Possingham 1995; Smith & McFarlane 1991; Smith & McFarlane 1994)
* Koala (*Phascolarctos cinereus)*	(Lunney *et al.* 1998); (Bryan 1997)
Arabian oryx (*Oryx leucoryx)*	(Liedeker *et al.* 1993)
Tibetan wild ass (*Equus kiang)*	(Sharma *et al.* 2004)
• Greater Glider • *(Petauroides volans)*	(Lindenmayer *et al.* 1994)
Lemur	(Smith *et al.* 1997)
* Tasmanian Devil (*Sarcophilus harrisii*) & Eastern Quoll (*Dasyurus viverrinus)*	(Jones *et al.* 1999)
Rodents	(Sutherland & Dickman 1999)
* New Holland Mouse *(Pseudomys novaehollandiae)*	(Lock & Wilson 1999); (Wilson *et al.* 1999)
Badger	(van der Zee *et al.* 1992)
Mt Graham red squirrel *(Tamiasciurus hudsonicus grahamensis)*	(Pereira & Itami 1991)
Harbour porpoise (*Phocoena phocoena)*	(Forney *et al.* 1991)
Manatee (*Trichechus spp.*)	(Ward & Johnstone 1993)

The proximity of foraging habitats from a Wood Stork colony and measures of patch contiguity were incorporated into habitat models for Wood Stork by (Hodgson *et al.* 1987, 1988). They found the largest foraging areas were closest to the colony nesting site suggesting a possible reason for the Stork's selection of the nesting site (Hodgson *et al.* 1987, 1988).

Glenn and Ripple (2004) found that there were no accepted standards in the wildlife literature for reporting details of digital map products used to assess habitat. Digital maps developed from remotely sensed images vary widely in how they represent landscapes. Consequently, certain characteristics of remotely

sensed data need to be addressed when reporting results obtained from digital maps to allow the reader to understand the strengths and limitations of the map product(s) used. Glenn & Ripple (2004) reviewed 44 articles published in The Journal of Wildlife Management between 2000-2002 that used digital maps developed from either satellite imagery or aerial photography to assess wildlife habitat and summarised which map parameters were reported and which were overlooked. Most papers failed to report important details about digital map products used to assess wildlife habitat. Glenn & Ripple (2004) provided a suggested list of map details to be reported when using digital maps to quantify wildlife habitat.

3.2.2 Analysis of animal movements

Movement patterns of individuals have been analysed using GIS to store data collected from radio telemetry studies (for Red Foxes reported in Haslett (1990), Cougars by Gagliuso (1991), and Spotted Owls by Young *et al.* (1987)). These studies also analysed the use of habitat by overlaying movement patterns with habitat variables.

Analysis of data on return of bird bands can provide information on distribution, dispersal, movements and mortality of individual birds and populations. A GIS was used in the analysis of band returns of American White Pelicans to

accurately map banding sites and return sites (Anderson & Anderson 1990). The use of GIS has the potential to permit more sophisticated analyses of data collected from bird-banding with larger quantities of data than have been undertaken in the past (Anderson & Anderson 1990).

3.2.3 Monitoring temporal change

GIS can be a powerful tool for the detection of spatial change over time. Changes in hydrology and vegetation caused by Beaver impoundments in a Minnesota national park were analysed over a 40 year period (Johnston & Naiman 1990). Data were mapped from aerial photographs and techniques of overlay and reclassification used to quantify changes. In another study, changes in the amount and location of foraging habitat for Wood Storks between a wet year and a dry year were analysed by Hodgson *et al.* (1987). van Sickle (1991) used overlays of infestations of pine beetles in different years to look at temporal change and (Rowland 1986) used surface modelling techniques to analyse infestation trends of Gypsy Moths and compare between years.

3.2.4 Management of species

GIS studies addressing the management of biodiversity vary considerably in design and comprehensiveness. Most studies stop at the point of providing an inventory base for management planning for wildlife species, although some studies have addressed specific management issues. Eng *et al.* (1991) developed a planning tool to integrate wildlife habitat assessment and forest management using a GIS linked to an expert system.

The selection of habitat management zones for Spotted Owl in forest used for timber production was based on selection of zones with the least area of accessible, merchantable timber (Davis & DeLain 1986). This was determined by evaluating for each habitat zone the distance from roads and amount of timber over a specified age.

GIS has the potential to assist in the identification of wildlife corridors at a regional scale to link similar patches of habitat or patches of habitat along a gradient, such as climate (Norton & Nix 1991). Norton & Nix (1991) suggested climatic data coupled to a digital elevation model may be used generate data on which an assessment of corridors at a regional level may be made.

3.2.5 Assessment of biological diversity

The advantages of applying GIS to the analysis of species diversity include the ability to use a methodological approach to predict species patterns (Miller *et al.* 1989). The spatial distribution of environmental variables (soil and vegetation) were used to develop a predictive model of areas with a high diversity of rare bird species in Tanzania (Miller *et al.* 1989). The distribution of these species were mapped then combined to record the number of rare species in an area. This was converted to an index of diversity. Diversity indices were also produced from soils and vegetation classes and overlayed with the species diversity. Statistical correlation and regression analyses were performed on these layers. The resulting predictions of areas of high biological diversity can be used to facilitate the selection and design of conservation reserves or identify areas for further investigation (Miller *et al.* 1989).

Prins (1997) provided an example of how high and low resolution satellite data can be integrated into GIS and used for decision support for nature and natural resource management in two fauna reserves in Senegal. Benefits included: large scale land cover mapping; analysis of resource utilisation; analysis of land degradation; modelling of biodiversity and modelling of habitat areas. Prins (1997) summarised the steps used in the biodiversity assessment method (based on avian data). In the first step, Prins (1997) produced a landscape diversity map

by applying a Shannon diversity index (using diversity index in IDRISI with a 5 x 5 template) to the Landsat TM classified land cover map. Secondly, landscape diversity was observed on the basis of average biomass production measured from integrated NOAA NDVI data. The method has been tested by correlating the digital scores with bid counting from the transect walking. The observation revealed high correlation with avian diversity and/or number of bird species.

3.2.6 Selection of survey sites

The selection of sampling sites for surveys or research can use the capability of GIS to select sites similar and/or different in as many environmental factors as possible (Haslett 1990). Alternatively, areas could be stratified according to pre-determined factors before selection of sites. To census rainforest pigeons in Northern New South Wales survey sites were selected using a GIS to select sites based on vegetation type, elevation and logging history (Date *et al.* 1990).

3.2.7 Assessment of impacts and hazards

Use of GIS to assess environmental impacts and potential wildlife hazards has mainly been applied to insect pests in timber-production forests. Overlays of environmental factors have been used to predict areas susceptible to insect

infestations for the prediction of future outbreaks and for planning control programs (van Sickle 1991; White 1986). van Sickle (1991) used overlays of infestations of pine beetles in different years to estimate timber-volume losses caused by the pests.

Hunter (1986) described a model developed to evaluate the potential risk of hazardous waste sites to rare and threatened species of wildlife and important areas such as wildlife reserves and areas with high concentrations of species. The model assigns values to data themes that effectively weight each theme before the map layers are overlayed and added together to create a new data layer. The values on the new layer can be used to assess the potential risk at any site.

The impact and value of feral pigs in geographic management units in eastern Australia was quantified using a GIS by (O'Brien 1991). Data on the population of density of pigs, poisoning rates, recreational hunting surveys, commercial catches and pest control officer surveys were used to assess the costs and benefits of feral pigs in each management unit to provide a basis for management planning. Similarly, Prins (1997) used a combination of low and high resolution satellite data to detect former, recent and ongoing land degradation. Overlaying villages, tracks and boreholes on top of the degradation map, provided reasons

for areas of degradation, including an impression of where the livestock are degrading the landscape (Prins 1997).

3.2.8 Linkages to models

Another area of application of GIS to wildlife is for the use of spatially-linked models (Burley 1989; Davis & DeLain 1986). The use of computer-generated models to simulate environmental events can provide a greater understanding of ecosystems, and offers improved predictive powers to conservation and land managers (Klomp & Lunt 1997). Modelling has been referred to increasingly in the ecological literature over the past 20 years and a diverse range of ecological systems and taxa have been considered. Relevant examples include; (Aspinall & Pearson 1993; Aspinall & Veitch 1993; Austin 1987, 1994; Austin *et al.* 1997; Austin & Meyers 1995, 1996; Austin *et al.* 1995; Austin *et al.* 1994a, b; Belbin *et al.* 1995; Buckley *et al.* 1992; Burley 1989; Catling *et al.* 1998; Clark *et al.* 1993; Cork & Catling 1996; Cumming 2002; Donovan *et al.* 1987; Elith 2000; Gros & Rejmanek 1999; Guisan *et al.* 2002; Gustafson *et al.* 2001; Kirkpatrick 1983; Lenton *et al.* 2000; Lindenmayer *et al.* 1991; Lindenmayer *et al.* 1990; Lindenmayer & Possingham 1995; Ling & West 1997; Loyn *et al.* 2000; Mackey & Bayes 1989; Margules & Austin 1994; McDonnell *et al.* 2002; Norton & Nix 1991; Norton & Possingham 1993; Pausas *et al.* 1997; Pausas *et al.* 1995; Pereira & Itami 1991; Possingham 1996; Pulliam *et al.* 1995; Radeloff *et al.* 1999; Rondinini *et al.* 2005; Roy & Tomar 2000;

Skidmore *et al.* 1996; Verner *et al.* 1986; Walker 1990, 1996; White 1986; Williams *et al.* 2004; Wilson *et al.* 1999).

Walker (1996) argued that the lack of understanding about spatial modelling by ecologists has left many data sets under-utilised. Ferrier & Watson (1997) have evaluated the effectiveness of environmental surrogates and modelling techniques in predicting the distribution of biological diversity and (Fielding & Bell 1997; Heuvelink 1998; Rykiel 1996) have reviewed methods for the assessment of prediction errors and error propagation in conservation presence/absence models. McCarthy *et al.* (1994) have reviewed the use and abuse of wildlife models for determining habitat requirements.

Beyond map-drawing and databases is the issue of query systems that allow users to interpret the information and ask pertinent questions. Green (1997) suggested that for dealing with complexity, the principal issue is to be able to look at the interactions of different processes. Most GIS' include overlays as a basic operation, but Green (1997) has recommended that researchers need to go further and carry out a range of analyses, and be able to run models, including simulations.

The LIFE Page of the World Wide Web (Bristow & Green 1994) provides several public, on-line facilities such as interpretive tools, including:

- MapMaker – which allows users to plot their own data on custom-made maps (Steinke *et al.* 1995);
- GARP (genetic algorithms for rule production) – which allows users to infer species distribution models from their own data (Stockwell 1992); and
- FRACTOP (Jelinek *et al.* 1996) – carries out fractal analysis of user-supplied images, such as aerial photos of forests.

There is a large volume of literature on methods for modelling wildlife distribution including habitat suitability indices (HIS)[1], statistical methods including generalised linear models (GLMs) and generalised additive models (GAMs) (see Austin *et al.* 1995), as well as spatial and inductive (cartographic and regression trees, neural nets, Bayesian and weights of evidence) models (see Walker 1990 and Miller *et al.* 1989).

Freitag *et al.* (1998) commented on how true absence data are generally not readily available and the existence of presence only data is of limited value for spatial interpolation (such as generalised linear models Nicholls 1991b) or for the prediction of species distributions from broad-scale environmental parameters (Nicholls 1991a). Thus data extrapolation to unsurveyed areas is not often attempted.

[1] HIS models test the ability of habitat to provide life requisites for a particular species, by determining a numerical index of appropriateness and assigning that value to a given land-use category or vegetation type at a given point in time (Lenton *et al.* 2000).

Lindenmayer *et al.* (1991) used a GIS to extract data from areas surrounding specific sites known to support arboreal marsupials. Habitat models were developed from site-specific data and partial correlation analyses used to determine if the variables surrounding the site better described the presence and abundance of arboreal marsupials than site-specific measures alone.

Walker (1990) argued that GIS are very good for applying deductive models of the distribution of species by applying known general relationships to specific observations. However, GIS have difficulty deriving general principles from specific examples, that is, inductive modelling. Walker and Moore (1988) described a system, (SIMPLE) which integrates a GIS with rule-induction, statistical and modelling functions to analyse species distribution data for kangaroos. The paper describes how the areal distributions of three kangaroo species (*Macropus* spp.) in Australia can be re-expressed in terms of their climatic characteristics using modelling capabilities.

Loyn *et al.* (2000) stated that GIS technology played an essential role in their study as it provided information at appropriate scales for wide-ranging owls and it also allowed models to be fed back onto maps, tested visually for realism and used to predict areas of high or low value for owls. Results were modelled by logistic regression with respect to habitat and landscape variables. The models

were then field-tested and were found to discriminate well between high and low probability sites.

There are now many freely available biodiversity tools available for downloading over the internet for modelling and reserve design which, are listed below. For example, http://nhsbig.inhs.uiuc.edu/ is a site which continues to develop as a clearinghouse for wildlife ecology related software. Most tools implement several principles of reserve selection, in particular representativeness, complementarity and efficiency. Most also produce several outputs to assist reserve design including alternative reserve designs and aggregate conservation measures. I have also provided readers with references to articles and manuals that describe their use; see for example:

- CODA - Conservation Options and Decision Analysis (Bedward *et al.* 1992a); (Bedward 1999a) and (Bedward 1999b). John Woinarski, Owen Price and Greg Connors of the Conservation Commission of the Northern Territory used CODA to explore long-term conservation planning options for the whole of the Territory (Price *et al.* 1995; Price *et al.* 1994). CODA analyses have provided maps showing possible sizes and configurations of reserves required to sample elements of the Territory's biodiversity;
- SPMODEL – Species modelling toolkit (Bennett *et al.* 1997);
- DAM – Data Audit Methodology toolkit (Bennett *et al.* 1996);

- VORTEX – population viability analysis software used to establish minimum viable populations (Brook *et al.* 1999; Howells & Edwards Jones 1997; Rivera & Fernandez 2004);
- WORLDMAP software for exploring geographical patterns in diversity, rarity and conservation priorities from large biological datasets (Pressey *et al.* 1993; Williams *et al.* 2005);
- PANDA - Protected Areas Network Design was developed to provide a user friendly framework for systematic protected areas network design to ARCGIS users - http://www.mappamondogis.it/panda_en.htm;
- CLUZ - Conservation Land-Use Zoning software is an ArcView GIS interface that allows users to design protected area networks and conservation landscapes - http://www.mosaic-conservation.org/cluz/index.html;
- Sites/SPEXAN/MARXAN - is software that delivers decision support for reserve system design. (Andelman *et al.* 1999; Ball 2000; Ball & Possingham 2000; Beck & Odaya 2001; Cook & Auster 2005; Leslie *et al.* 2003; McDonnell *et al.* 2002; Possingham *et al.* 2000; Possingham *et al.* 1993; Stewart *et al.* 2003; Stewart & Possingham 2003; Kelley *et al.* 2002) - http://www.ecology.uq.edu.au/index.html?page=27710
- ALEX - Analysis of Likelihood of EXtinction is suitable for modeling most vertebrate populations and some invertebrate and plant populations. ALEX was written to apply to most species that are under threat, not just

populations that are extremely rare. The advantages of this programme are that it can model large populations quickly, it incorporates catastrophes and habitat dynamics, and it allows the user to specify a wide range of environmental processes. Its main application is for modeling of metapopulations. The main weaknesses are that the model does not include genetics, only one sex is modelled, and the age structure is very simple (Possingham & Davies 1995);

- GAPPS - Generalised Animal Population Projection System, originated from a specific model developed for grizzly bears (*Ursus arctos horribilus*) and is most suitable for large mammal population projections. The programme is an individual-based model and incorporates catastrophes, inbreeding depression, and environmental variation. It has a small range of density-dependence functions but cannot simulate metapopulations. (Brook *et al.* 2000a; Brook *et al.* 1999; Dixon *et al.* 1991; Dobson *et al.* 1992; Downer 1993; Harris *et al.* 1986);
- INMAT - INbreeding MATrix is a matrix-based model developed to look at short-term inbreeding effects in stochastic environments. The programme has been used on mammals, birds, fish, and reptiles. The main disadvantages are that, although the model incorporates environmental stochasticity, it does not simulate catastrophes, it only models one sex in the population, does not incorporate metapopulation

dynamics, and has limited density-dependence functions. (Brook *et al.* 2000a; Brook *et al.* 1999; Mills & Smouse 1994);

- RAMAS software is for building ecological models. It includes RAMAS Red List, RAMAS GIS, RAMAS Metapop, RAMAS Landscape, RAMAS Multispecies Assessment, RAMAS Ecotoxicology, RAMAS Ecosystem, RAMAS Risk Calc, RMAS Stage (Akçakaya *et al.* 1999; Brook *et al.* 2000a; Brook *et al.* 1999);
- STELLA is used in many disciplines besides biology and can be adapted to suit almost any species or population. STELLA can also be used for performing multispecies PVA where the relationship among several species can be simulated. (Systems 2001);
- PATN - Multivariate pattern analysis software developed by Lee Belbin, CSIRO - useful in identifying naturally occurring subgroups (Fischer *et al.* 2001; Hamilton & Cocks 1995; Jacobs & Wilson 1996);
- C-PLAN – The Conservation Planing System developed by NSW NPWS designed to support conservation planning decisions (Clark & Slusher 2000; Ferrier *et al.* 2000; Finkel 1998; Pressey *et al.* 1995; Richardson & Funk 1999);
- FRAGSTATS - a spatial pattern analysis software which uses Arcview. It is used for quantifying landscape structure. Fragstats quantifies landscape structure through numerous metrics including: area, patch density, size

and variability metrics; edge, shape, core area, and diversity metrics, and contagion and interspersion metrics. (Leary *et al.* 2000);

- EcoSim – is an interactive computer program for null model analysis in community ecology (Gotelli & Entsminger 2005);
- LAMOS - a LAndscape MOdelling Shell for exploring the interaction of landscape processes such as fire, seed dispersal and vegetation dynamics (Lavorel *et al.* 2000);
- MUSE - Multi strata Spatially Explicit ecosystem modelling shell for gap and spatially heterogeneous tree/grass vegetation models. Operates on spatial scales of between 100 to 10,000 m2 (Druckenbrod *et al.* 2005; Gignoux *et al.* 1998);
- MacComp - performs statistical calculations of an animal's habitat using study area, home range, and radio location data;
- NestCalc - calculates a measure of unexpected species absence/presence among habitat islands (departure from perfect nestedness) (Atmar & Patterson 1993);
- BioPak - computes biomass, area, height, length, and volume of plant components (Hansen *et al.* 2000; Means 1995);
- MIST - Management Information System is a unified database management system designed to service protected area and park management needs (Schmitt & Sallee 2002);

- ECOBAS – Mathematical models in ecology. (Benz *et al.* 1997; Benz *et al.* 2001; Hoch *et al.* 1998);

- Biotas - designed to assist ecologists in the analysis and understanding of spatial and temporal data. Functions include home range, habitat use, movements, nearest neighbours and spatial randomness;

- BioRap Toolbox – Rapid biodiversity assessment tool used to assemble and analyse biodiversity data for Papua New Guinea (Austin 1998; Margules & Redhead 1995);

- Bio-dap - calculates diversity indices ;

- BIOCLIM/ANUCLIM/ESOCLIM - produces estimates of monthly mean climate variables, bioclimatic parameters, and indices relating to crop growth. The main components of the package are: ESOCLIM for calculating values of monthly mean climate, BIOCLIM and BIOMAP, the bioclimatic prediction system and GROCLIM, a simple generalised crop model (Lindenmayer *et al.* 1991); (Houlder *et al.* 1999); (Eeley *et al.* 1999). http://cres.anu.edu.au/outputs/anuclim/doc/references.html;

- UINDEX4 - is a DOS executable program for the estimation of population size index numbers by the (Underhill 1989) method (Underhill & Prys-Jones 1994);

- SDR - Species Diversity and Richness is a program that offers a full suite of commonly-used techniques for measuring and analysing sample

diversity. http://gcmd.nasa.gov/records/PISCES_SpeciesDiversity.html (Pisces Conservation 2004b);

- ECOM - offers a range of analytical techniques for visualising and ordering the relationships in multivariate data commonly used by community ecologists including Canonical Correspondence Analysis (CCA), Redundancy Analysis (RA) and Multiple Regression (MR). http://www.pisces-conservation.com/pdf/ecominstructions.pdf (Pisces Conservation 2004a); and
- PVA - Population viability analysis is a powerful method for evaluating the probability of extinction in the face of variation Pearce & McCarthy 1994; Possingham 1995). A general overview of PVA and discussion of its strengths and weaknesses is given in articles by Lindenmayer *et al.* (1993); Ralls & Taylor (1997); Reed *et al.* (2002); Reed *et al.* (1998) and Brook *et al.* (2000a; 2000b), and books by Sjögren-Gulve & Ebenhard (2000) and Beissinger & McCullough (2002). Comparisons of the different generic PVA models are given by Brook (1999); Brook *et al.* (1997, 2000a, b); Keedwell (2004a, b); Lindenmayer *et al.* 1995); Mills *et al.* 1996 and Chapman *et al.* (2001).

3.2.9 Habitat restoration

Where there are many potential sites for habitat restoration and resources are limited, it is important to carefully target sites where there is a high probability of successful reinstatement of the desired community to maximise conservation benefits. Spatially referenced data on soils, geology and land use can be successfully combined into a computerised GIS to aid the location of sites with a high potential for habitat reconstruction (Pywell & Putwain 1996).

3.2.10 Reserve design and area selection

It is generally recognised that formal reserves play a crucial role in the conservation of biodiversity, although they should be dedicated and managed in the context of a wide range of *in situ* and *ex situ* protection measures (McNeely *et al.* 1990; Soulé 1991). The creating of protected area networks to stem the loss of biodiversity has led to the development of a variety of systematic iterative reserve selection procedures (see Bedward *et al.* 1992b; Church *et al.* 1996; Freitag *et al.* 1997; Kirkpatrick 1983; Lombard *et al.* 1995; Margules *et al.* 1988; Nicholls & Margules 1993; Pressey *et al.* 1994a; Pressey & Nicholls 1989a; Pressey *et al.* 1996; Rebelo & Siegfried 1992; Saetersdal *et al.* 1993; Kelley *et al.* 2002; Justus & Sarkar 2002; Sarkar *et al.* 2004; Moffett *et al.* 2006). It is widely recognised that regional

representativeness (Austin & Margules 1986) should be a fundamental goal of such selection procedures (Margules & Austin 1994; Pressey *et al.* 1994a; Pressey *et al.* 1993). The achievement of this objective is data-dependent, however, and biodiversity assessments are often hampered by the low spatial resolution and uneven spatial coverage of input data (Davis *et al.* 1990; Pressey *et al.* 1994a).

A variety of methods are available for reserve selection. Population viability analysis (PVA) provides quantitative targets but only for single species and not communities (Brook *et al.* 2000a; Brook & Kikkawa 1999; Brook *et al.* 2000b; Ferdinands & Whitehead 1999; Goldingay & Possingham 1995; Griffiths 1999; Soule 1986). For broadscale assessments, tools such as GAP analysis usually requires complete coverages and for fauna these are often derived from presumed, and not necessarily actual, distributions (Kiester *et al.* 1996; Scott *et al.* 1993; Woinarski 1992). Gap analysis is a method for identifying the 'gaps' in the network of conservation land and water areas (Jennings 2000).

Burley (1988) first described a concept for the identification of 'conservation gaps' as a process to identify and classify various elements of biodiversity and examine the existing system of protected areas. The process was to then determine which elements (e.g. vegetation types, habitat types, and species) are not represented or poorly represented in existing conservation areas. Finally, this information was used as a way to set priorities for the next steps of

conservation actions, such as designing future reserves and planning land acquisitions (Jennings 2000). Davis *et al.* (1990) illustrated the application of GIS to conservation "gap" analysis. The data suggested for input to the process included: species richness derived by overlaying range maps of vertebrate species; significant habitats known to contain rare species, known locations of rare species, and areas likely to contain rare species identified from predictive models using ecological variables; a map of vegetation communities; and a map of existing boundaries of nature reserves. Areas of high conservation value not currently included in a conservation reserve system can be identified by undertaking a series of overlays and reclassifications. The output of these analyses can be in the form of a map of the sites of high conservation value and tables summarising communities not represented or under-represented in existing reserve systems (Davis *et al.* 1990). The suitability of existing reserves in northern New South Wales was analysed for rainforest pigeons by (Date *et al.* 1990). The amount of habitat used by pigeons that occurred in national parks was predictively determined before an assessment was made as to whether this was adequate across all seasons. Gonzalez-Rebeles *et al.* (1998) described an effort to apply gap analysis to the Rio Bravo/Rio Grande region of Mexico and the United States to determine how well native biodiversity is represented in the network of conservation lands. The project generated valuable geographic and biological data sets to support conservation and land-use planning; provided opportunities for cooperative, binational data sharing; and developed the

potential standardisation of procedures applicable in this region with common ecological characteristics.

Partial GAP analysis can also be applied with fauna attributes in existing reserves compared to those outside (Lombard *et al.* 1995; Woinarski 1992) in order to determine which taxa are already reserved and need not influence further site selection, termed "elimination planning" (Kirkpatrick & Brown 1991). These often involve other selection techniques such as scoring and/or iterative algorithms. The former uses indices to identify areas of richness or rarity (Purdie 1987) but can be inefficient except where ground-truthing is included to fine tune outcomes (Pressey & Nicholls 1989b). Iterative reserve selection algorithms employ a looping procedure whereby the potential contribution of unselected sites to the reserve goals are reassessed each time a site is added to the reserve option list (Kirkpatrick 1983; Pressey & Nicholls 1989a; Rebelo & Siegfried 1992); Lombard *et al.* 1995; Margules *et al.* 1991). Variations to this method attempt to account for reserve design principles (spatial arrangement of potential sites) and the provision of possible alternatives to chosen sites (Bedward *et al.* 1992b; Nicholls & Margules 1993). For some taxa, iteration selects sites in diversity and rarity "hotspots" in order to achieve comprehensiveness (Lombard *et al.* 1995) but the applicability of this outcome to other taxa may result in inefficiencies with endangered species being missed (Fagan & Kareiva 1997). McFarland (1998) stated that a preoccupation with comprehensiveness can also come at a

cost to representativeness. To more fully address the latter, numerical classifications (e.g. PATN) are useful in assessing the spatial distribution of areas similar/dissimilar in certain values (Austin & Margules 1986; Mackey & Bayes 1989).

The criteria used for making additions to reserves appears to vary primarily in how specific values are viewed (McFarland 1998). Some are considered on the basis of their current representation in protected areas (Kirkpatrick 1983) or their irreplaceability[2] (often geographically restricted values) (Ferrier *et al.* 2000; Pressey 1999; Pressey *et al.* 1994b). Alternatively, degree of dissimilarity to the values already in reserves can be used (Woinarski *et al.* 1996). Each has its own advantages and disadvantages depending on the conservation goals set, scale of assessment and other constraints imposed, e.g. availability of funding and land for reserve acquisition (Woinarski *et al.* 1996).

Rodrigues (2004a; 2004b) demonstrated that the global network is far from complete, even for the representation of terrestrial vertebrate species. Brooks *et al.* (2004) and Rodrigues (2004a) present a first attempt to provide a global framework for the next step of strategically expanding the network to cover mammals, amphibians, freshwater turtles and tortoises, and globally threatened

[2] Irreplaceability refers to the importance of an area for achieving an explicit conservation goal for a country, a region or a single protected area (Pressey 1999)

birds. Rodrigues (2004a) identified unprotected areas of the world that have remarkably high conservation value (irreplaceability) and are under serious threat. The expansion of the global protected-area network in these regions is urgently needed to prevent the loss of unique biodiversity.

3.3 FACTORS TO CONSIDER FOR WILDLIFE GIS

3.3.1 Data

Quality of data is fundamentally important to the reliability of the output from a GIS. Data quality is a function of scale, spatial resolution and spatial dependence as well as collection methods. The data layers and attributes important in a GIS for wildlife applications will vary according to the questions posed. Several studies have listed their ideal or minimum dataset requirements (Davis *et al.* 1990). The recommended datasets all include descriptors of climate, topography, surface water, vegetation, soil, location and some include other variables describing cultural features and disturbance. Johnson (1990) argued that databases developed for general purposes are often unsuitable for research applications because of the specificity of data needs to answer questions. She also argued that databases developed for research projects are often less versatile

than databases developed for management purposes and therefore may not be suitable to management applications.

3.3.2 Scale

The source of scales of data can be varied and thus they can be viewed as a series of filters that indicate the nature of the information contained in the different data sets (Aspinall & Pearson 1993). The scale of data used in an analysis needs to be large enough to represent diversity in relation to the distribution patterns of species (Miller *et al.* 1989). The minimum size of the measurement unit, or grain size, of a GIS should be based on biology rather than the limitations of technology; for example, the pixel resolution of satellite images (Schulz & Joyce 1992; van Horne 1990). Important biological processes will be masked unless the grain size is appropriate and it may become difficult to determine the applicability of models (van Horne 1990). As grain size increases, small, rare patches of habitat and linear features such as streams and roads may not be discernible and species that respond to changes in habitat below the grain size of available data will not be accurately modelled (Schulz & Joyce 1992).

For raster data, the size of the grid cell should reflect the size of the home range of the species under investigation, the homogeneity of the habitat, the degree of

habitat specialisation, and the intended use of the model (Laymon & Barrett 1986; Laymon & Reid 1986). As a rule of thumb Laymon & Barrett (1986) proposed that grid cells be about one quarter the area of the normal home range of a species under investigation. For example, a species with highly specialised microhabitat requirements living in a heterogeneous landscape might require a higher resolution for models predicting preference. Presence/absence models for habitat generalists in homogeneous landscapes would require a much lower resolution. In general, Laymon & Barrett (1986) state that the most important factors determining the optimum resolution will be home range size and landscape heterogeneity.

3.3.3 Raster versus Vector GIS Coverages

GIS store and manipulate data as either rasters or vectors. Both systems have been used in wildlife applications. Raster-based systems store data as grid-cells and vector-based systems depict homogeneous areas as polygons delimited by curvilinear boundaries (Johnson 1990).

Johnson (1990) discussed the suitability of raster and vector GIS analysis for different ecological applications. They concluded that both systems had advantages for different types of analysis. Raster systems were found to be more useful for proximity analysis because it is less complex than with vector systems.

Analysis of temporal change is easier with raster systems because it can be done on cell by cell and the proportion of cells changed in a period can be measured. Vector systems are preferable for analysis of linear features, such as perimeters, stream lengths, landscape corridors or ecotones, and fractal dimension for determination of patch shape. Buffering and overlaying to identify areas of spatial coincidence are easily undertaken in both environments, however overlaying more than two coverages is easier with a system linked to a database management system.

Haslett (1990) argued that vector-based GIS is better for many ecological applications because it is often the very small landscape features that are of interest. He argues these small features may be missed in raster-based systems depending on the size of grid-cell and the rule applied to determine presence or absence in a cell. Further, vector systems can map precise boundaries and the resulting polygons are more ecologically meaningful than grid (Haslett 1990). However, ecological boundaries, such as soils or wildlife distributions, are often imprecise or 'fuzzy' (Johnson 1990). Mapping of polygon boundaries in these areas may not be any more precise than using a raster system and may imply a level of certainty beyond that which is justified. Further, data from digital remote sensing are in raster format and therefore easily transferred to raster GIS (Shaw & Atkinson 1990).

The most appropriate GIS system to use for any wildlife application will ultimately depend on what questions are being asked and the most appropriate techniques available to answer those questions. However, the type and format of data available and the GIS systems available will also be important factors in the decision.

3.3.4 Advantages of using GIS and Remote Sensing

GIS can be valuable tools for the analysis of spatial data. Tasks that were once done manually, such as measuring areas and overlaying maps to identify areas of coincidence, can be done easily using a GIS given appropriate training. The amount of time spent digitizing maps can be comparable to the amount of time it would take to manually measure areas using a planimeter, but the database created during the former process is available for further analysis as well as production of maps (Johnston & Naiman 1990). GIS make updating of spatial data easier than using printed maps, which require the whole map to be redrawn.

GIS have made possible analyses that were not feasible using manual methods, especially over large areas and with large sample sizes (Shaw & Atkinson 1990); (Johnston & Naiman 1990). The use of GIS in analyses frequently enables a more detailed classification system to be applied to environmental variables than using

manual techniques and therefore reduces the possibility of oversimplifying classifications (Johnston & Naiman 1990). The ability to use GIS to reclassify areas into new categories permits efficient use of databases for multiple purposes and the application of Boolean algebra[3] .

The advantages of remote sensing over field mapping of habitat are that large areas can be considered relatively quickly, interpretation and analysis can be more easily standardised, with satellite imagery much of the data processing may be automated, and the information can be frequently updated by new flights or satellite passes (Kirby *et al.* 1996).

3.3.5 Disadvantages of GIS

One of the major impediments to the use of GIS in biodiversity applications is the lack of digital data available at appropriate resolution (Johnson 1990; Shaw & Atkinson 1990). The initial conversion of data into digital form can be very time consuming and therefore very costly (Haslett 1990; Johnson 1990). Data that are available may not be suitable because of poor quality, low spatial resolution, incomplete coverage, inconsistencies and inaccuracies (Miller *et al.* 1989; Scott *et al.* 1991a; Scott *et al.* 1991b) due to the lack of standards for the quality of digital

[3] Logical or mathematical operations that apply the rules of Boolean algebra, in which the results take on one of two values e.g. yes/no, true/false, 0/1. The operators AND, OR, NOT, NOR are used to search for specific attribute values in a single map layer

(Shaw & Atkinson 1990). Problems may arise in trying to combine data collected at different scales and differing accuracies as errors will accumulate and be compounded in any final output (Haslett 1990; Shaw & Atkinson 1990).

Another limitation of GIS is the inability to integrate existing ecosystem models into the GIS itself. This is a product of the large amounts of processing power required to run the models and their incompatibility with existing GIS software. Contemporary GIS lack a capability for developing new hypotheses about spatial-varying relationships between features (McCormick 1994). McCormick (1994) also described how most wildlife distribution studies utilise GIS for its mapping and manipulation capabilities. However when more complex statistical analysis is required then the user must look at statistical modelling packages outside of the GIS (such as S-PLUS).

3.4 ADDITIONAL GEOSPATIAL TECHNOLOGIES AND APPLICATIONS

3.4.1 GIS and remote sensing

Remote sensing information produced by satellite or aerial photography must be interpreted before use in a GIS (Farina 1998). Generally, data from remote sensing are imported into a GIS after classification and georeferencing (Farina

1998). The procedures of land classification are independent of GIS techniques, but when the data have to be introduced into a GIS it is necessary to know at least the spatial scale (the resolution) of the images for a georeference (Farina 1998). In landscape ecology it is often useful to process spatial data at different scales; in fact, in a landscape patterns and processes are visible and function along a broad range of spatial scales (Turner *et al.* 1989).

3.4.2 Remote sensing in landscape ecology

Remote sensing has facilitated extraordinary advances in the modelling, mapping and understanding of ecosystems (Lefsky *et al.* 2002). Typical applications of remote sensing involve either images from passive optical systems, such as aerial photography (Sanjeevi 1999) and Landsat Thematic Mapper (Bechtel *et al.* 2004; Ferguson 1991; Goward & Williams 1997; Jano *et al.* 1998; Kelly 1987; Lauver & Whistler 1993; Long & Skewes 1996; Nelson 1983; Todd *et al.* 1980; Young *et al.* 1987), or to a lesser degree, active radar sensors such as RADARSAT (Taft *et al.* 2003; Waring *et al.* 1995). Remotely sensed data from satellites and aircraft are used to monitor and assess larger areas than previously possible with ground-based methods, and in a cost effective and repeatable way (CSIRO 2000a, b). Remote sensing and GIS are often used together in landscape analysis and classification e.g. (Davis *et al.* 1990). For example, the detection of linear structures in a human-dominated landscape can represent an important

element for landscape description. Goossens *et al.* (1991) have tested the capacity of SPOT multispectral imaging of a rural area in Belgium to detect ecological infrastructures. Linear structures such as hedgerows, edges, drainage ditches and roads are detected in different measure by SPOT sensors. The height of objects (tall objects have longer shade), the sun's angle (the lower the angle the longer the shade), and the orientation of trees and edges play a role in edge detection.

The availability of images captured by satellites or aircraft along a multispectral reflectance permits a wide range of applications of these techniques to landscape study. Remote sensing data can be collected at different spatial and temporal scales, creating a powerful tool to study processes (Farina 1998). Remote sensed data can be processed and improved through digital techniques, available on inexpensive platforms. The resolution scale ranges from 10 to 20 or 30 m. The Landsat Thematic Mapper has a resolution of 30x30 m on the ground; SPOT has a 10x10 m ground resolution. In a landscape each element has a characteristic multispectral response. Hall *et al.* (1991) used Landsat Multispectral Scanner (MSS) data (60 m resolution) to study the boreal forest landscape across a temporal scale of 10 years.

SPOT Multispectral High-Resolution Visible (HRV), Landsat Thematic Mapper TM and NOAA, Advanced Very High Resolution Radiometer (AVHRR) were

used to compare the change of landscape structure in the northern Wilconsin lake district by Benson & MacKenzie (1995). They examined the effects of increasing grain size from 20 m to 1100 m on landscape parameters and whether structural parameters remained relatively constant over this range and whether aggregation algorithms permit extrapolation within this range. Studies such as these which examine how landscape parameters change with scale (e.g. the effect of satellite resolution) can provide a better understanding of the usefulness of remote sensing and large scale landscape measures. However, satellite imagery predetermine grain and, therefore, the choice of satellite sensor must be appropriate for the research question asked. Benson & MacKenzie (1995) showed that grain has an important effect on most landscape parameters and that there is a large gap between the grain size of a TM images and that of AVHRR. Benson & MacKenzie (1995) demonstrated that an approach involving aggregation of pixels can be used to interpolate between sensor grains.

Generally, the decrease in resolution caused by pixel aggregation introduces a large proportion of errors, which strongly influence the reliability of large-scale modelling (Farina 1998). Understanding the behaviour of aggregated spatial data is useful in preserving the information.

Remote sensing also allows reliable classification of land cover types (Farina 1998). However, higher-order patterns in the land cover mosaic, representing

different landscape types, cannot be immediately recognised using this technique.

3.4.3 NOAA AVHRR

NOAA stands for the National Oceanic and Atmospheric Administration[4]. They operate several satellite receiving platforms, including the TIROS series[5]. The NOAA satellites carry the Advanced Very High Resolution Radiometer AVHRR instrument, which measures the amount of radiation emanating from the earth in each of 5 wavebands, commonly called Band 1 to Band 5, or Channel 1 to Channel 5.

Broadscale patterns of plant growth after rain or seasonal vegetation changes are frequently apparent in NOAA's AVHRR satellite data. These data, with a resolution of approximately 1 km^2, can provide us with information on the plant growth across the entire continent and allows us to predict the amount of plant growth across vast regions or fuel loads for assessing the risk of bushfires (CSIRO 2000a, b).

[4] It is the arm of the United States Government responsible for meteorological information.

[5] TIROS stands for Television Infrared Observational Satellite.

NOAA satellites have insufficient motive power and control systems to be able to correct orbital drift (Department of Primary Industry and Fisheries 1999). Thus, over time their orbit changes from that initially intended for them, and this can diminish their utility.

Keating (1997) stated that many researchers have found that the spectral resolution of AVHRR imagery makes it appropriate for assessing regional-scale changes in forest cover, but its 1.1 km spatial resolution renders it ineffective for mapping land cover within relatively small areas. Goward *et al.* (1991) stated that errors of ± 50% are possible with the NOAA-NDVI product owing to such factors as poor sensor calibration, poor image registration, variable angular-induced pixel sizes, and incomplete cloud screening.

3.4.4 Vegetation Mapping

Landsat Thematic Mapper (TM)

TM imagery may be quite useful for mapping vegetation when ground-truthing is possible and when the selected cover categories are spectrally distinct (Keating 1997). Keating (1997) reported that because Landsat Thematic Mapper imagery has a spatial resolution of 30 x 30m and a spectral resolution that is superior to other image types, it may enable geographers to produce high quality maps of land cover. Keating's (1997) study has demonstrated, therefore, that TM Imagery

has considerable utility in tropical highlands areas if sophisticated digital image processing techniques are included in the mapping process.

Reusing (2000) discussed how a map was generated using multispectral remote-sensing data, and provided details of variety within Ethiopian woodlands. A hybrid data classification procedure was applied to incorporate relief and climatic conditions and to improve classification accuracy. Similarly, Davis *et al.* (1994) and Sanjeevi (1999) provided an account of the use of remotely sensed images (Landsat TM data and aerial photographs) and GIS technology to characterise vegetation communities in southwestern California and measure the oath of habitat and vegetation succession in a coastal dune system in south Wales, United Kingdom. Davis *et al.* (1994) demonstrated how a vector-based GIS, combined with remotely sensed data, can be used to produce improved landscape-ecological maps compared to those generated using traditional mapping procedures.

Imhoff *et al.* (1997) described how remote sensors, such as Landsat Thematic Mapper (TM) are being used with increasing success to classify vegetation type by floristics, but discrimination among structural types is usually not possible.

Most arid land remote sensing efforts have focussed on detecting vegetation changes using spectral indices, such as the normalized vegetation index, with

limited success (Asner *et al.* 2000). Many remote sensing studies have focused on estimating changes in vegetation extent in arid environments (Graetz *et al.* 1988; Smith *et al.* 1990). The sparseness of vegetation in arid and semiarid regions means that soil is a dominant factor in remotely sensed measurements (Ray & Murray 1996). This means the measurement of plant cover in arid and semiarid areas is complicated by variability in the soil reflectance as well as spectral interactions between the sparse plant canopies and the soil (Ray & Murray 1996).

Havstad *et al.* (2000) stated that remote sensing tools offer a unique capability to study and monitor vast areas (such as the Jornada Experimental Range in southern New Mexico) for changes and to assess rangeland health. The objectives of one such study, namely JORNEX, were to develop remote sensing techniques to assess rangeland conditions, to quantify rangeland vegetation and landscape characteristics, and to measure plant/atmospheric interactions (Havstad *et al.* 2000). These measurements are being used to quantify physical, hydrological and vegetational responses to changes in components in the water and energy balance at different scales and to evaluate techniques of scaling data (Havstad *et al.* 2000).

Knight (1995) described the methodology and application of a model, remote environment and management assessment (REMA) using Landsat MSS images to provide empirical interpretations of the pattern and process of cover change

caused by alternating rainfall and drought with depletion disturbances. Assessments were interpreted by examining the likely influence of climate, grazing, and geomorphology on cover changes.

Vegetation structure

A GIS analysis of vegetation structure in areas where cheetahs were observed was conducted by Gros & Rejmanek (1999) and habitat preferences were determined. Bunting and Lucas (2006) identified the delineation of tree crowns in Australian mixed-species forests of complex structure as problematic because of their varying dimensions and reflectance characteristics, the existence of several layers of canopy (including understorey), and shadowing within and between crowns. Bunting and Lucas (2006) overcome this problem by applying an algorithm for delineating tree crowns using eCognition Expert and hyperspectral Compact Airborne Spectographic Imager (CASI-2) data acquired over a forested landscape in central east Queensland, Australia.

Within the Lockyer Valley catchment in Queensland, Australia, Apan *et al.* (2002) developed appropriate mapping assessment techniques to quantify the nature and magnitude of riparian landscape structural changes within a catchment. It highlighted the use of satellite imagery and GISs in mapping and analysis if landscape structural change, as well as the identification of key issues related to

spatial resolution, stream buffering widths and the quantification of land transformation process.

Normalised difference vegetation index

The NDVI is a measure, which is responsive to green vegetation. Nevertheless, the NDVI is affected by many factors other than the greenness of the vegetation, including the spectral characteristics of the soil, and differences in the optical characteristics of the atmosphere from place to place and from time to time (Department of Primary Industry and Fisheries 1999). Efforts have been made by many scientists all over the world to map landcover using AVHRR and NDVI. For example, the International Geosphere-Biosphere Programme-Data and Information System (IGBP-DIS) began the 1 km landcover project in 1990 and a global 1 km landcover dataset was created on a continent-by-continent basis (Chen *et al.* 1999). The NDVI has been the most widely used index in global vegetation studies (Chen *et al.* 1999; Goward *et al.* 1985; Malingreau *et al.* 1989; Roberts *et al.* 1997; Roderick *et al.* 1996; Teillet *et al.* 1997; Townshend *et al.* 1991; Townshend *et al.* 1994; Tucker & Sellers 1986), however within Australia very few examples exist (Hobbs 1995).

Huete *et al.* (1997) and Lawrence and Ripple (1998) compared various vegetation indices over a global set of TM images and reported that in the arid and semiarid biomes, the NDVI was much more sensitive to canopy background variations

than the SARVI[6]. Progress toward improved monitoring of vegetation patterns and biospheric processes has been partly restricted by the limitations of the AVHRR sensor and partly by the inherent limitations of using empirical or semi empirical spectral indices (Huete *et al.* 1997).

Airborne video system

To provide even more detail about characteristics and state of arid landscapes CSIRO has an airborne video camera providing high spatial resolution from 2 metres down to 20 centimetres (CSIRO 2000a, b). At this scale individual trees and shrubs and even individual grass clumps are able to be distinguished. The airborne video system has been successfully used as a sampling tool to "ground-truth" satellite-derived indices of vegetation cover and is presently being used to determine the extent to which landscapes "leak" or conserve water and nutrients which are essential for plant growth (CSIRO 2000a, b).

Synthetic Aperture Radar

Imhoff *et al.* (1997) linked the use of synthetic aperture radar (SAR) and aerial photography to studies of landscape spatial heterogeneity and bird community ecology. Their results indicated that SAR data are able to discern structural differences relevant to bird habitat quality within floristically homogeneous stands while multispectral sensors successfully identified floristic differences

[6] Soil and atmosphere resistant vegetation index (SARVI)

among habitat types. Imhoff *et al.* (1997) suggested that efforts to map bird diversity should focus on species-specific habitat relationships and that some measure of vegetation structure is needed to understand bird habitat. Imhoff *et al.* (1997) approach advances the use of SAR data in the three-dimensional mapping of animal habitats from remotely sensed data, and extends current capabilities for mapping and modelling large-scale patterns in the distribution of biological diversity.

LiDAR (Light detection and ranging)

LiDAR is an emerging remote sensing technology that directly measures the three-dimensional distribution of plant canopies and can accurately estimate vegetation structural attributes (Lefsky *et al.* 2002). LiDAR is an active remote sensing technique, analogous to radar, but using laser light (Dubayah & Drake 2000). LiDAR instruments measure the roundtrip time for a pulse of laser energy to travel between the sensor and a target (Dubayah & Drake 2000). LiDAR instruments have demonstrated the capability to accurately estimate important forest structural characteristics such as canopy heights, stand volume, basal areas and aboveground biomass and is used in many forestry applications (Brandtberg *et al.* 2003; Drake *et al.* 2002a; Drake *et al.* 2002b; Drake *et al.* 2003; Drake & Weishampel 2001; Dubayah & Drake 2000; Holmgren & Persson 2004; Morsdorf *et al.* 2004; Riano *et al.* 2003; Suarez *et al.* 2005; Zimble *et al.* 2003). Toyra *et al.* (2003) evaluated the airborne scanning light detection and ranging (LiDAR)

technology for hydrological applications in wetlands, deltas, or other similar areas. Holmgren and Persson (2004) in their study used LiDAR to identify individual trees. Currently, applications of lidar remote sensing in ecology fall into three general categories: remote sensing of ground topography, measurement of the three dimensional structure and function of vegetation canopies, and prediction of forest stand structure attributes (such as above ground biomass).

3.5 CONCLUSIONS

As more data becomes available in a digital form and the capabilities of GIS increase, the use of GIS in wildlife research and management will inevitably expand and new applications will be developed. Meanwhile, GIS can aid in improving the information on which many management decisions are based by enabling more complex analyses over larger areas with larger sample sizes than was feasible using manual methods. However, better information does not ensure that better landuse decisions will be the result.

None of the studies considered in this review have attempted to map habitat of a species over its entire range at a detailed scale suitable for on-ground management. Most studies have stopped at the point of providing an inventory base to use for future management planning. In the next chapters, my study

attempts to integrate habitat mapping with management of the species to look at the implications of management strategies on land use planning.

GIS use for wildlife research and management is broad and varied and is providing end-users with better methods for managing and manipulating large volumes of spatial data. As more people become aware of the capabilities and limitations of GIS and the appropriate context for its use, the technology and benefits it can offer can only improve. Despite the limitations of the technologies considered, the urgency with which biodiversity issues must be addressed requires that effective use of existing data should be made.

CHAPTER 4 - CASE STUDY OF THE BURT PLAIN BIOREGION - I. EVALUATION OF DOMINANT VEGETATION COMMUNITIES

4.1 INTRODUCTION

The vegetation of central Australia represents a significant component of the regional biodiversity and provides habitat for myriad fauna (Friedel *et al.* 1988; Pitts 1994; Wilson 1994; Woinarski *et al.* 1996). Vegetation patterns can be complex and may be influenced by a range of environmental factors operating at different scales in space and time (Davis *et al.* 1990; Dunkerley & Brown 2002; Goward *et al.* 1985; Mabbutt & Fanning 1987). For example, major variation from a local to regional scale in soil nutrients and water availability may strongly influence the distribution of vegetation communities and their structure and floristic composition (Buckley 1983; Dawson & Ahern 1973; Dunkerley 2002; Stanley 1983; Tongway & Ludwig 1990). Broadscale maps of the dominant vegetation cover for the Burt Plain are available, but no detailed studies have been undertaken to identify important environmental factors affecting vegetation patterns. Environmental gradient analysis has been used in studies elsewhere (i.e. Austin 1987, 1994; Austin *et al.* 1984; Austin *et al.* 1994a; Austin *et al.* 1994b; Austin *et al.* 1990) to determine environmental correlates of vegetation patterns and to characterise the environmental niche of plant communities. This information can be used to inform vegetation management at a regional level and to guide further

research and field based studies of the dynamics of these communities and their constituent biota (Barrett & Fox 1995; Friedel *et al.* 1988; Wilson 1995).

In this Chapter I use a case study in the Burt Plain bioregion of central Australia to examine the relationship between several environmental variables and the distribution of vegetation, attempting to characterise the environmental niche of dominant plant communities. This bioregion was selected as a case study to examine the use of geospatial technologies and techniques for supporting regional conservation planning and management. In particular, I undertake a systematic assessment of these variables to:

- describe the species composition, distribution and nature of the dominant vegetation communities within the Burt Plain bioregion;
- characterise environmental niche of communities with respect to selected environmental and management variables – latitude, longitude, climate, land systems and land units, geology, hydrography, topography, and tenure; and
- outline the major landscape processes associated with the above.

4.2 BURT PLAIN BIOREGION

4.2.1 Location and extent

The Burt Plain bioregion occurs in central arid Australia, in the Northern Territory and covers a total area of 73 972sq km[1] or 7 381 727 ha or about 5.5% of the Territory (Figure 4.1). It supports a relatively diverse range of ecosystems and biota (Connors *et al.* 1996; Morton *et al.* 1995b). At the beginning of my research bioregional surveys were being conducted by the Parks and Wildlife Commission in the Macdonnell Ranges bioregion.

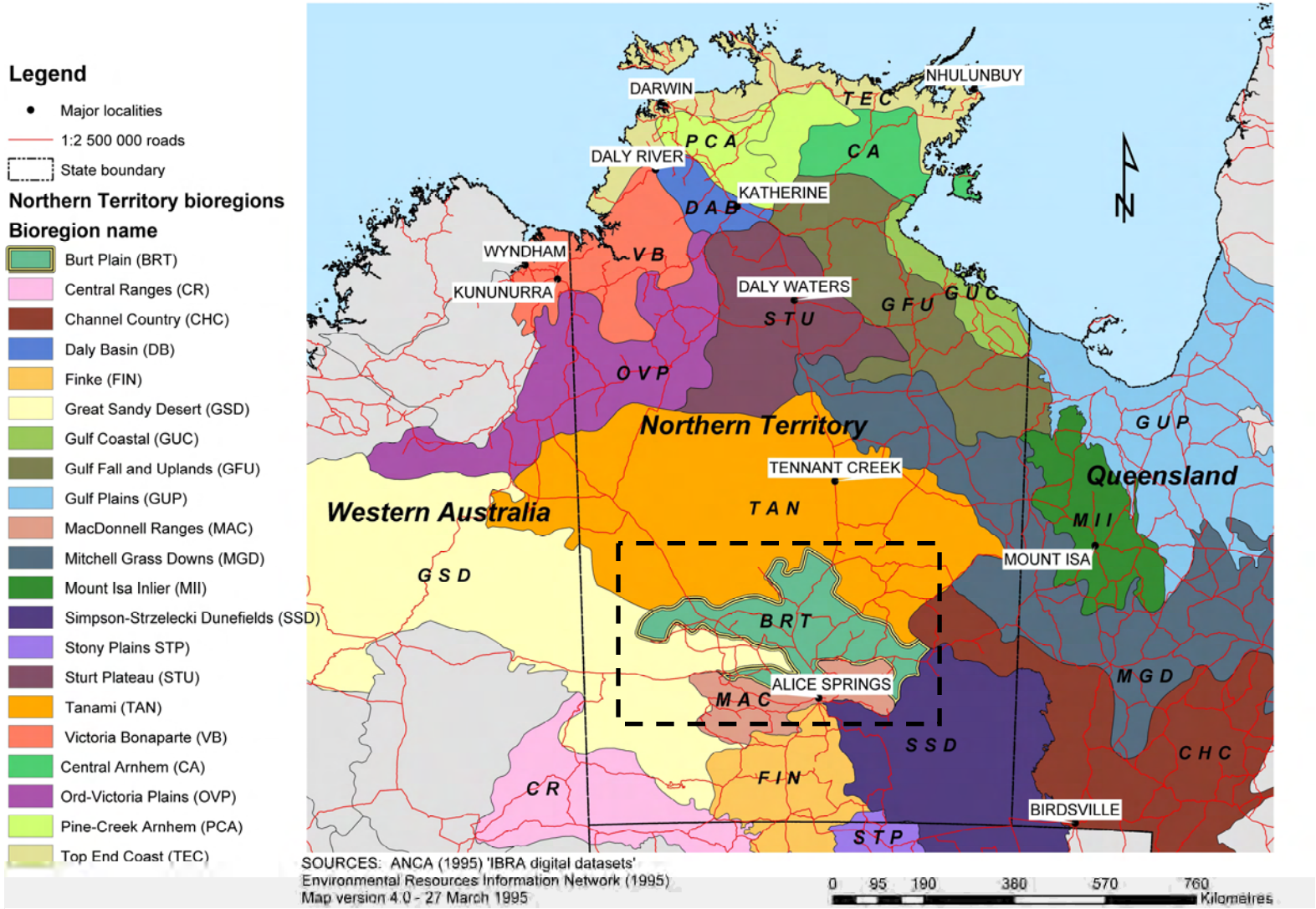
Analysing geospatial data available for the bioregion will allow both government and non –government agencies to improve the design of surveys, on-ground survey work and data analyses. Improving the scientific base to enhance conservation planning and management in the bioregion is a priority for the Northern Territory government (Connors *et al.* 1996; Fleming 1991; Territory 1998).

The Burt Plain bioregion is sparsely populated and the closest major towns are Tennant Creek in the north and Alice Springs in the south. Although the Burt Plain bioregion is an irregular shape and if an imaginary box was created

[1] (Connors *et al.* 1996)

around it the bioregion would extend 130°W longitude to 136° E longitude and -24°S to -21°N latitude (Figure 4.1).

Figure 4.1 Location of Burt Plain bioregion in central Australia. Shown also in colour are the other bioregions found in and adjacent in the Northern Territory.



4.2.2 Land Tenure and Use

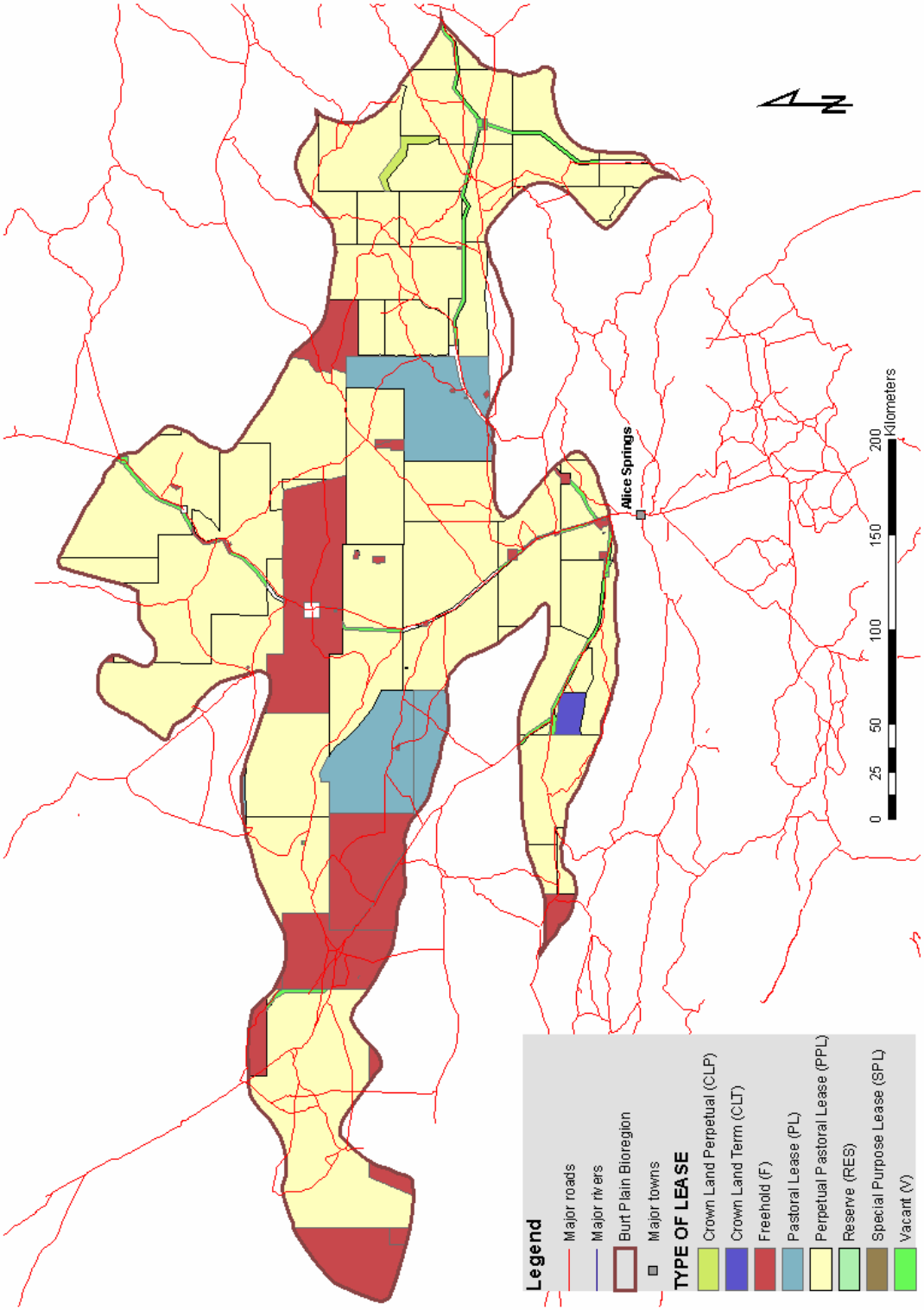
Approximately 40% of the Northern Territory is gazetted as Aboriginal land, with less than 4% National Park/Reserve estate and most of the remainder is leased by the crown for pastoralism (Woinarski *et al.* 1992). Most of the land in the Burt Plain bioregion is used for cattle grazing with lesser areas used for purposes including conservation, mining and tourism. Many properties have diversified their interests, especially during times of drought, but beef production remains the primary focus. Land tenure is mainly pastoral leases and freehold (83.6%), with 14.7% Aboriginal freehold and only 0.25% reserved area (Connors *et al.* 1996), which includes the Dulcie Ranges National Park (Figure 4.2).

A summary of tenure types as a percentage of the Burt Plain bioregion and the area (hectares) is provided in Table 4.1.

Table 4.1 Percentages and area of each Tenure Type within the Burt Plain bioregion.

Tenure Type	**Abbreviation**	**% of Burt Plain**	**Area (ha)**
Perpetual Pastoral Lease	PPL	74.96	5 533 353
Freehold	F	14.78	1 091 288
Pastoral Lease	PL	7.82	577 064
Vacant	V	1.32	97 217
Crown Lease Perpetual	CLP	0.26	19 322
Crown Lease Term	CLT	0.38	27 755
Special Purpose Lease	SPL	0.004	301
Reserve	RES	0.002	133

Figure 4.2 Land tenure within the Burt Plain bioregion



4.2.3 Climate

The climate of arid Australia is more variable than in arid lands elsewhere in the world, with highly erratic rainfall, extremes of long dry periods and flooding deluges. The southern half of the Northern Territory is arid or semi-arid (<400 mm average annual rainfall), with unpredictable rainfall events and extremely high variability between years in total rainfall (Stafford Smith & Morton 1990). Hooper *et al.* (1987) divided the Northern Territory into three zones: Humid, Semi-Arid and Arid Zone, based on median annual rainfall, to conveniently describe the natural resource base. The Burt Plain bioregion falls within the Arid Zone, as the monsoonal effect is diminished and annual median rainfall varies between approximately 250-500mm. However the majority of rain generally occurs in October to March, and total precipitation in any one year is usually dependent on the degree to which the northern monsoonal influence penetrates inland (Wilson *et al.* 1990). While annual rainfall is occasionally well above average, droughts are common and may persist for several years (Luke & McArthur 1978), like the major drought of 1957-1966 (Bureau of Meteorology 1989).

Temperature follows a normal distribution, with the peak temperatures between December to January, before the summer rains, when extended periods in excess of 40^{o}C are common (Hooper *et al.* 1987). Mean minimum temperatures in the winter are between 3^{o}C and 10^{o}Cand occur between June and July. Evaporation is far greater than rainfall in most areas, thus

contributing to the arid climate (Wilson *et al.* 1990). Relative humidity ranges from 38 per cent in June to 18 per cent in September and October (Hooper *et al.* 1987).

4.2.4 Soils, Geology, Topography and Hydrography

The Burt Plain bioregion is dominated by flat to undulating plains and low rocky ranges of Pre-Cambrian granites supporting a range of mulga *Acacia aneura* shrubland and grassland communities on red earths. Soils are characteristically very infertile over vast areas compared to other deserts of comparable aridity. Rudosols[2] are a widespread and diverse group of soils and few have commercial land uses because of their properties or occurrence in arid regions, or both (Isbell 1996). The largest areas of these soils occur in the desert regions of arid central and northwest Australia (Isbell 1996). Soil fertility is predominantly linked to the underlying rock type. However, the redistribution of soil and nutrients by wind and water results in localised areas of more productive soils. Even in a landscape that may appear flat and featureless, water and nutrients concentrate in patches, around bushes and trees, or in gentle depressions (Bastin & Chewings 1998). These water and nutrient rich sites are the key to the productivity of the Burt Plain area. They are very important for native plants and animals as well as the pastoral industry. As these productive areas are easily over-grazed and eroded, special emphasis must be placed on their management. The bioregion's soil

[2] *Rudosols are also known as lithosols; alluvial soils; calcareous and siliceous sands; shallow stony soils; deep sands.*

types vary from relatively stable stony soils to highly erodable red earths. The dominant soils of the bioregion can be summarised as:

- stony to sandy or coarse soils;
- shallow stony or absent soils;
- granite or sandy plains; and
- red clayey sands to sandy red earths (Parks and Wildlife Commission of the Northern Territory 2001).

The Burt Plain Bioregion encompasses a complex of uplands and extensive plains with several separate internal drainage units. The uplands, which include the Dulcie Ranges, consist of numerous outcrops and ranges of low relief (Parks and Wildlife Commission of the Northern Territory 2001). The rivers of the arid zone are usually dry, but rise rapidly to flood levels after substantial rain. The annual average recorded flow of two major rivers the Todd and Finke is 60 Mm^3 and 75 Mm^3, respectively (Hooper *et al.* 1987). Surface water in the bioregion is drained by a number of roughly southerly and easterly flowing river systems (Figure 4.3). The Burt Plain bioregion relief ranges from 180 to 1330 m above sea level (Figure 4.4) and has a relatively complex terrain (Figure 4.5).

Figure 4.3 Burt Plain bioregion showing hydrography (watercourses and waterbodies at 1:250 000)

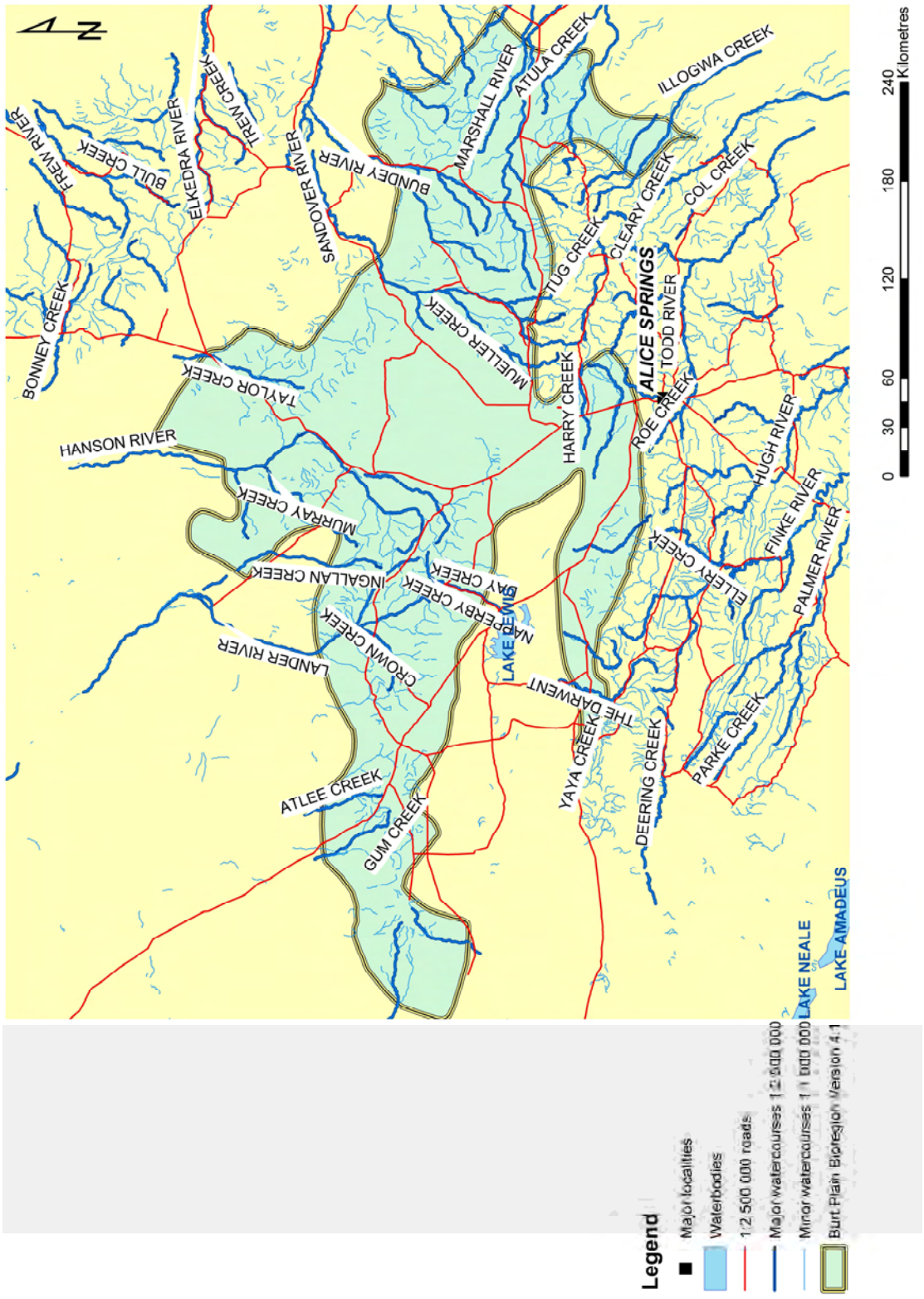


Figure 4.4 Relief in and around the Burt Plain bioregion based on a 9 Second DEM (AUSLIG 1998); major contours are also shown.

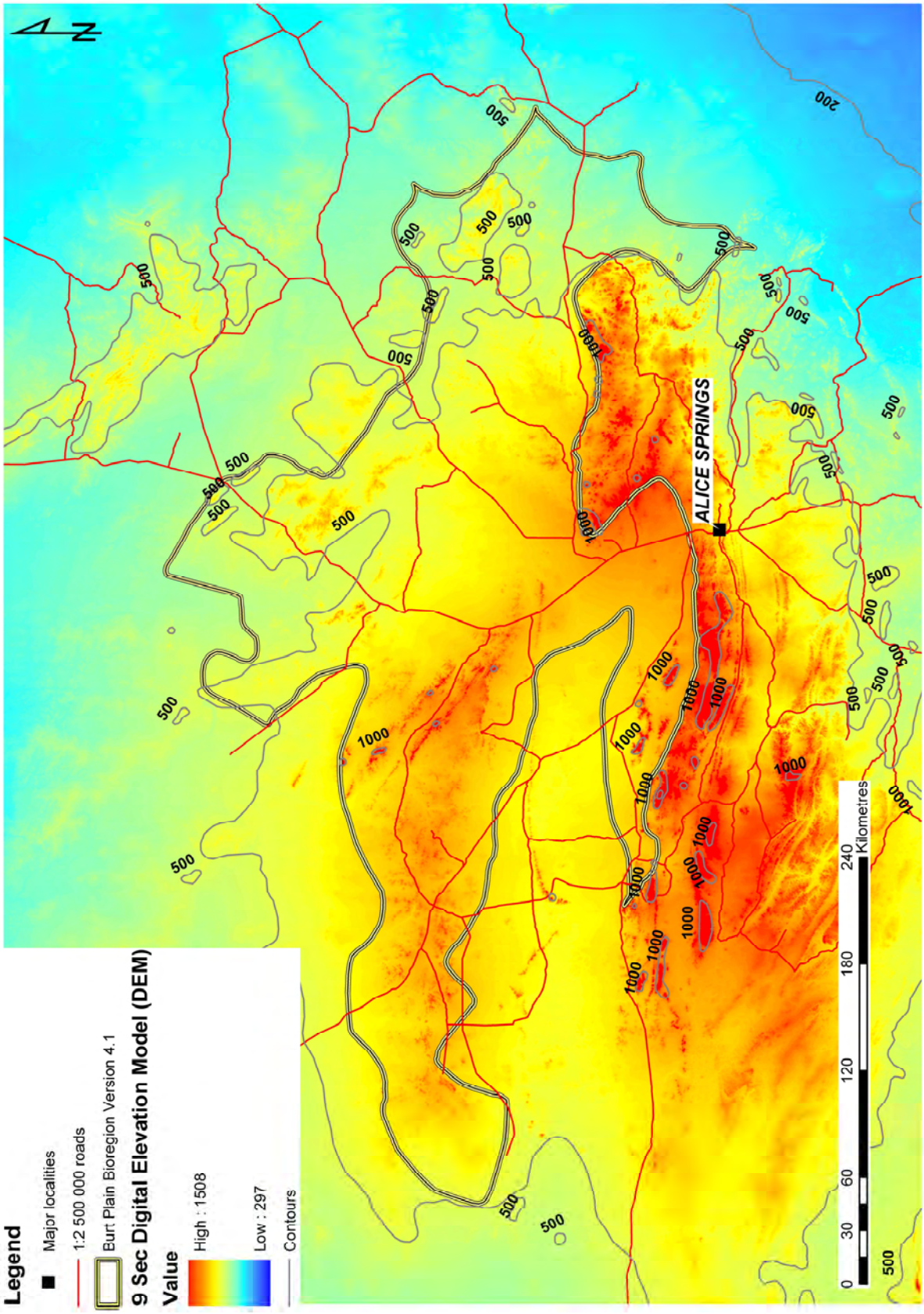
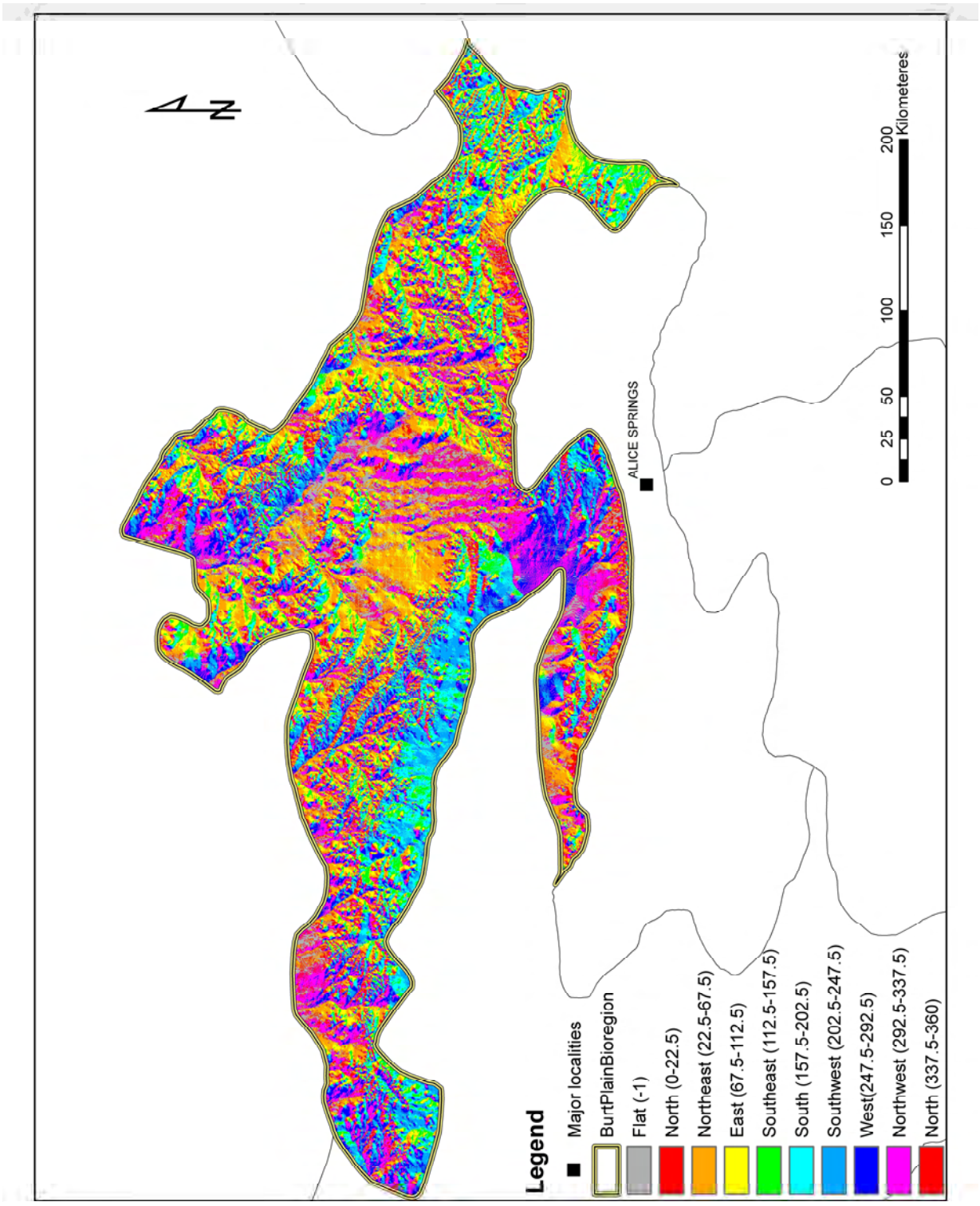


Figure 4.5 Aspect within the Burt Plain bioregion as derived from a 9 Second DEM (AUSLIG 1998); aspect classes are shown in brackets and represent variation in degrees from true north.



4.2.5 Biodiversity

Of the 889 plant species recorded from the Burt Plain bioregion, three species *Eleocharis papillose (*Dwarf Desert Spike-rush), *Ipomoea* A83192 Stirling (Bush Potato), and *Macrozamia macdonnellii* (MacDonnell Ranges Cycad) are listed in the Northern Territory as vulnerable under the *Territory Parks and Wildlife Conservation Amendment Act 2000* (White *et al.* 2000); (Connors *et al.* 1996), while *Ipomoea* A83192 Stirling and *Macrozamia macdonnellii* are also listed as vulnerable under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Table 4.2). The conservation status of at least 64 other taxa is uncertain due to insufficient data, but of concern and more information is required to determine their true conservation status in the Northern Territory (Table 4.3). Table 4.4 lists 41 plant taxa that are listed as lower risk-near threatened under the *Territory Parks and Wildlife Conservation Amendment Act 2000*.

Connors *et al.* (1996) reported this bioregion as having one of the highest proportion of weeds to native plants of all the NT bioregions, suggesting that habitat modification or degradation is substantial. Twenty eight (3.0% of the total species) weed species and 59 (6.2% of the total species) introduced plant species were recorded for the Burt Plain bioregion.

Table 4.2 Significant plant taxa occurring in the Burt Plain Bioregion (*Source:* updated from White (2000)). 'NT Status' refers to listing in the schedules of the *Territory Parks and Wildlife Conservation Amendment Act 2000*.

Scientific Name	Common Name	NT Status	Significance * White *et al.* (2000a)
SIGNIFICANT AT THE NATIONAL LEVEL			
Austrostipa centralis		NT	3RC-
Cratystylis centralis	Bluebush Daisy	NT	3RC-
Daviesia eremaea	Desert Broom-bush	DD	3K
Eleocharis papillosa	Dwarf Desert Spike-rush	VU	3R
Eragrostis subtilis		DD	3K
Goodenia halophila		DD	3K
Gossypium nelsonii		NT	3RC-
Hakea grammatophylla		NT	3RC-
Heliotropium subreniforme		DD	3K
Ipomoea A83192 Stirling †	Bush Potato	VU	2V
Isotoma luticola		NT	3R
Ixiochlamys integerrima		DD	3K
Kohautia australiensis		DD	3KC-
Leucopogon sonderensis	Mt Sonder Beard-heath	NT	3RC-
Macrozamia macdonnellii	MacDonnell Ranges Cycad	VU	3VCa
Marsilea A99150 Neutral Junction		DD	1K
Ptilotus aristatus var. *exilis* †		NT	2R
Ptilotus aristatus var. *stenophyllus* †		NT	2R
Samolus eremaeus	Water Pimpernel	DD	3KC-
Sauropus ramosissimus		DD	3KC-
Scaevola graminea †		DD	3R
Scaevola obovata		LC	3K
Sedopsis filsonii	Pink Rock-wort	NT	3RC-
Sida A88135 Hale River		DD	3K
Stylidium inaequipetalum	Uluru Triggerplant	LC	3RCa
SIGNIFICANT AT THE NORTHERN TERRITORY LEVEL			
Acacia macdonnellensis subsp. *teretifolia*		DD	3k (border)
Amaranthus cochleitepalus		NT	3rC-
Arabidella trisecta	Shrubby Cress	DD	3kC-
Aristida longicollis	Bull Wiregrass	NT	3r
Astrebla lappacea	Curly Mitchell Grass	DD	3k
Bulbine alata	Native Leek	DD	3k
Bulbostylis pyriformis		NT	3rC-
Calandrinia disperma		DD	3k
Calandrinia pleiopetala		NT	3rC-
Calotis cuneifolia	Blue Burr-daisy	DD	3k
Calotis kempei		DD	3k
Calotis squamigera		NT	3r
Centipeda racemosa	Erect Sneezeweed	DD	3k
Chenopodium pumilio	Clammy Goosefoot	DD	3k
Corchorus walcottii	Woolly Corchorus	DD	3k
Crotalaria dissitiflora subsp. *dissitiflora*		DD	3k
Cullen graveolens	Native Lucerne	DD	3k
Cyperus gilesii		DD	3k
Daucus glochidiatus	Australian Carrot	DD	3k
Digitaria hystrichoides †	Curly Umbrella Grass	NT	3r
Dissocarpus biflorus var. *biflorus*	Twin-flower Saltbush	DD	3k
Dysphania sphaerosperma		NT	3r
Einadia nutans subsp. *nutans*		NT	3rC-
Elacholoma hornii	Elacholoma	NT	3rC-
Enneapogon intermedius		DD	3k
Eragrostis A51007 Limestone		LC	3k
Eragrostis crateriformis		DD	3k
Eragrostis lanicaulis		DD	3k
Eremophila cordatisepala		NT	3r
Eremophila dalyana †	Gidgee Fuchsia-bush	NT	3rC-
Eremophila youngii subsp. A78292 Suplejack Station		NT	3r
Eriachne benthamii	Swamp Wanderrie	DD	3kC-
Erodium angustilobum		DD	3kC-
Fimbristylis D70268 Connells Lagoon		NT	3rC-
Gilesia biniflora	Gilesia	DD	3k
Glinus orygioides		NT	3r
Gomphrena leptophylla		DD	3k
Goodenia angustifolia		NT	3r

Gymnanthera cunninghamii †		NT	3r
Heliotropium ballii		DD	3k
Heliotropium glanduliferum		LC	3k
Heliotropium inexplicitum		DD	3k
Heliotropium sphaericum		DD	3k
Ixiochlamys nana	Small Fuzzweed	DD	3kC-
Juncus aridicola †	Tussock Rush	NT	3rC-
Lawrencia viridi-grisea		DD	3r
Lechenaultia lutescens		DD	3k
Lythrum paradoxum		DD	3k
Maireana lanosa		NT	3rC-
Maireana lobiflora	Lobed Bluebush	DD	3k
Maireana schistocarpa		DD	3k
Marsilea costulifera	Narrow-leaf Nardoo	DD	3k
Mimulus prostratus	Monkey Face	DD	3k
Oldenlandia argillacea		DD	3kC-
Ophioglossum polyphyllum		NT	3rC-
Osteocarpum salsuginosum	Bone Fruit	NT	3r
Oxalis radicosa		DD	3kC-
Parietaria cardiostegia		NT	3r
Phyllanthus erwinii		DD	3k
Pimelea microcephala subsp. *microcephala*	Shrubby Riceflower	NT	3r
Plantago cunninghamii	Sago Weed	DD	3k
Poranthera triandra	Three-petal Poranthera	NT	3rC-
Potamogeton pectinatus	Fennel Pondweed	NT	3r
Ptilotus aervoides		DD	3k
Sclerolaena birchii	Galvinised Burr	DD	3k
Sclerolaena densiflora †		NT	3r
Sclerolaena minuta		DD	3k
Sclerolaena muricata var. *muricata*		NT	3r
Sida A71181 Bond Springs		DD	3kC-
Sida A90797 Rainbow Valley		LC	3kC-
Sida D70364 Huckitta		LC	3k
Sida everistiana		NT	3r
Sida goniocarpa		NT	3r
Spartothamnella puberula	Red-berried Stick-plant	NT	3rC-
Streptoglossa cylindriceps		DD	3kC-
Tephrosia brachycarpa		DD	3k
Trianthema glossostigma		NT	3r
Triumfetta centralis		DD	3k
Triumfetta chaetocarpa		DD	3k
Triumfetta clivorum subsp. *brevipetala*		DD	3k
Triumfetta johnstonii		DD	3k
Triumfetta maconochieana		DD	3k
Vittadinia pterochaeta	Rough Fuzzweed	NT	3r
SIGNIFICANT AT THE SOUTHERN NORTHERN TERRITORY LEVEL			
Bothriochloa bladhii subsp. *bladhii*	Forest Bluegrass	LC	sthNT (disjunct)
Cyperus castaneus		LC	sthNT (disjunct)
Desmodium filiforme		LC	sthNT (disjunct)
Eragrostis exigua		LC	sthNT (disjunct)
Fimbristylis nuda		LC	sthNT (disjunct & apparently rare)
Fimbristylis sieberana		LC	sthNT (disjunct)
Imperata cylindrica	Blady Grass	LC	sthNT (disjunct & apparently rare)
Najas tenuifolia	Waternymph	LC	sthNT (disjunct)
Plumbago zeylanica	Plumbago	LC	sthNT (disjunct)
Psilotum nudum	Skeleton Fork Fern	LC	sthNT (rare)
Schoenus falcatus		LC	sthNT (disjunct & apparently rare)
SIGNIFICANT AT THE BURT PLAIN BIOREGION LEVEL			
Acacia hemignosta	Club-leaf Wattle	LC	BRT (southern range limit)
Acacia holosericea	Silver Wattle	LC	BRT (southern range limit)
Acacia jensenii	Spear Wattle	LC	BRT (disjunct)
Acacia macdonnelliensis subsp. *macdonnelliensis*	Hill Mulga	LC	BRT (eastern & northern range limit)
Acacia murrayana	Colony Wattle	LC	BRT (northern range limit)
Acacia perryi		LC	BRT (southern range limit)
Acacia salicina	Cooba	LC	BRT (disjunct)
Actinoble uliginosum	Flannel Cudweed	LC	BRT (northern range limit)
Amyema hilliana	Ironwood Mistletoe	LC	BRT (northern range limit)
Aristida arida		LC	BRT (northern range limit)}
Aristida hygrometrica	Northern Kerosene Grass	LC	BRT (disjunct)
Aristida strigosa	Rough Three-awn	LC	BRT (northern range limit)
Atriplex limbata		LC	BRT (northern range limit)
Atriplex spongiosa	Little Pop Saltbush	LC	BRT (northern range limit)
Bergia ammannioides	Water-fire	LC	BRT (apparently rare)

Bonamia deserticola	Creep Weed	LC	BRT (southern range limit)
Brachyachne convergens	Spider Grass	LC	BRT (disjunct)
Buchnera linearis	Dainty Bush Flower	LC	BRT (southern range limit)
Calocephalus knappii	Billybuttons	LC	BRT (northern range limit)
Corymbia eremaea subsp. *oligocarpa*	Mallee Bloodwood	LC	BRT (northern range limit)
Cremnothamnus thomsonii	Cliffside Daisy	LC	BRT (western & eastern range limits)
Cyanthillium cinereum		LC	BRT (disjunct)
Cyperus exaltatus	Giant Sedge	LC	BRT (disjunct)
Cyperus polystachyos	Bunchy Sedge	LC	BRT (rare & disjunct)
Desmodium campylocaulon	Creeping Tick-trefoil	LC	BRT (disjunct)
Dysphania glomulifera subsp. *eremaea*		LC	BRT (northern range limit)
Dysphania platycarpa		LC	BRT (disjunct & northern range limit)
Dysphania simulans	Salt-lake Rat-tail	LC	BRT (northern range limit)
Ectrosia scabrida	Hares-foot Grass	LC	BRT (southern range limit)
Enneapogon eremophilus		LC	BRT (western range limit)
Eucalyptus intertexta	Bastard Coolabah	LC	BRT (northern range limit)
Eucalyptus sessilis	Finke River Mallee	LC	BRT (northern range limit)
Fuirena incrassata		LC	BRT (apparently rare)
Glycine falcata		LC	BRT (disjunct)
Gompholobium polyzygum		LC	BRT (disjunct)}
Goodenia cycloptera	Serrated Goodenia	LC	BRT (northern range limit)
Goodenia gibbosa	Colony Goodenia	LC	BRT (northern range limit)
Goodenia maideniana	Salt Hand-flower	LC	BRT (disjunct & eastern range limit)
Grahamia australiana	Anacampseros	LC	BRT (disjunct)
Heliotropium conocarpum	White Heliotrope	LC	BRT (disjunct)
Indigofera basedowii	Showy Indigo	LC	BRT (northern range limit)
Indigofera monophylla		LC	BRT (eastern range limit)
Indigofera trita		LC	BRT (disjunct)
Iseilema eremaeum		LC	BRT (disjunct & apparently rare)
Iseilema macratherum	Bull Flinders Grass	LC	BRT (disjunct & apparently rare)
Isoetes muelleri	Quillwort	LC	BRT (disjunct)
Ixiochlamys cuneifolia	Silverton Daisy	LC	BRT (northern range limits)
Ixiochlamys filicifolia		LC	BRT (northern range limits)
Kennedia prorepens	Purple-flowered Pea Vine	LC	BRT (disjunct & apparently rare)
Lepidium oxytrichum	Green Peppercress	LC	BRT (northern range limit)
Levenhookia chippendalei	Tanami Pretty-pink	LC	BRT (eastern range limit)
Ludwigia octovalvis	Willow Primrose	LC	BRT (disjunct & rare)
Lysiana murrayi	Mulga Mistletoe	LC	BRT (northern range limit)
Maireana aphylla	Cottonbush	LC	BRT (northern range limit)
Maireana astrotricha	Southern Bluebush	LC	BRT (northern range limit)
Maireana scleroptera		LC	BRT (northern range limit)
Maireana spongiocarpa		LC	BRT (northern range limit)
Merremia davenportii	White Morning Glory	LC	BRT (southern range limit)
Minuria cunninghamii	Bush Minuria	LC	BRT (westerly range limit)
Myoporum acuminatum	Boobialla	LC	BRT (disjunct)
Neobassia proceriflora	Soda Bush	LC	BRT (disjunct)
Neptunia monosperma	Sensitive Plant	LC	BRT (disjunct but possibly introduced)
Oldenlandia mitrasacmoides subsp. *mitrasacmoides*		LC	BRT (southern range limit)
Olearia ferresii		LC	BRT (northern range limit)
Olearia stuartii		LC	BRT (northern range limits)
Ozothamnus kempei		LC	BRT (eastern range limit)
Parietaria debilis	Shade Pellitory	LC	BRT (northern range limit)
Paspalidium basicladum		LC	BRT (northern range limit)}
Peplidium muelleri		LC	BRT (apparently rare)}
Pimelea trichostachya	Spiked Riceflower	LC	BRT (northern range limit)
Polygala A77628 Davenport Range		LC	BRT (apparently rare)
Portulaca intraterranea	Buttercup Pigweed	LC	BRT (apparently rare)
Prostanthera striatiflora	Striped Mint-bush	LC	BRT (northern range limit)
Rotala diandra		LC	BRT (southern range limit)
Rotala mexicana		LC	BRT (apparently rare)
Rotala occultiflora		LC	BRT(disjunct)
Sclerolaena calcarata	Red Copper Burr	LC	BRT (disjunct)
Sclerolaena johnsonii	Johnsons Copper Burr	LC	BRT (northern range limit)
Sclerolaena muelleri		LC	BRT (eastern range limit)
Sclerolaena obliquicuspis	Limestone Copper Burr	LC	BRT (northern limit)
Sclerolaena urceolata	Squash Bush	LC	BRT (northern range limit)
Senecio laceratus		LC	BRT (northern range limit)
Sida A64076 Suplejack Station		LC	BRT (apparently rare)
Sida A86753 Pindan		LC	BRT (apparently rare & eastern range limit)
Solanum orbiculatum subsp. *orbiculatum*	Wild Tomato	LC	BRT (northern range limit)
Solanum sturtianum	Thargomindah	LC	BRT (northern range limit)
Spartothamnella teucriiflora	Mulga Stick-plant	LC	BRT (northern range limit)
Stackhousia A90542 Mt Liebig		LC	BRT (apparently rare)
Stenopetalum anfractum	Zig-zag Plant	LC	BRT (northern & eastern range limits)
Stenopetalum decipiens	Hill Thread-petal	LC	BRT (northern range limit)

Swainsona canescens	Grey Swainsona	LC	BRT (northern range limit)
Swainsona phacoides	Dwarf Swainsona	LC	BRT (northern range limit)
Thyridolepis mitchelliana	Window Mulga Grass	LC	BRT (northern range limit)
Trachymene gilleniae		LC	BRT (western range limit)
Trema tomentosa var. *viridis*	Peach-leaved Poison Bush	LC	BRT (disjunct)
Triglochin hexagonum	Six-point Arrowgrass	LC	BRT (disjunct)
Triodia intermedia	Winged Spinifex	LC	BRT (disjunct & southern range limit)
Vittadinia sulcata		LC	BRT (disjunct)
Wahlenbergia caryophylloides	Northern Bluebell	LC	BRT (disjunct)
Zornia albiflora		LC	BRT (southern range limit)
Zygophyllum prismatothecum	Square-leaf Twinleaf	LC	BRT (northern range limit)

VU = Vulnerable; NT = Lower Risk-Near Threatened; LC = Lower Risk-Least Concern; DD = Data Deficient.

† Burt Plain-centric taxon.

* Abbreviations used in Table 4.3 are given below.

BRT = Burt Plain Bioregion;

Conservation Codes as in White *et al.* (2000a & b) are as follows:

Distribution Categories

'1' Taxa that are known only from the type collection

'2' Taxa with a maximum geographic range within Australia of less than 100 kilometres.

'3' Taxa with a geographic range within Australia exceeding 100 kilometres.

Conservation Status

'V' Nationally Vulnerable. These taxa are not presently endangered but are at risk of disappearing from the wild over a longer period through continued depletion or changes in ecological processes and land uses.

'R' Nationally Rare. These taxa are rare but not currently considered to be threatened and may be represented by a relatively large population in a very restricted area or by smaller populations spread over a wide range.

'r' Rare in the Northern Territory. These taxa are rare but not currently considered to be threatened and may be represented by a relatively large population in a very restricted area or by smaller populations spread over a wide range.

'K' Nationally Poorly Known. These taxa may potentially belong to any threatened category but there is presently insufficient information to confidently assign codes.

'k' Poorly Known in the Northern Territory. These taxa may potentially belong to any threatened category but there is presently insufficient information to confidently assign codes.

Reservation Codes

'C' Conserved within a conservation reserve anywhere nationally.

Adequacy of Reservation Codes

'a' Considered to be adequately reserved, with a total population of 1000 plants or more known to occur within conservation reserves.

'-' Taxon has been recorded from a conservation reserve but the population size within the reserve is unknown.

Table 4.3 Threatened and data deficient plant taxa that have been recorded from the Burt Plain Bioregion. 'NT Status' refers to listing in the schedules of the *Territory Parks and Wildlife Conservation Amendment Act 2000*; 'AUS Status' refers to listing in the schedules of the *Environment Protection and Biodiversity Conservation Act 1999*; 'Res_cnt' is the number of reserves in the southern region of the Northern Territory from which the taxon has been recorded; '% BRT' is the percentage of all Northern Territory records from the Burt Plain Bioregion.

Scientific Name	Common Name	NT Status	AUS Status	Res _cnt	% BRT
Threatened Taxa					
Eleocharis papillosa ∝ Nat.	Dwarf Desert Spike-rush	VU	-	2	23
Ipomoea A83192 Stirling ∝ Nat. †	Bush Potato	VU	VU	0	100
Macrozamia macdonnellii ∝ Nat.	MacDonnell Ranges Cycad	VU	VU	5	7
Data Deficient Taxa					
Acacia macdonnellensis subsp. *teretifolia* ∝ NT		DD	-	0	42
Arabidella trisecta ∝ NT	Shrubby Cress	DD	-	1	14
Astrebla lappacea ∝ NT	Curly Mitchell Grass	DD	-	0	19
Bulbine alata ∝ NT	Native Leek	DD	-	0	10
Calandrinia disperma ∝ NT		DD	-	0	8
Calotis cuneifolia ∝ NT	Blue Burr-daisy	DD	-	0	67
Calotis kempei ∝ NT		DD	-	2	11
Centipeda nidiformis		DD	-	0	15
Centipeda racemosa ∝ NT	Erect Sneezeweed	DD	-	0	19
Chenopodium pumilio ∝ NT	Clammy Goosefoot	DD	-	1	29
Corchorus walcottii ∝ NT	Woolly Corchorus	DD	-	0	10
Crotalaria dissitiflora subsp. *dissitiflora* ∝ NT		DD	-	1	18
Cullen graveolens ∝ NT	Native Lucerne	DD	-	0	29
Cyperus gilesii ∝ NT		DD	-	0	50
Daucus glochidiatus ∝ NT	Australian Carrot	DD	-	6	19
Daviesia eremaea ∝ Nat.	Desert Broom-bush	DD	-	0	6
Dissocarpus biflorus var. *biflorus* ∝ NT	Twin-flower Saltbush	DD	-	0	20
Enneapogon intermedius ∝ NT		DD	-	2	12
Eragrostis crateriformis ∝ NT		DD	-	0	33
Eragrostis lanicaulis ∝ NT		DD	-	1	17
Eragrostis subtilis ∝ Nat.		DD	-	1	33
Eriachne benthamii s.lat ∝ NT	Swamp Wanderrie	DD	-	2	24
Erodium angustilobum ∝ NT		DD	-	1	3
Gilesia biniflora ∝ NT	Gilesia	DD	-	0	20
Gomphrena leptophylla ∝ NT		DD	-	0	8
Goodenia cylindrocarpa		DD	-	1	22
Goodenia halophila ∝ Nat.		DD	-	0	33
Heliotropium ballii ∝ NT		DD	-	0	8
Heliotropium inexplicitum ∝ NT		DD	-	2	14
Heliotropium sphaericum ∝ NT		DD	-	0	17
Heliotropium subreniforme ∝ Nat.		DD	-	0	8
Ixiochlamys integerrima ∝ Nat.		DD	-	0	50
Ixiochlamys nana ∝ NT	Small Fuzzweed	DD	-	1	14
Kohautia australiensis ∝ Nat.		DD	-	2	6
Lawrencia viridi-grisea ∝ NT		DD	-	0	10
Lechenaultia lutescens ∝ NT		DD	-	0	9
Leiocarpa tomentosa		DD	-	4	6
Lythrum paradoxum ∝ NT		DD	-	2	23
Maireana lobiflora ∝ NT	Lobed Bluebush	DD	-	1	6
Maireana schistocarpa ∝ NT		DD	-	1	18
Marsilea A99150 Neutral Junction ∝ Nat. †		DD	-	0	100
Marsilea costulifera ∝ NT	Narrow-leaf Nardoo	DD	-	0	20
Mimulus prostratus ∝ NT	Monkey Face	DD	-	0	6
Oldenlandia argillacea ∝ NT		DD	-	1	12
Oxalis radicosa ∝ NT		DD	-	2	12
Phyllanthus erwinii ∝ NT		DD	-	7	14
Plantago cunninghamii ∝ NT	Sago Weed	DD	-	0	55
Ptilotus aervoides ∝ NT		DD	-	0	56
Samolus eremaeus ∝ Nat.	Water Pimpernel	DD	-	4	35

Sauropus ramosissimus ∝ Nat.		DD	-	2	3
Scaevola graminea ∝ Nat. †		DD	-	0	75
Sclerolaena birchii ∝ NT	Galvinised Burr	DD	-	0	20
Sclerolaena minuta ∝ NT		DD	-	0	45
Sida A71181 Bond Springs ∝ NT		DD	-	2	33
Sida A88135 Hale River ∝ Nat.		DD	-	1	30
Streptoglossa cylindriceps ∝ NT		DD	-	1	15
Tephrosia A88109 Granites		DD	-	0	67
Tephrosia brachycarpa ∝ NT		DD		1	11
Triumfetta centralis ∝ NT		DD	-	2	28
Triumfetta chaetocarpa ∝ NT		DD	-	0	57
Triumfetta clivorum subsp. *brevipetala* ∝ NT		DD	-	0	20
Triumfetta johnstonii ∝ NT		DD	-	0	24
Triumfetta maconochieana ∝ NT		DD	-	3	40
Vittadinia pustulata		DD	-	5	11

VU = Vulnerable; DD = Data Deficient.

∝ beside the taxon name indicates a significant taxon where: ∝ Nat. = national level; ∝ NT = Northern Territory level.

† Burt Plain-centric taxon.

Table 4.4 Near threatened plant taxa that have been recorded from the Burt Plain Bioregion. 'Res_cnt' is the number of reserves in the southern region of the Northern Territory from which the taxa have been recorded; '% BRT' is the percentage of all Northern Territory records from the Burt Plain Bioregion.

Scientific Name	Common Name	Res_cnt	% BRT
Amaranthus cochleitepalus ∝ NT		5	4
Aristida longicollis ∝ NT	Bull Wiregrass	0	67
Austrostipa centralis ∝ Nat.		4	5
Bulbostylis pyriformis ∝ NT		4	20
Calandrinia pleiopetala ∝ NT		1	5
Calotis squamigera ∝ NT		0	33
Cratystylis centralis ∝ Nat.	Bluebush Daisy	1	20
Digitaria hystrichoides ∝ NT	Curly Umbrella Grass	0	50
Dysphania sphaerosperma ∝ NT		0	25
Einadia nutans subsp. *nutans* ∝ NT		3	30
Elacholoma hornii ∝ NT	Elacholoma	3	19
Eremophila cordatisepala ∝ NT		0	11
Eremophila dalyana ∝ NT †	Gidgee Fuchsia-bush	1	100
Eremophila youngii subsp. A78292 Suplejack Station ∝ NT		0	50
Fimbristylis D70268 Connells Lagoon ∝ NT		1	11
Glinus orygioides ∝ NT		0	8
Goodenia angustifolia ∝ NT		2	30
Gossypium nelsonii ∝ Nat.		2	27
Gymnanthera cunninghamii ∝ NT †		0	88
Hakea grammatophylla ∝ Nat.		4	5
Isotoma luticola ∝ Nat.		0	10
Juncus aridicola ∝ NT †	Tussock Rush	1	92
Leucopogon sonderensis ∝ Nat.	Mt Sonder Beard-heath	1	6
Maireana lanosa ∝ NT		1	25
Ophioglossum polyphyllum ∝ NT		3	18
Osteocarpum salsuginosum ∝ NT	Bone Fruit	0	11
Parietaria cardiostegia ∝ NT		2	15
Pimelea microcephala subsp. *microcephala* ∝ NT	Shrubby Riceflower	0	31
Poranthera triandra ∝ NT	Three-petal Poranthera	2	20
Potamogeton pectinatus ∝ NT	Fennel Pondweed	0	20
Ptilotus aristatus var. *exilis* ∝ Nat. †		0	100
Ptilotus aristatus var. *stenophyllus* ∝ Nat. †		0	100
Sclerolaena densiflora ∝ NT †		0	100
Sclerolaena muricata var. *municata* ∝ NT		0	33
Sedopsis filsonii ∝ Nat.	Pink Rock-wort	5	10
Sida everistiana ∝ NT		1	25
Sida goniocarpa ∝ NT		1	50
Sonchus hydrophilus		3	22
Spartothamnella puberula ∝ NT	Red-berried Stick-plant	6	14
Trianthema glossostigma ∝ NT		0	14
Vittadinia pterochaeta ∝ NT	Rough Fuzzweed	0	50

∝ beside the taxon name indicates a significant taxon where: ∝ Nat. = national level; ∝ NT = Northern Territory level.

† Burt Plain-centric taxon.

Dulcie Ranges and Relict Plant Populations

The Dulcie Ranges occur as rugged and highly dissected ranges on Arapunya Station with steep gorges containing permanent and semi-permanent waterholes (Morton *et al.* 1995a). The gorges provide habitat for a significant suite of plant species (Latz & Langford 1983). Seventeen rare and relict species were found in the Dulcie Ranges (Gibson *et al.* 1989; Latz & Langford 1983). The Dulcie Ranges were considered third in importance for relict plants (harbouring 13 species or 19% of total known from central Australia) after the MacDonnell (46%) and George Gill Ranges (40%) and of equal or more importance than the James Range system (Morton *et al.* 1995a).

Fauna

As with all other central Australian bioregions, the Burt Plain bioregion has suffered substantial loss of mammal species over the century (Connors *et al.* 1996). Connors *et al.* (1996) reported 319 vertebrate species recorded in the Burt Plain bioregion, with 11 species (3.4 %) being listed as rare or threatened (Table 4.5). No vertebrate species have been recorded as being restricted in the NT to the Burt Plain bioregion. Feral animal species recorded in the bioregion include: European Rabbit *(Oryctolagus cuniculus)*, House Mouse *(Mus musculus)*, Feral Cat *(Felis catus)*, Red Fox *(Vulpes vulpes),* Feral Camel (*Camelus dromedarius*), Wild Dog *(Canis lupus familiaris),* Feral Horse *(Equus caballus)*, Feral Donkey *(Equus asinus)* and Feral Pigeon *(Columba livia)*.

Table 4.5 List of rare and threatened vertebrates recorded in the Burt Plain bioregion

Scientific Name	**Common Name**	**Conservation Status**	
		EPBC[3]	**NT[4]**
**Isoodon auratus auratus*	Golden Bandicoot	VU	EN
**Lagorchestes hirsutus*	Mala	EW	EN
**Zyzomys pedunculatus*	Central Rock-rat	EN	EN
Sterna albifrons	Little Tern	V	DD
Dasycercus cristicauda	Mulgara	VU	VU
Macrotis lagotis	Greater Bilby	VU	VU
Petrogale lateralis	Black-footed Rock-wallaby	VU	NT
**Macroderma gigas*	Ghost Bat	VU	DD
Egernia kintorei	Great Desert Skink	VU	VU
Falco hypoleucos	Grey Falcon		NT
Pseudomys desertor	Desert Mouse		LC

(* represent records of species which are probably no longer present in the bioregion)

EX = Extinct; EW = Extinct in the Wild; CR = Critically Endangered; EN=

Endangered; VU = Vulnerable; NT = Lower Risk-Near Threatened; LC =

Lower Risk-Least Concern; DD = Data Deficient.

[3] EPBC refers to listing in the schedules of the *Environment Protection and Biodiversity Conservation Act 1999*.
[4] NT Status refers to listing in the schedules of the *Territory Parks and Wildlife Conservation Amendment Act 2000*.

4.3 METHODS

4.3.1 Spatial Datasets

Vegetation

Information on vegetation types is based on Wilson *et al.* (1990), who mapped NT vegetation types at 1:1000000 scale, defining 112 mapping units or vegetation communities. Mapping units were interpreted after recognition of vegetation patterns on Landsat (bands 4, 5 and 7), with reference to existing vegetation and land resource maps and some 1:500000 Landsat imagery (Wilson *et al.* 1990). Modification of the mapping units were carried out after three years of field work, data analysis and re-interpretation, with further reference to geological, topographic and existing vegetation maps.

Each mapping unit was classified based on a scheme recommended by (Dickinson & Kirkpatrick 1985), and guidelines adopted by the Australian Biological Resources Scheme (ABRS) in 1975, and other broadscale surveys such as Carnahan (1976) and Boyland (1984). The scheme is based on structure of major strata combined with dominant and/or characteristic species from each layer (Wilson *et al.* 1990).

Digital Elevation Model (DEM)[5]

The Australian Surveying and Land Information Group's (AUSLIG) standard product 'GEODATA 9 Second DEM Version 2' was used as a base Digital Elevation Model (DEM) for this research. The DEM grid spacing is 9 seconds in longitude and latitude (approximately 250m) and each grid cell has a value that represents the average elevation over the cell. The source data used to produce the DEM were:

- Spot heights from GEODATA TOPO-250K relief the (25000 points revised);
- Linear watercourse features from the drainage layers of the GEODATA TOPO-250K Hydrography theme (9 000 features revised);
- Radar altimeter point elevation data for Lake Eyre;
- Trigonometric data points from the National Geodetic Data Base (19000 points revised); and
- Spot heights (87000), stream lines (11000), sink point data (21000), selected cliff lines and associated contour lines digitised from 1:100000 scale mapping. The scale of the final product has a resolution between 1:250000 and 1:500000 (AUSLIG 1998).

Two tiles of the Australian 9 Second DEM were required to cover the entire Burt Plain bioregion. Each tile nominally covers 6 degrees of longitude by 4 degrees of latitude. These were then converted to ArcInfo GRID format (using the ASCIIGRID command in the GRID module), mosaicked (using the

[5] A topographic surface arranged in a data file as a set of regularly-spaced x,y,z locations where z represents elevation.

mosaic[6] command within GRID) and then clipped to the Burt Plain bioregion (using the GRIDCLIP command within GRID) to form one DEM for the entire case study region. The two tiles used were:

SF52 Lake Mackay	SF53 Alice Springs

DEM accuracy has root mean square elevation errors ranging between 7.5 and 20 metres across Australia (AUSLIG 1998).

Latitude and Longitude

Using the aforementioned DEM, two grid coverages were derived each for latitude and longitude.

Climate Surfaces

The climate surfaces used in my research were derived from the software package ANUCLIM Version 5.0[7] which had been previously generated by the ANUSPLIN[8] package (Hutchinson 1999) based on long-term monthly averages of the climate variables at fixed points within the region. The

[6] A raster dataset composed of two or more merged raster datasets—for example, one image created by merging several individual images or photographs of adjacent areas

[7] ANUCLIM is a software package of programs developed by the Centre for Resource and Environmental Studies (CRES) at the Australian National University (ANU) – see http://cres.anu.edu.au.

[8] The climate surface coefficient files are produced from irregular networks of actual meteorological variables by the ANUSPLIN package , a separate package to ANUCLIM.

ANUCLIM package enables users to obtain estimates of monthly mean climate variables, bioclimatic parameters, and indices relating to crop growth. The main components of the package utilised were:

- ESOCLIM (ESTimation Of CLIMate), which was used to generate output files containing the climate variable estimates at specified points on the ground; and
- BIOCLIM, which was used to generate bioclimatic surrogate parameters, derived from the climate surfaces.

ESOCLIM generated estimates of monthly climate values by calculating the values of the monthly mean climate surfaces for the following climate variables:

- Maximum temperature ^{o}C;
- Minimum temperature ^{o}C;
- Rainfall (mm);
- Raindays; and
- Evaporation.

The mosaicked and clipped DEM outlined above (which contains elevation values) was also required as the third independent variable. Using the GRID module once again, the Burt Plain bioregion DEM was then converted back from GRID and UNIX format to ASCII[9] and DOS format for the running of

[9] American Standard Code for Information Interchange. Text files are often referred to as ASCII files.

ESOCLIM. The resulting files for each month, for each of the climate variables, were then converted to GRID format using the ASCIIGRID command in ArcInfo.

Land Systems and Land Resource Data (Land Unit Mapping)

The former Department of Lands, Planning and Environment (DLPE) made available Land Resource data and associated reports pertaining to seven stations within the Burt Plain bioregion (Figure 4.6, Table 4.6). These data were mapped at scales ranging from 1:15000 to 1:100000. A summary of the 'land unit' mapping datasets is shown below. A land unit is defined as a reasonably homogeneous part of the land surface, distinct from surrounding terrain, with similar properties in landform, soils or vegetation (Perry 1962). Appendix 1 gives a full description of all land systems found in the Burt Plain bioregion.

Figure 4.6 Land parcels in the Burt Plain bioregion where Land Resource Surveys of the Alice Springs and Barkly Regions have been undertaken by the Department of Lands, Planning and Environment. *Note: only a small portion of Bond Springs (i.e. the Upper Todd catchment) has been mapped.

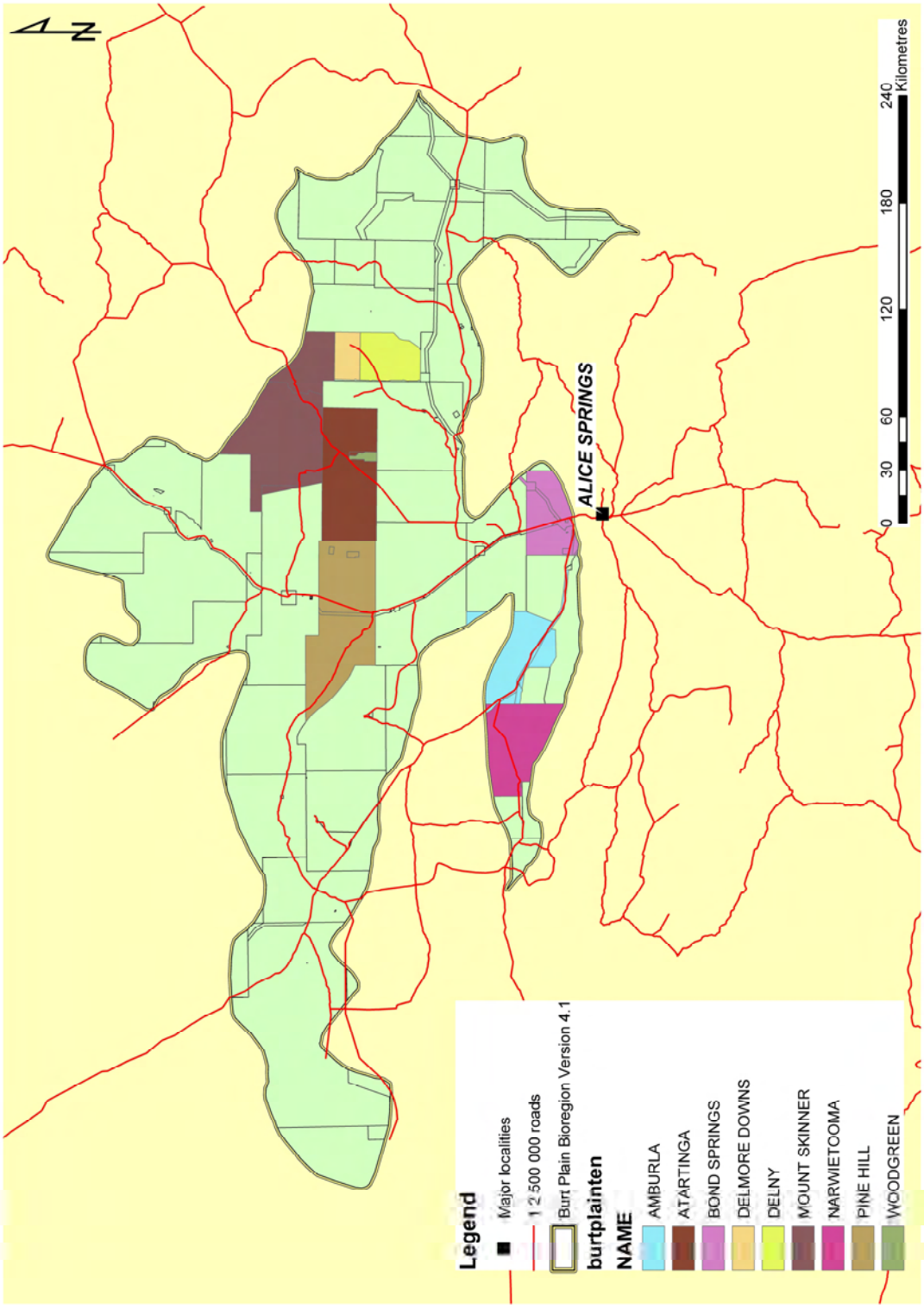


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Table 4.6 The Department of Lands, Planning and Environment (DLPE) Land Resource data and associated reports pertaining to seven pastoral stations within the Burt Plain bioregion.

AMBURLA	
Location	100 km north-west of Alice Springs on the Tanami Road
Area	2 020 km^2
Scale	1:100 000 (southern part of station at 1:50 000)
Method	Stereo-interpretation of aerial photographs and extensive on-ground survey
Date	1989
Number of Land Units	32
Report	Grant (1989)
DELNY/DELMORE DOWNS	
Location	170 km north-east of Alice Springs
Area	1 215 km^2
Scale	1:50 000 (southern part of station at 1:50 000)
Method	Stereo-interpretation of aerial 1:50 000 photographs and extensive on-ground survey
Date	1989
Number of Land Units	36
Report	Grant, R. (In prep.)
MOUNT SKINNER	
Location	160 km north of Alice Springs
Area	3 038km^2
Scale	1:100 000
Method	Stereo-interpretation of aerial photographs and extensive on-ground survey
Date	1986
Number of Land Units	40
Report	Grant (1987)
NARWIETOOMA	
Location	142 km north-west of Alice Springs
Area	2 725km^2
Scale	1:100 000
Method	Stereo-interpretation of 1:50 000 aerial photographs and extensive on-ground survey
Date	1993
Number of Land Units	27
Report	Bowman & Villiger (1995)

PINE HILL	
Location	150 km north of Alice Springs on the Stuart Highway
Area	2 752 km^2
Scale	1:100 000
Method	Stereo-interpretation of 1:50 000aerial photographs
Date	1998
Number of Land Units	30
Report	Reu & Garbin (1999)
UPPER TODD RIVER CATCHMENT – BOND SPRINGS	
Location	North of Alice Springs
Area	85 km^2
Scale	1:15 000
Method	Stereo-interpretation of 1:15 000 aerial photographs and extensive on-ground survey
Date	December 1994
Number of Land Units	32
Report	Grant (1994)
ATARTINGA/WOODGREEN	(from image classification)
Location	140 km north of Alice Springs on the Sandover Highway
Area	2 220km^2
Scale	1:100 000
Method	Landsat 5 TM Image Classification captured 18/12/1996
Date	1997
Number of Land Units	32
Reference	Unpublished

Tenure

The Northern Territory Tenure – 1995 spatial data were derived from the Department of Lands, Planning and Environment tenure database. This database provides basic delineation and listing of land ownership and leaseholds in the Northern Territory. There are 12 types of tenure in the data. The positional accuracy of the data is approximately 1:200000; the attribute

accuracy is unknown and the last update was completed in 1995. The DLPE Northern Territory (now known as Department of Infrastructure, Planning and Environment DIPE) supplied these data [10].

Interim Biogeographic Regions of Australia

Following the publication of Version 4.0 of the IBRA, PWCNT and DLPE staff made some further amendments to the NT region boundaries (P. Pert personal information). The version of the bioregions currently used in the NT includes those changes and is used in this research and has separate regions for those combined for IBRA 4.0. The NT version is referred to here as IBRA NT 4.1. The criteria used to determine region boundaries have not been well documented. Different criteria were used in different places, including soils, vegetation, terrain, climate and the interplay of these. The IBRA regions for the NT were created using a synthesis of subjective knowledge, previous regionalisations, the 1:1000000 scale NT Vegetation Map (Wilson *et al.* 1990), and various Land Systems and Resource Survey Maps. For use with other datasets in this research the Burt Plain bioregion was clipped from the IBRA BT 4.1 using GIS software.

[10] The Northern Territory Department of Infrastructure, Planning and Environment (DIPE) was created in November 2001 from the following Agencies:

- Department of Transport and Works;
- Department of Lands, Planning and Environment (DLPE); and
- Parks and Wildlife Commission of the Northern Territory (PWCNT).

4.3.2 Software and Hardware

All/most spatial analyses conducted here were undertaken using ARC/INFO GIS software produced by Environmental Systems Research Institute, Inc. (ESRI). Various modules of ARC/INFO 7.2.1 based on a UNIX system (and accessed on a PC via Xwin32[11]) were utilised at various stages for manipulation and analysis of data including the GRID[12] module, and ARCEDIT and ARCPLOT for display and query purposes. INFO[13] was also used to produce area and frequency statistics. Coverages and files were transferred from the UNIX server to the PC using WS_FTP95[14]. ArcView 3.1 and ArcView Spatial Analyst 1.0a (also produced by ESRI), based on a Microsoft Windows compatible PC system was also utilised for production of maps, and also for some spatial analyses. Microsoft Excel was also used extensively in statistical analysis and graphing of the data following GIS analysis.

4.3.3 Data Analysis

Data Conversion and Manipulation

Prior to further analysis, a number of steps had to be taken to manipulate

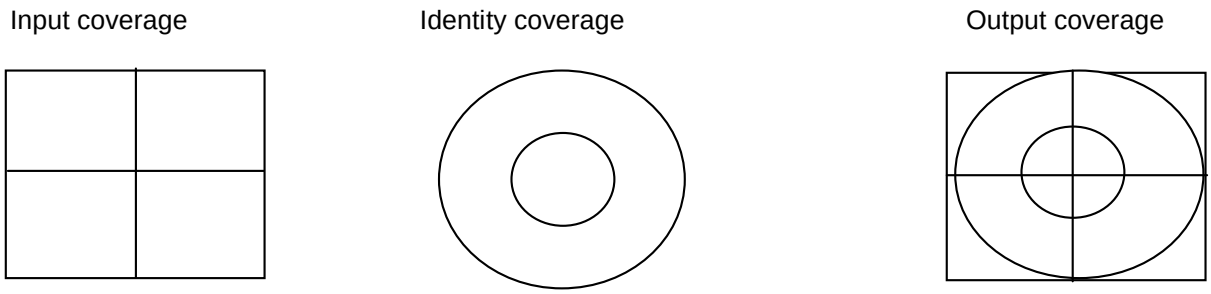
[11] Xwin32 – simulates an Xterminal window on personal computers.
[12] An ARC/INFO software product that provides a fully-integrated raster (cell-based) geoprocessing system for use with ARC/INFO. GRID supports a Map Algebra spatial language that allows sophisticated spatial modeling and analysis to be performed.
[13] A tabular DBMS used by ARC/INFO to store and manipulate feature attribute and related tables.
[14] Ws_FTP95 – File transfer protocol used for uploading and downloading files from PC to unix servers and vice versa.

spatial data into a format suitable for ARC/INFO. The majority of the data was supplied in ARC/INFO export format (*.e00) or ArcView shapefiles, with the exception of the climate surfaces (as described in Section 4.3.1) and the Landsat TM7 image files which were in ER Mapper (v6.0) format. To create ARC/INFO coverages from the *.e00 files for further use and analysis the ARC: IMPORT command was used. ArcView shapefiles were also converted to ARC/INFO coverages using the ARC command SHAPEARC. All of the data was already projected in a geographical coordinate system 1966 Australian Geodetic Datum (AGD-66) spheroid; that is, with latitudinal and longitudinal values.

Analysis

Using ARC/INFO the majority of coverages were clipped to the Burt Plain bioregion (using the ARC command CLIP), as subsetting the data would save on processing time in further spatial analyses. Once clipped, various topological overlays were performed. Using the IDENTITY command, the output coverage from this process preserved all the input features plus those portions of the polygon coverage that overlapped the input coverage (Figure 4.7). Input features, preserved in the output data set also received attribute of the polygons they intersect.

Figure 4.7 Diagram showing the results of an ARC/INFO spatial join of two coverages using the ARC command IDENTITY.



4.4 RESULTS

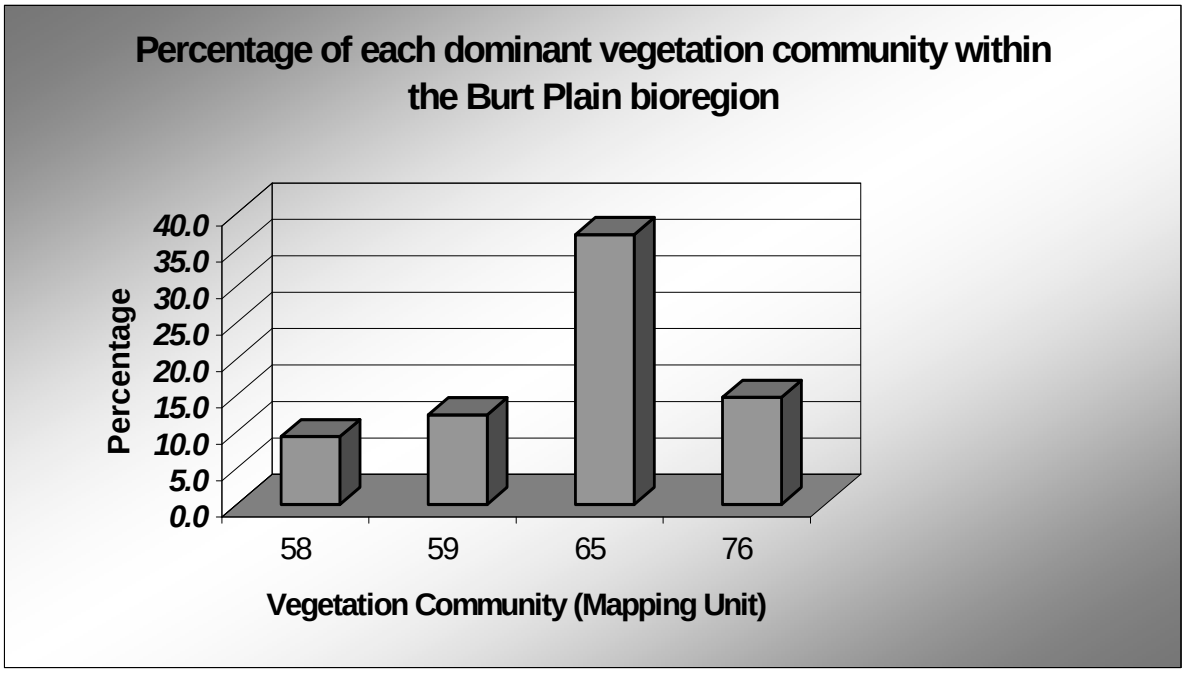
4.4.1 Nature and distribution of vegetation communities

There are 25 vegetation communities in the Burt Plain bioregion (delineated by the 1:1000000 Northern Territory Vegetation Types Map (Wilson *et al.* 1990). Of those 25, four dominant vegetation communities occupy approximately 73.3% of the bioregion. The other 26.7% is made up of 21 communities, each covering less than 4% of the entire bioregion. The four dominant vegetation communities are:

A. Mapping Unit 65 - *Acacia aneura* (Mulga) tall open-shrubland with *Eragrostis eriopoda* (Woollybutt) open-grassland understorey, which covers an area of 2 771 054.33 hectares or 37.04% of the Burt Plain (Figure 4.8);
B. Mapping Unit 76 - *Triodia pungens* (Soft Spinifex), *Plectrachne schinzii* (Curly Spinifex) hummock grassland with Acacia tall sparse-shrubland overstorey, which covers an area of 1098704.82 hectares or 23.17% of the Burt Plain (Figure 4.8);
C. Mapping Unit 59 - *Acacia estrophiolata* (Ironwood), *Atalaya hemiglauca* (Whitewood) low open-woodland with open-grassland understorey, which covers 919927.52 hectares or 12.30% of the Burt Plain (Figure 4.8); and

D. Mapping Unit 58 - *Acacia aneura* (Mulga)/mixed species low open-woodland with open-grassland understorey, which covers 696045.26 hectares or 9.30% (Figure 4.8)

Figure 4.8 Percentage of each dominant vegetation community (mapping unit) within the Burt Plain bioregion; vertical axis represents percentage of Burt Plain bioregion covered by the community.



Vegetation Community 58

Vegetation community 58 (or mapping unit 58) covers 9.3% of the Burt Plain bioregion and covers an area of 696045.26 hectares, in 12 discrete patches (Figure 4.9). *Acacia aneura* (Mulga) is a common component of the upper layer although generally this stratum is co-dominated by species such as *Atalya*

hemiglauca (Whitewood), *Acacia estrophiolata* (Ironwood), and *Hakea chordophylla* (Wilson *et al.* 1990). The ground layer is usually an open-grassland dominated by short tussock grasses such as *Enneapogon polyphyllus* (Limestone Bottlewashers), *Aristida* spp. and *Dactyloctenium radulans* (Button grass), but also *Salsola kali* (Prickly saltwort) and *Sclerolaena s*pp.

The tenure type is predominantly Perpetual Pastoral Lease (73%) (Figure 4.9), and the land systems are:

A. Napperby NA (15%) - Granite hills, relief 152.4 m; and gneiss ridges, relief 50 ft; some shallow soils; sparse grass. Lowlands; red earths and other soils; sparse low trees over short grasses;
B. Warburton WA (15%) - Plains with up to 4.6 m relief; red earths and texture-contrast soils; mainly medium dense low trees over short grass or woollybutt; and
C. Delny DE (14%) - Peneplain, dissected margins, and lower erosional plains, relief up to 30.5 m; red earths, calcareous earths, and stony texture-contrast soils; mulga, gidgee, or sparse low trees over short grass.

The predominant soils are:

A. Mx24 (14%) - Plains on granite with some schist and gneiss and with occasional rocky hills and ridges: chief soils are alkaline and neutral red earths, and

B. My120 (14%) - Low dissected undulating plateaux on schist and gneiss with spurs, ridges, and mesas; some with laterite cappings: chief soils are neutral red earths often containing ironstone gravels. Associated are soils on calcrete platforms; some shallow stony soils with rock outcrop on areas of strong relief; soils in gilgai complex with soils in some side valleys.

The predominant geology is:

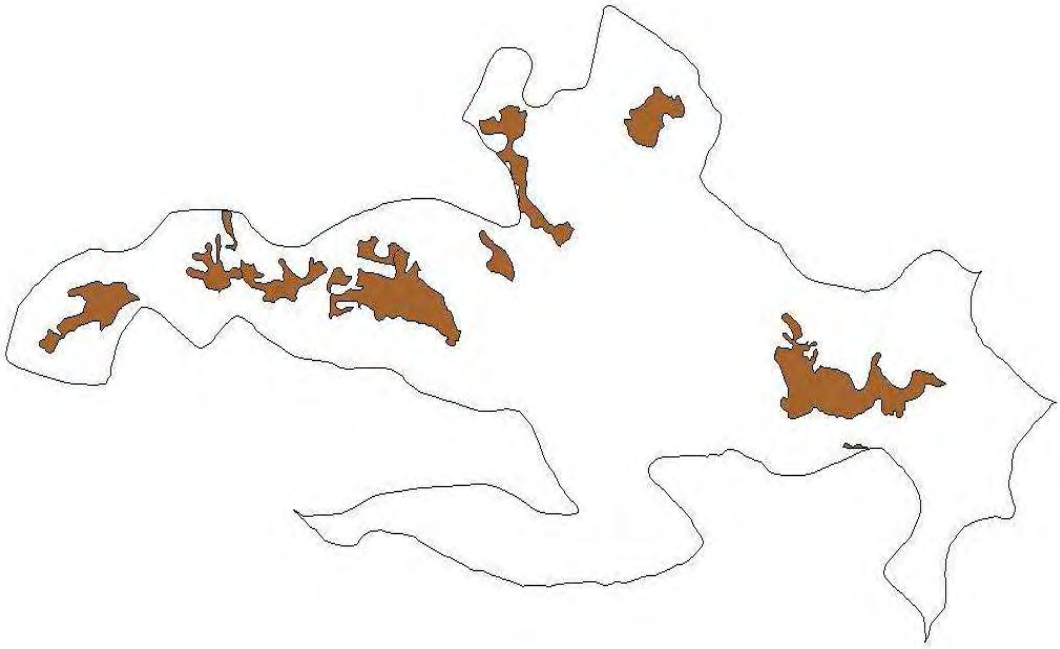
A. APA (42%) – Pre-Cambrian high-grade metamorphics, granite, gabbro in Arunta block; and
B. PCA (38%) – Pre-Cambrian granitic rocks, minor acid volcanics in Arunta block (Figure 4.10). Appendix 4 gives a full description of all geology types found in the Burt Plain bioregion.

As calculated using ESOCLIM, the mean annual temperature for Vegetation Community 58 ranged from a maximum of 30.9^{o}C to a minimum of 12.8^{o}C. The maximum temperature ranged between 33.6 – 35.8^{o}C in the wet season (December – March), whereas the minimum temperature ranged between 7.4 – 11.6^{o}C in the dry season. Total annual rainfall ranged from a minimum of 252.6 mm to a maximum of 331.7 mm, with an average in the dry season between 8.9 – 13.9 mm, and in the wet season 31.4 – 42.3 mm. The number of total annual raindays ranged from a minimum of 41.4 with less days occurring in the dry season to a maximum of 54.7 total annual raindays, with

more days occurring in the wet season. Total annual evaporation ranged between 2902.3 – 3186.0 mm, with a mean annual evaporation ranging between 241.9 – 265.5 mm. Based on the DEM, the elevation across Vegetation Community 58 ranged between 441.3 – 826.5 metres. Mean annual evaporation had significant positive correlations with mean annual temperatures, particularly for the wet season. Elevation was only positively correlated with one of the environmental gradients i.e. mean annual raindays. A summary of the major gradients and associated correlation and covariance matrices for Vegetation Community 58 were calculated and are given in Tables 4.7, and 4.8 (Figure 4.12-4.16).

Based on an analysis of herbarium records provided, 361 plant species have been recorded for Vegetation Community 58.

Figure 4.9 Spatial distribution of Vegetation Community 58 for the Burt Plain bioregion (for full descriptions of soils and geology refer to Appendices 4 and 5)



Area: 696 045 hectares (9.3% of the Burt Plain)

No. of patches: 12

Tenure: Perpetual Pastoral Lease (PPL)

Land Systems: Napperby (NA); Warburton (WA); Delny (DE)

Geology: APA; PCA

Soils: Mx24; My120

No. of bores: 154

Dominant species: Mulga *(Acacia aneura)*/mixed species low open woodland with open-grassland understorey

Figure 4.10 Percentage of tenure type by area for Vegetation Community 58

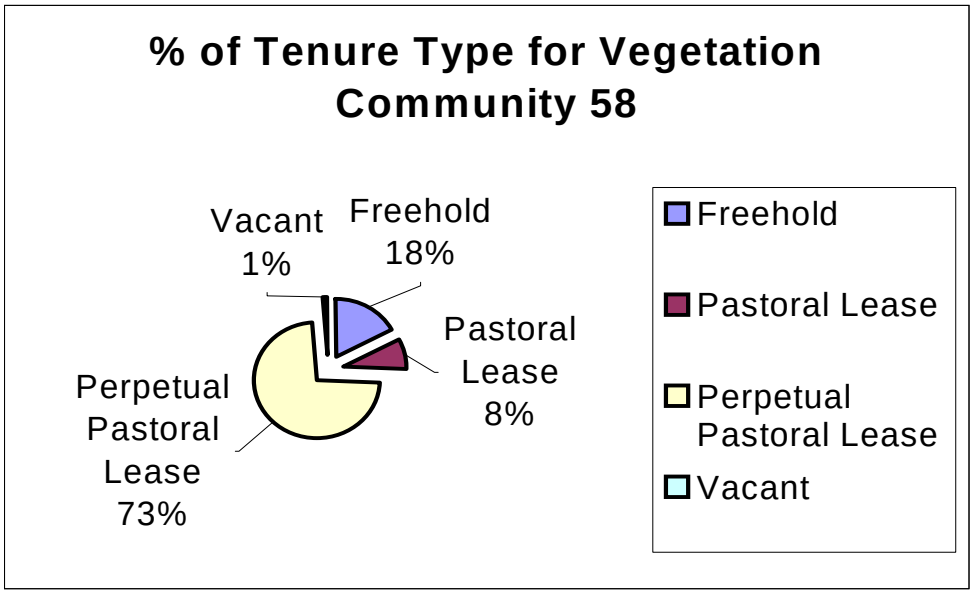


Figure 4.11 Geology of the Burt Plain bioregion (see Appendix 5 for full description)

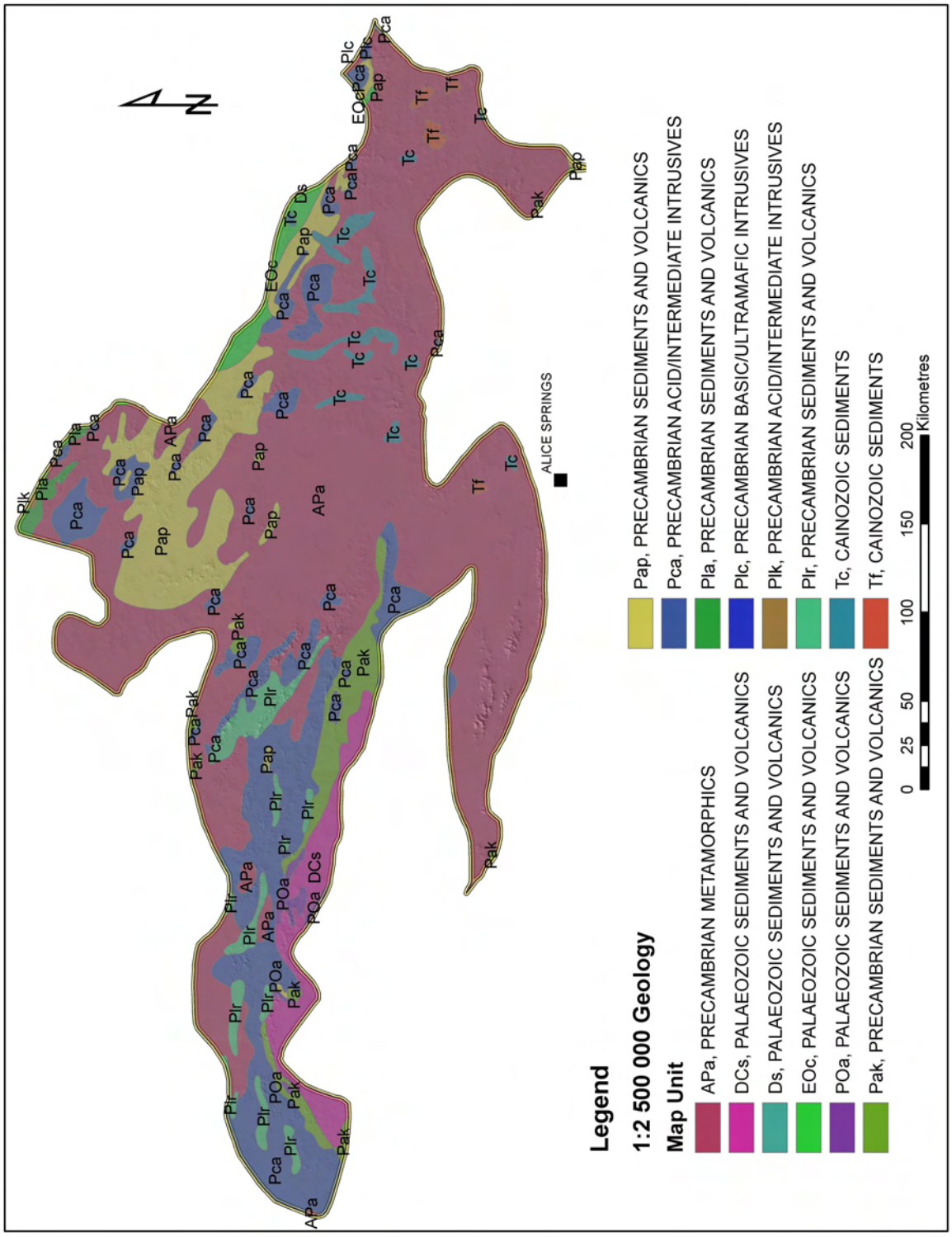


Table 4.7 A summary of the major climatic gradients encompassed by Vegetation Community 58 in the Burt Plain bioregion, NT.

Major Gradients	**Min**	**Max**
Mean Annual Maximum Temperature (^{o}C)	28.4	30.9
Mean Annual Minimum Temperature (^{o}C)	12.8	16.5
Mean Annual Temperature (^{o}C)	20.1	23.6
Average Temperature Dry Season (^{o}C)	15.3	18.8
Maximum Temperature Dry Season (^{o}C)	23.2	26.1
Minimum Temperature Dry Season (^{o}C)	7.4	11.6
Average Temperature Wet Season (^{o}C)	26.0	28.4
Maximum Temperature Wet Season (^{o}C)	33.6	35.8
Minimum Temperature Wet Season (^{o}C)	18.2	21.5
Total Annual Rainfall (mm)	252.6	331.7
Average Rainfall Dry Season (mm)	8.9	13.9
Average Rainfall Wet Season (mm)	31.4	42.3
Mean Annual Rainfall (mm)	21.1	27.7
Total Annual Raindays	41.4	54.7
Average Raindays Dry Season	1.8	2.9
Average Raindays Wet Season	4.7	6.2
Total Annual Evaporation (mm)	2902.3	3186.0
Average Evaporation Dry Season (mm)	164.9	200.5
Average Evaporation Wet Season (mm)	312.6	331.5
Mean Annual Evaporation (mm)	241.9	265.5
Elevation	441.3	826.5

Table 4.8 Summary of environmental gradient statistics for Vegetation Community 58

Covariance Matrix							
	Xraind58m	Xrainf58m	Xevap58m	Xallwtmp58m	Xalltmp58m	Xalldtmp58m	Dem58mask
Xraind58m	0.0386153	0.213102	-0.225198	0.00451007	0.0174995	0.0304889	13.7315
Xmxtmp58m	-0.00923293	0.0920277	2.15862	0.282235	0.332457	0.382678	-8.92396
Xmntmp58,	0.0442319	0.757091	3.90469	0.486065	0.614453	0.742841	3.0111
Xrainf58m	0.213102	1.84541	1.62975	0.266262	0.42456	0.582857	65.7773
Xevap58m	-0.225198	1.62975	23.9658	2.49989	3.03165	3.56341	-149.534
Xallwtmp58m	0.00451007	0.266262	2.49989	0.316409	0.38415	0.451891	-5.66154
Xalltmp58m	0.0174995	0.42456	3.03165	0.38415	0.473455	0.56276	-2.95643
Xalldtmp58m	0.0304889	0.582857	3.56341	0.451891	0.56276	0.673629	-0.251325
Dem58mask	13.7315	65.7773	-149.534	-5.66154	-2.95643	-0.251325	5111.7

Correlation Matrix							
	Xraind58m	Xrainf58m	Xevap58m	Xallwtmp58m	Xalltmp58m	Xalldtmp58m	Dem58mask
Xraind58m	1	0.798291***	-0.234093*	0.0408018	0.129421	0.189039	0.977362****
Xrainf58m	0.798291***	1	0.245064*	0.348449*	0.454206*	0.522763**	0.677247**
Xevap58m	-0.234093*	0.245064*	1	0.907822***	0.900003****	0.886869***	-0.427228**
Xallwtmp58m	0.0408018	0.348449*	0.907822****	1	0.992515****	0.97881****	-0.140775*
Xalltmp58m	0.129421	0.454206**	0.900003****	0.992515****	1	0.996491****	-0.060096*
Xalldtmp58m	0.189039	0.522763**	0.886869**	0.97881****	0.996491****	1	-0.00428294
Dem58mask	0.977362****	0.677247**	-0.427228**	-0.140775*	-0.060096	-0.00428294	1

**** Very Strong correlation > 0.9; *** Strong correlation 0.7 to 0.9; ** Moderate correlation 0.4 to 0.7; * Weak, low correlation (not very significant) 0.2 to 0.4; Very weak to negligible correlation 0.0 to 0.2

Figure 4.12 Mean Annual Temperature (°C) for the Burt Plain bioregion for Vegetation Community 58

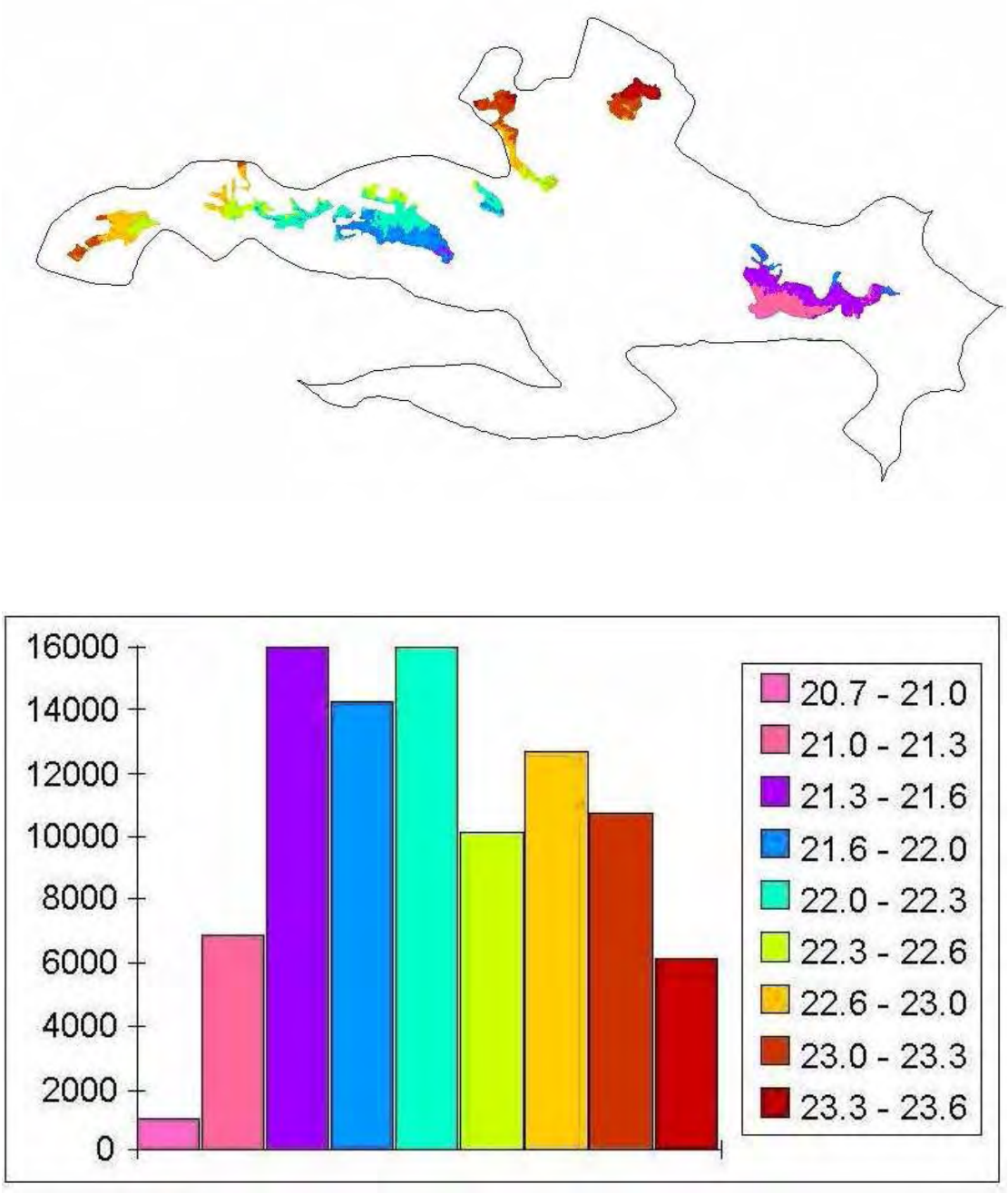
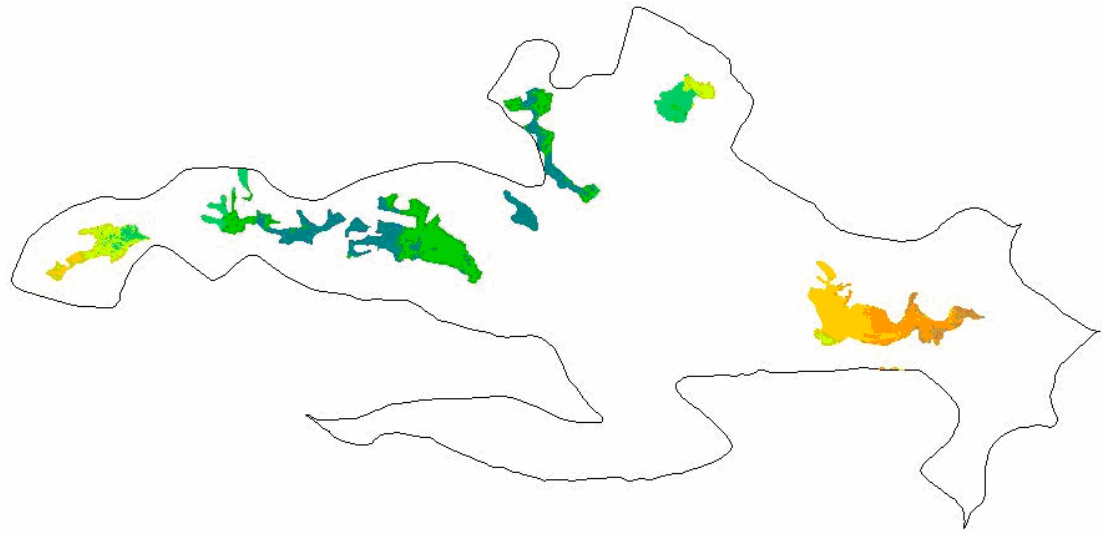


Figure 4.13 Mean Annual Rainfall (mm) for the Burt Plain bioregion for Vegetation Community 58



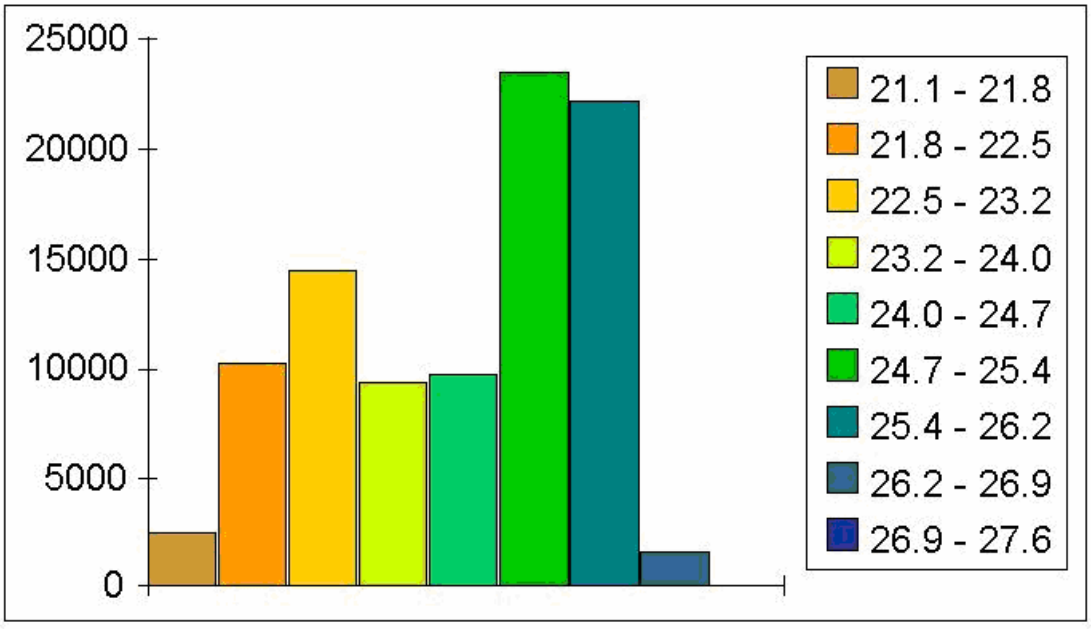


Figure 4.14 Mean Annual Evaporation (mm) for the Burt Plain bioregion for Vegetation Community 58

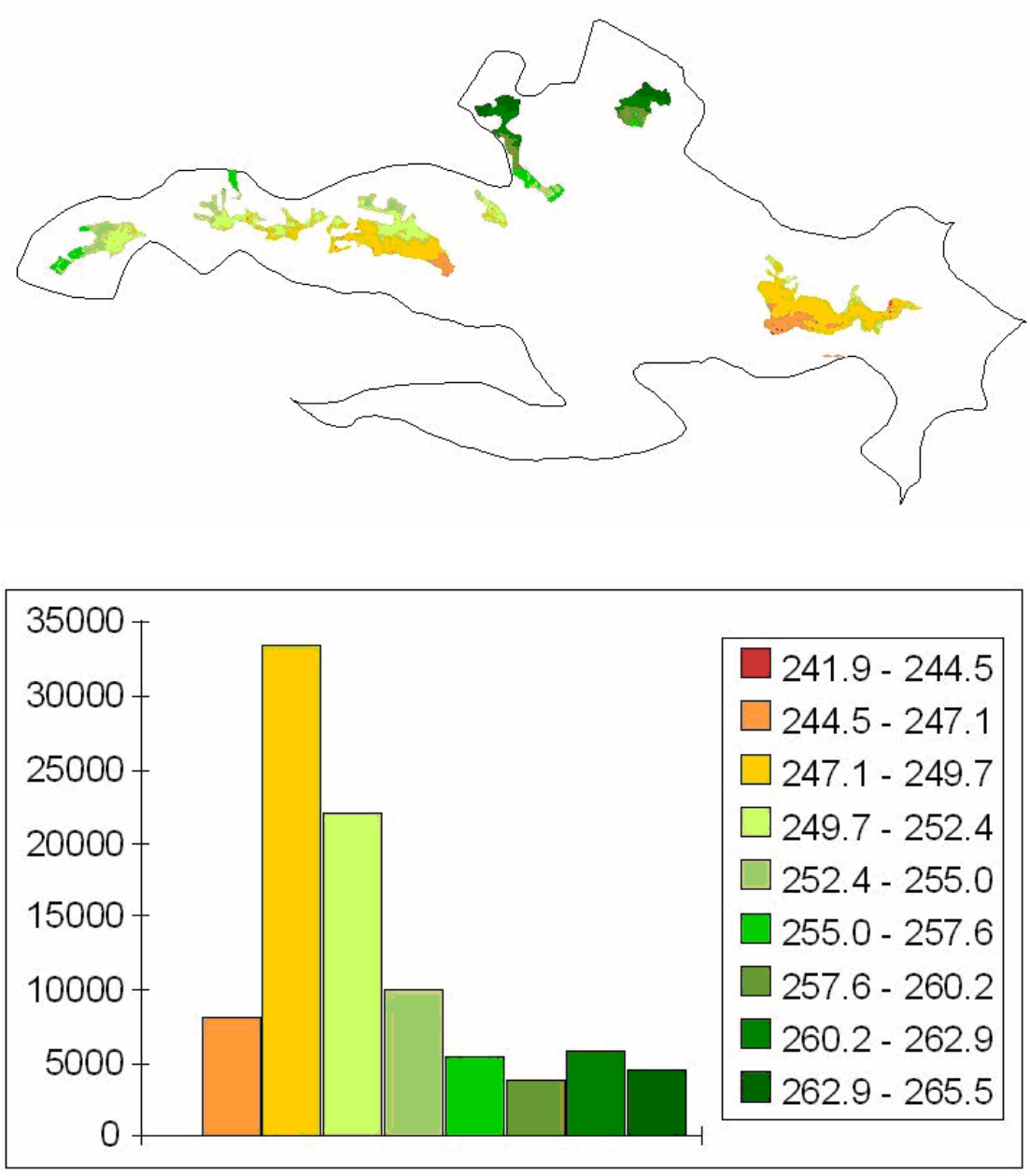


Figure 4.15 Elevation (m above sea level) for the Burt Plain bioregion for Vegetation Community 58

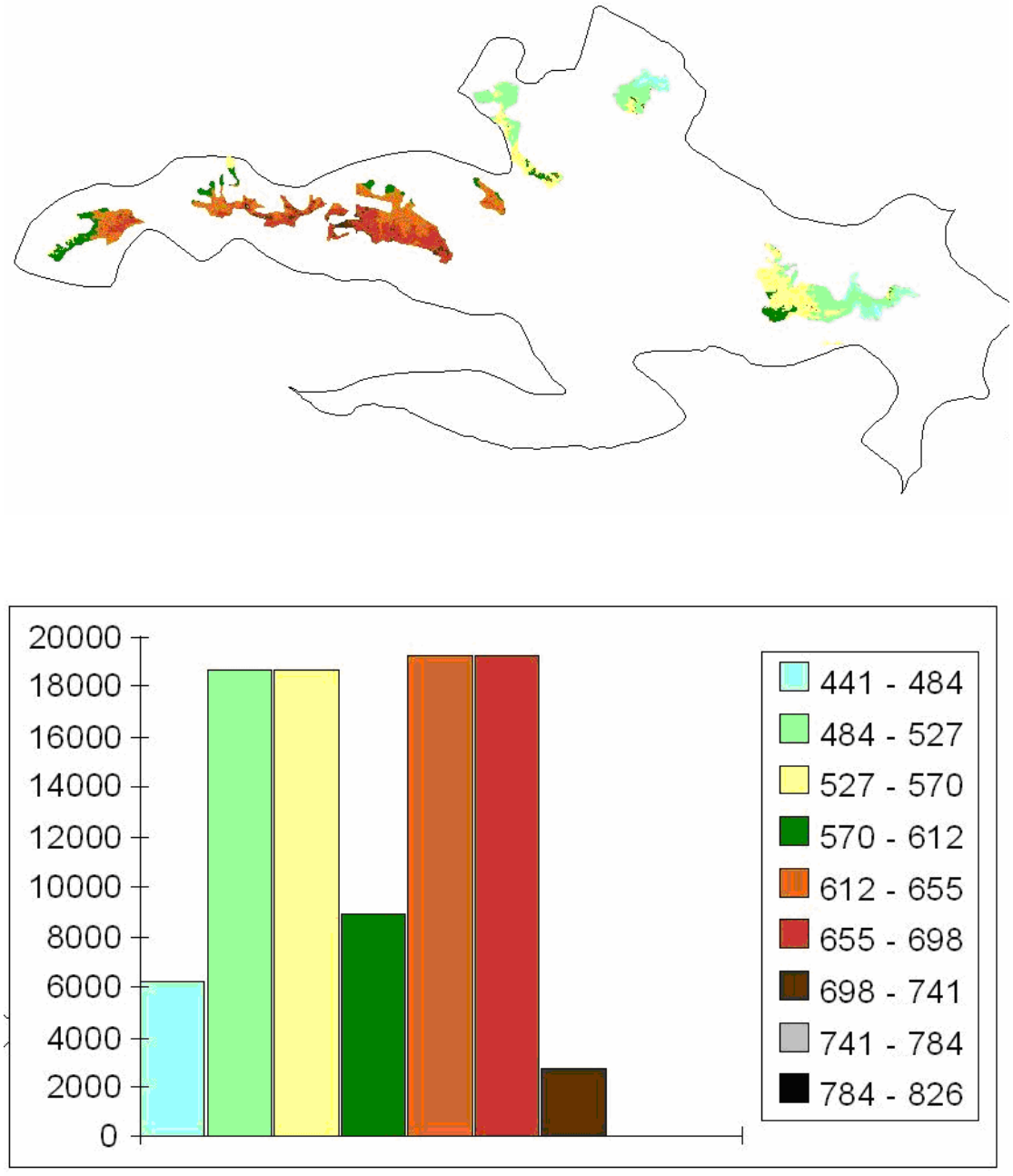
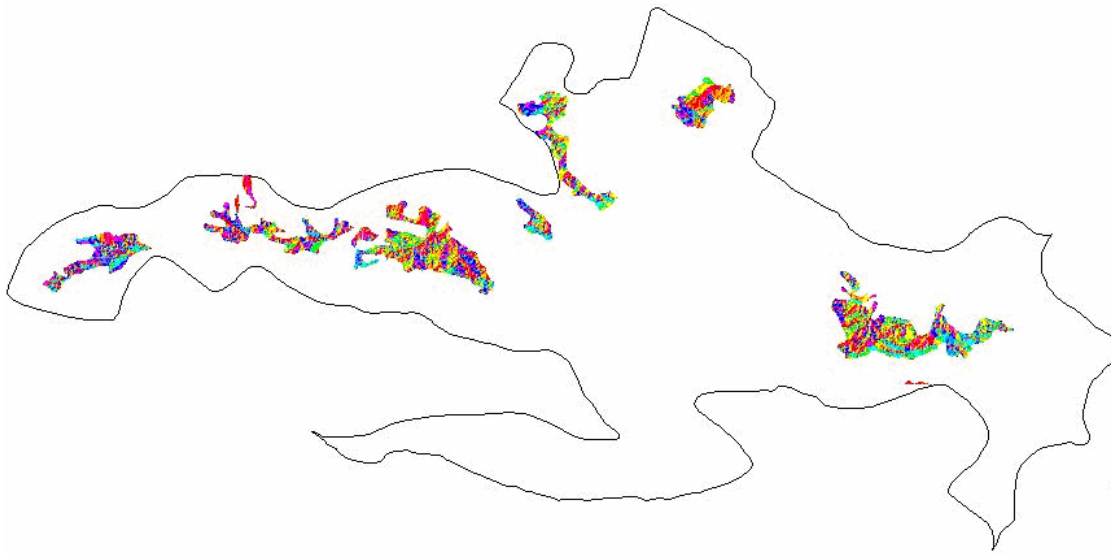
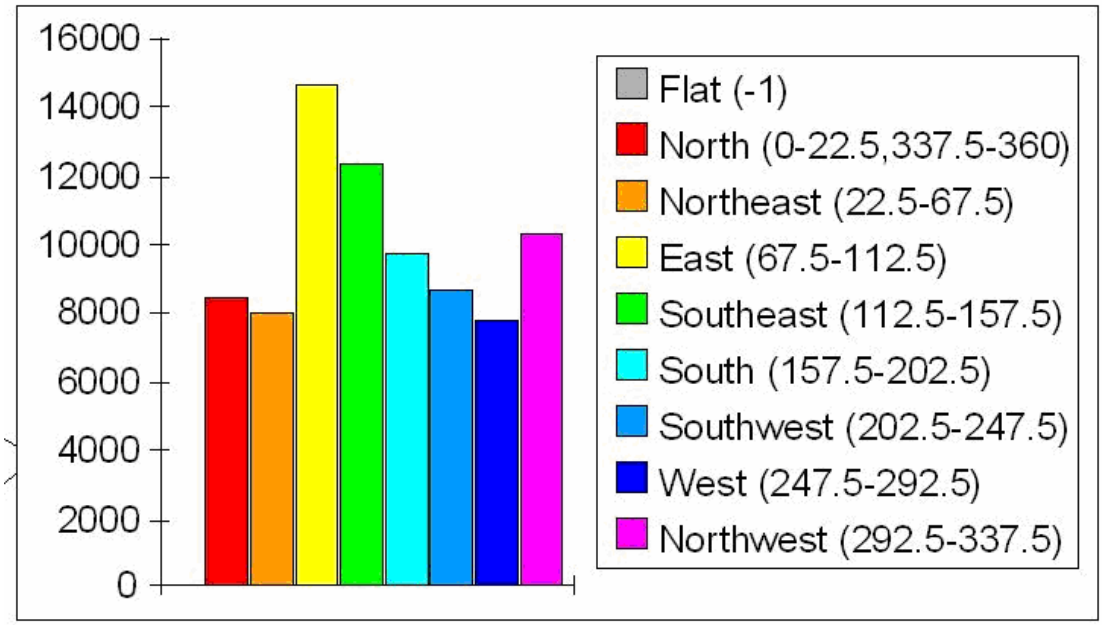


Figure 4.16 Aspect for the Burt Plain bioregion for Vegetation Community 58





Vegetation Community 59

Vegetation community 59 (or mapping unit 59) covers 12.3% of the Burt Plain bioregion and covers an area of 919 927.52 hectares, comprising 13 patches (Figure 4.17). *Acacia estrophiolata* is normally dominant in the upper stratum although a mixture of other species include *Atalya hemiglauca*, and *Hakea* spp. (Wilson *et al.* 1990). The structure of this layer ranges from low open-woodland to scattered trees (Wilson *et al.* 1990). The ground layer is usually a mixed species sparse-grassland with grasses such as *Eragrostis* and *Aristida* common on sandier soils and *Chrysopogon fallax* and *Chloris pectinata* common on wetter areas (Wilson *et al.* 1990). Forbs and chenopods are seasonally dominant in many areas (Wilson *et al.* 1990).

The land tenure type is predominantly Perpetual Pastoral Lease (86%) (Figure 4.18), and the land systems are:

A. Kanandra KN (16%) - Sandy plains on the north side of the MacDonnell and Harts Ranges; sandy alluvial soils, red clayey sands, and sandy red earths, sparse low trees over kerosene grass;
B. Dinkum DI (12%) - Hummocky sandy plains and some stony plains of schist and gneiss, relief mainly up to 6.1 m ; red clayey sands and sandy red earths, mainly open or with sparse low trees over short grass; and
C. Indiana IN (12%) - Stony schist and gneiss plains closely dissected up to 9.1 m by flat, unchannelled valleys; shallow, stony, texture-contrast

soils with open or sparse shrubs and low trees or no trees over short grass, some coarse soils with spinifex.

The predominant soils are:

A. AB68 (14%) - Sandy plains: chief soils are red earthy sands, sometimes with a clay D horizon, and firm red deep sands. Associated are soils; and some sands on dunes. As mapped, small areas of unit BF1 and some hilly areas with shallow soils and rock outcrops are included;
B. AB69 (13%) - Sandy plains as for unit AB68 interspersed with stony plains as for unit Nb11; and
C. Nb11 (12%) – Undulating stony plains on schist and gneiss. Chief soils are crusty loamy soils, with stone and gravel mantles. Associated soils on the stony plains; and on calcrete platforms; and sandy in alluvial areas.

The predominant geology is:

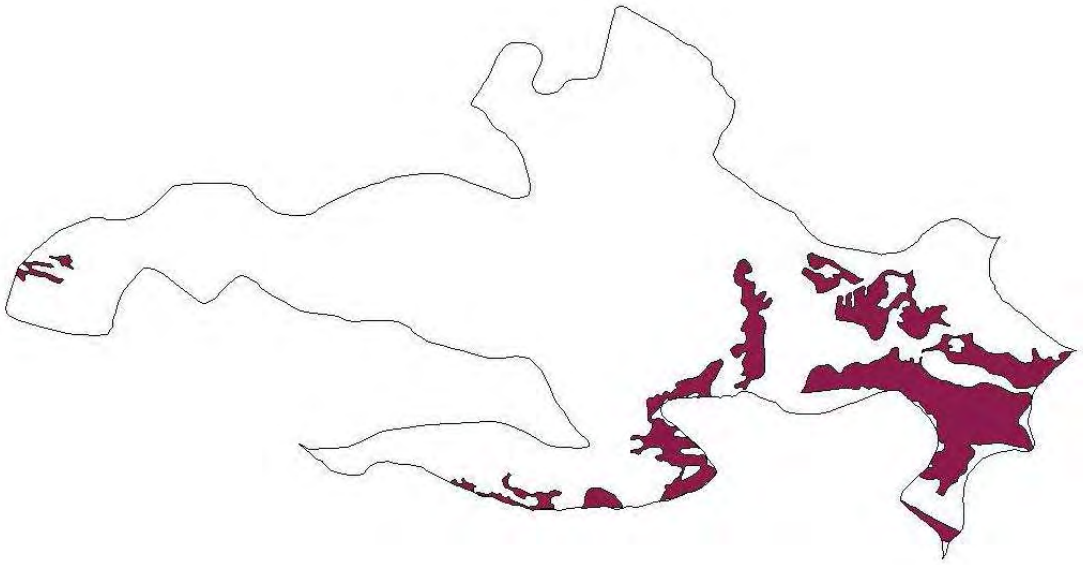
A. APA (84%) – Pre-Cambrian high-grade metamorphics, granite, gabbro in Arunta block.

As calculated using ESOCLIM, the mean annual temperature for Vegetation Community 59 ranged from a maximum of 23.6^{o}C to a minimum of 18.7^{o}C. The maximum temperature ranged between 31.4 – 36.1^{o}C in the wet season (December – March), whereas the minimum temperature ranged between 6.2 – 10.7^{o}C in the dry season. Total annual rainfall ranged from a minimum of 229.1 mm to a maximum of 337.6 mm, with an average in the dry season between 9.9 – 15.8 mm, and in the wet season 27.8 – 40.4 mm. The number of

total annual raindays ranged from a minimum of 36.7 with less days occurring in the dry season to a maximum of 60.3 total annual raindays, with more days occurring in the wet season. Total annual evaporation ranged between 2701.4 – 3120.1 mm, with a mean annual evaporation ranging between 225.1 – 260.0 mm. Based on the DEM the elevation across Vegetation Community 59 ranged between 317.6-1010.6 m. Mean annual evaporation had significant positive correlations with mean annual temperatures, particularly for the wet season. Elevation was positively correlated with three of the environmental gradients i.e. mean annual raindays, mean annual maximum temperature and mean annual evaporation.

A summary of the major gradients and associated statistics for Vegetation Community 59 are given in Tables 4.9, 4.10 (Figure 4.19-4.23). After analysis of herbarium records, 449 species have been recorded for Vegetation Community 59.

Figure 4.17 Spatial distribution of Vegetation Community 59 for the Burt Plain bioregion (for full descriptions of soils and geology refer to Appendices 4 and 5)



Area: 919 927 hectares (12.3% of the Burt Plain)

No. of patches: 13

Tenure: Perpetual Pastoral Lease (PPL)

Land Systems: Kanandra (KN); Dinkum (DI); Indiana (IN)

Geology: Nb11; APA

Soils: AB68; AB69

No. of bores: 198

Dominant species: Ironwood *(Acacia estrophiolata)*, Whitewood *(Atalaya hemigaluca)* low open woodland with open-grassland understorey.

Figure 4.18 Percentage of tenure type by area for Vegetation Community 59 for the Burt Plain bioregion

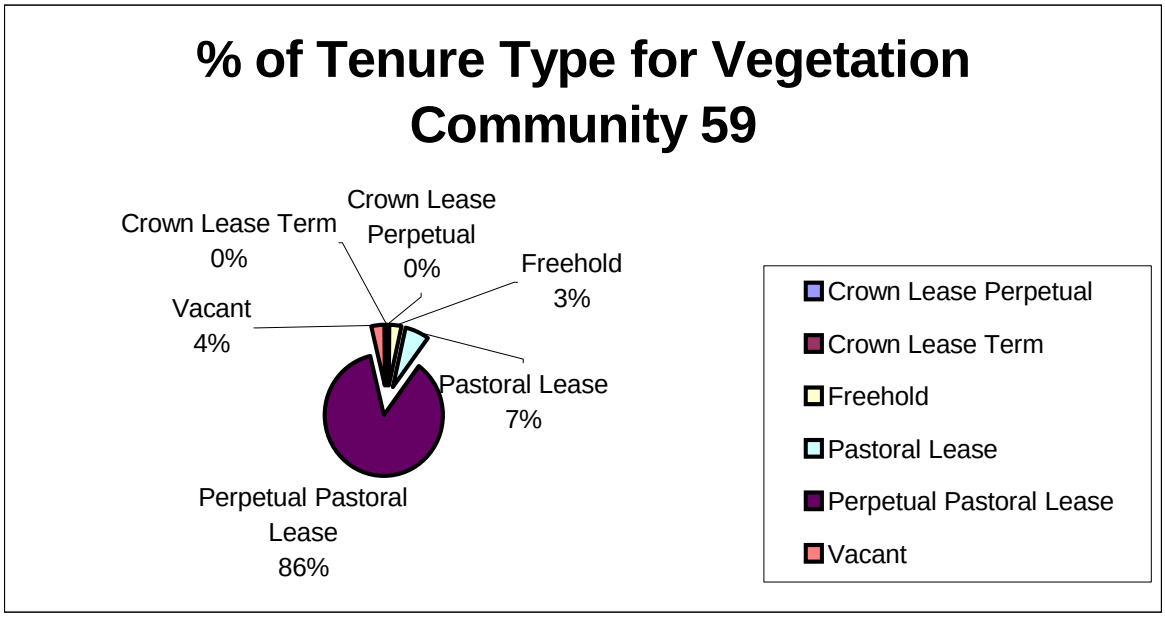


Table 4.9 Summary of major climate gradients for Vegetation Community 59 for the Burt Plain bioregion, NT.

Major Gradients	Min	Max
Mean Annual Maximum Temperature (°C)	25.9	31.3
Mean Annual Minimum Temperature (°C)	11.5	15.9
Mean Annual Temperature (°C)	18.7	23.6
Average Temperature Dry Season (°C)	13.4	18.6
Maximum Temperature Dry Season (°C)	20.4	26.5
Minimum Temperature Dry Season (°C)	6.2	10.7
Average Temperature Wet Season (°C)	24.1	28.6
Maximum Temperature Wet Season (°C)	31.4	36.1
Minimum Temperature Wet Season (°C)	16.7	21.1
Total Annual Rainfall (mm)	229.1	337.6
Average Rainfall Dry Season (mm)	9.9	15.8
Average Rainfall Wet Season (mm)	27.8	40.4
Mean Annual Rainfall (mm)	19.1	28.1
Total Annual Raindays	36.7	60.3
Average Raindays Dry Season	1.9	3.8
Average Raindays Wet Season	4.0	6.2
Total Annual Evaporation (mm)	2701.4	3120.1
Average Evaporation Dry Season (mm)	150.3	186.5
Average Evaporation Wet Season (mm)	299.9	345.2
Mean Annual Evaporation (mm)	225.1	260.0
Elevation	317.6	1010.6

Table 4.10 Summary of environmental gradient statistics for Vegetation Community 59

Covariance Matrix									
	Xraind59m	Xmxtmp59m	Xmintmp59m	Xevap59m	Dem59mask	Xanrainf59m	Xallwtmp59m	Xalltmp59m	Xalldtmp59m
Xraind59m	0.134875	-0.293037	-0.107544	-1.7391	44.8029	0.450463	-0.202643	-0.200291	-0.197938
Xmxtmp59m	-0.293037	0.820132	0.462221	4.65081	-100.612	-0.911053	0.613537	0.641177	0.668816
Xmintmp59m	-0.107544	0.462221	0.39136	2.60461	-40.0973	-0.245168	0.385017	0.426791	0.468564
Xevap59m	-1.7391	4.65081	2.60461	28.4687	-593.801	-5.14966	3.48266	3.62771	3.77276
Dem59mask	44.8029	-100.612	-40.0973	-593.801	14974.4	148.903	-70.3909	-70.3545	-70.318
Xanrainf59m	0.450463	-0.911053	-0.245168	-5.14966	148.903	1.76792	-0.605425	-0.57811	-0.550796
Xallwtmp59m	-0.202643	0.613537	0.385017	3.48266	-70.3909	-0.605425	0.471908	0.499277	0.526646
Xalltmp59m	-0.200291	0.641177	0.426791	3.62771	-70.3545	-0.57811	0.499277	0.533984	0.56869
Xalldtmp59m	-0.197938	0.668816	0.468564	3.77276	-70.318	-0.550796	0.526646	0.56869	0.610734

Correlation Matrix									
	Xraind59m	Xmxtmp59m	Xmintmp59m	Xevap59m	Dem59mask	Xanrainf59m	Xallwtmp59m	Xalltmp59m	Xalldtmp59m
Xraind59m	1	-0.88108***	-0.468093**	-0.887515***	0.996931****	0.922492****	-0.803226***	-0.74633***	-0.689663**
Xmxtmp59m	-0.88108***	1	0.815867***	0.962505****	-0.907886****	-0.756608***	0.986212****	0.968884****	0.945015****
Xmintmp59m	-0.468093**	0.815867***	1	0.780317***	-0.523784**	-0.294743*	0.895907***	0.933604****	0.958417****
Xevap59m	-0.887515***	0.962505****	0.780317***	1	-0.909457****	-0.725879***	0.950163****	0.930433****	0.904795****
Dem59mask	0.996931****	-0.907886****	-0.523784**	-0.909457****	1	0.91516****	-0.837362***	-0.786779***	-0.735302***
Xanrainf59m	0.922492****	-0.756608***	-0.294743*	-0.725879***	0.91516****	1	-0.662828**	-0.594999**	-0.530071**
Xallwtmp59m	-0.803226***	0.986212****	0.895907***	0.950163****	-0.837362***	-0.662828**	1	0.994601****	0.980989****
Xalltmp59m	-0.74633***	0.968884****	0.933604****	0.930433****	-0.786779***	-0.594999**	0.994601****	1	0.995831****
Xalldtmp59m	-0.689663**	0.945015****	0.958417****	0.904795****	-0.735302***	-0.530071**	0.980989****	0.995831****	1

**** Very Strong correlation > 0.9; *** Strong correlation 0.7 to 0.9; ** Moderate correlation 0.4 to 0.7; * Weak, low correlation (not very significant) 0.2 to 0.4; Very weak to negligible correlation 0.0 to 0.2

Figure 4.19 Mean Annual Temperature (°C) for the Burt Plain bioregion for Vegetation Community 59

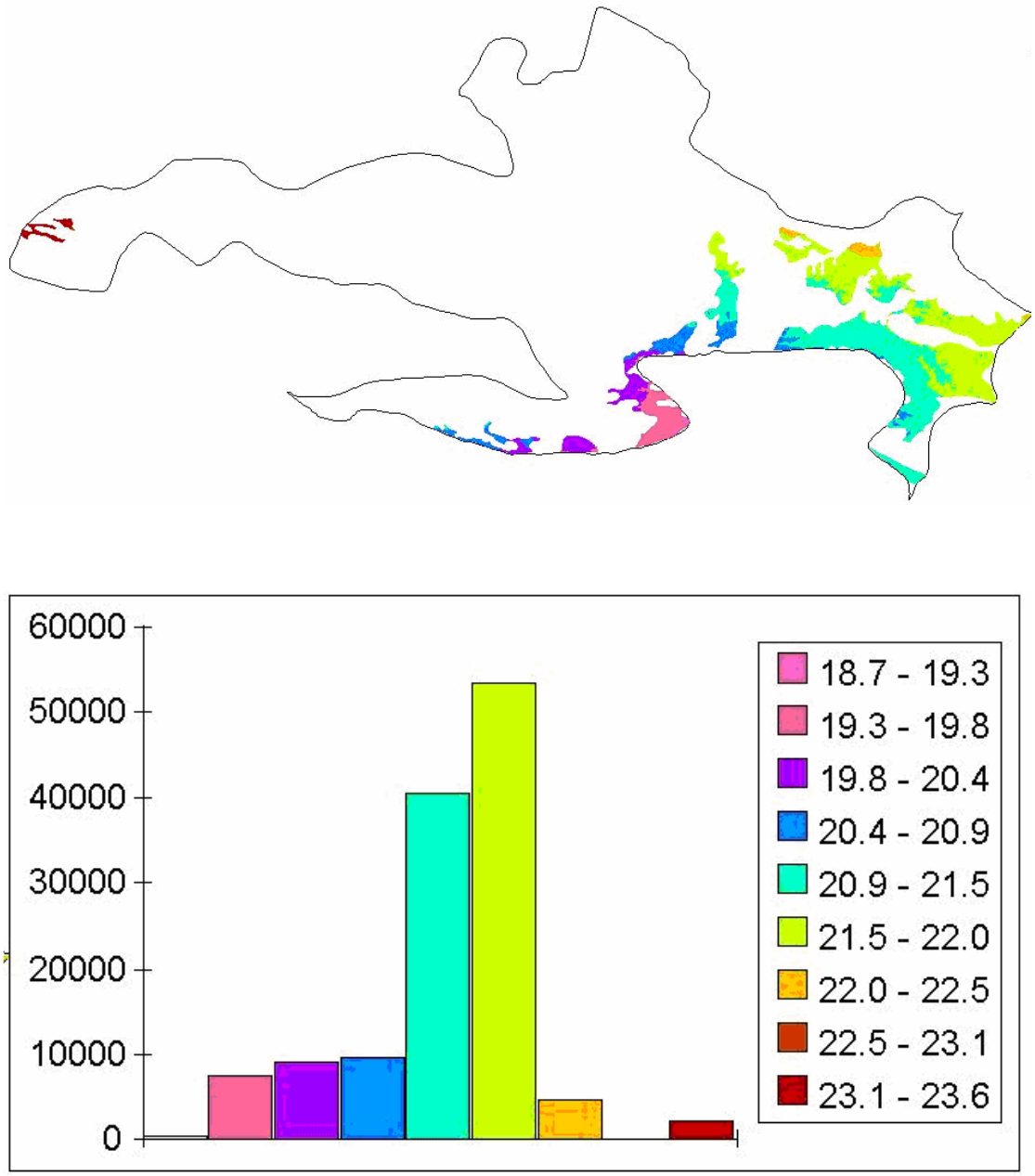
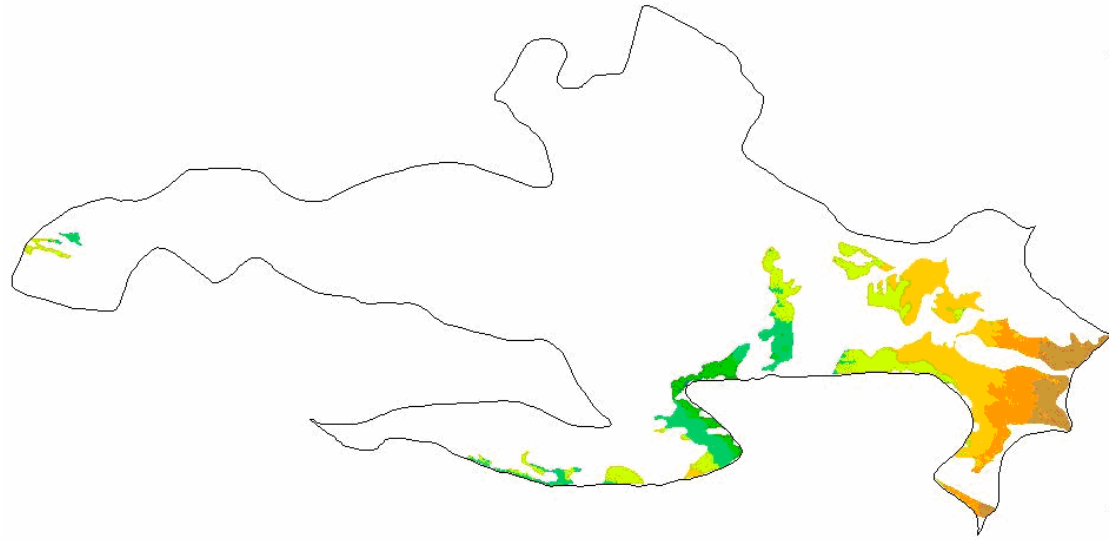


Figure 4.20 Mean Annual Rainfall (mm) for the Burt Plain bioregion for Vegetation Community 59



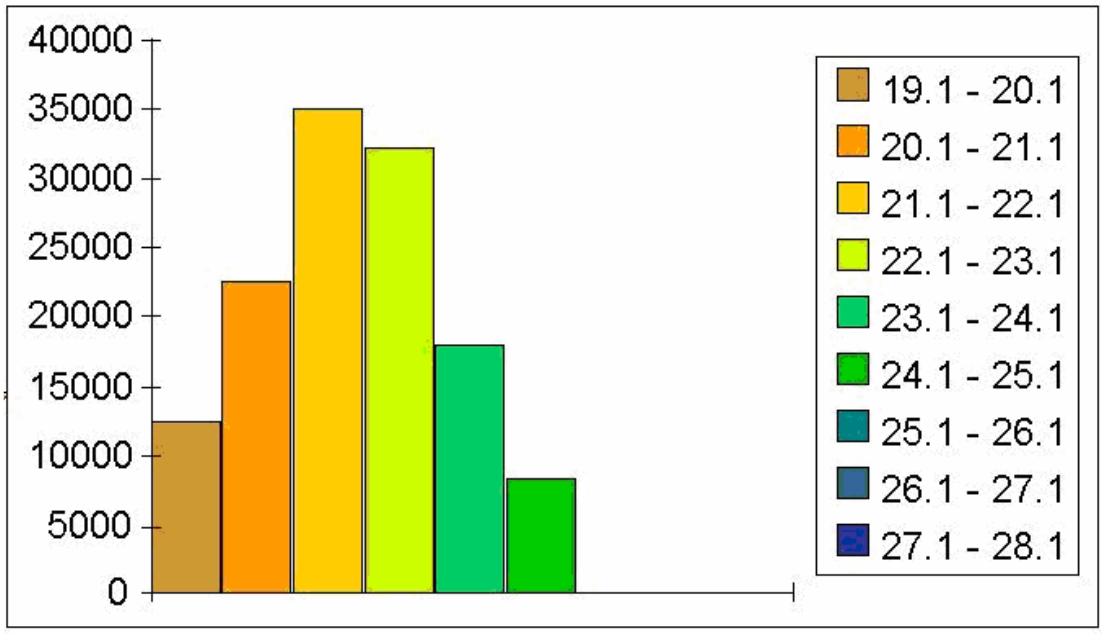
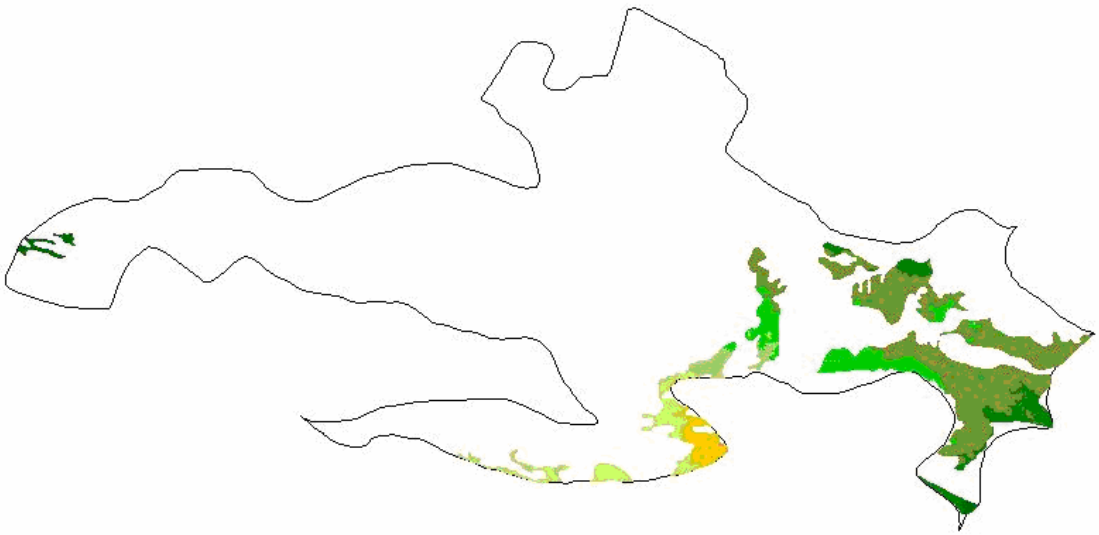


Figure 4.21 Mean Annual Evaporation (mm) for the Burt Plain bioregion for Vegetation Community 59



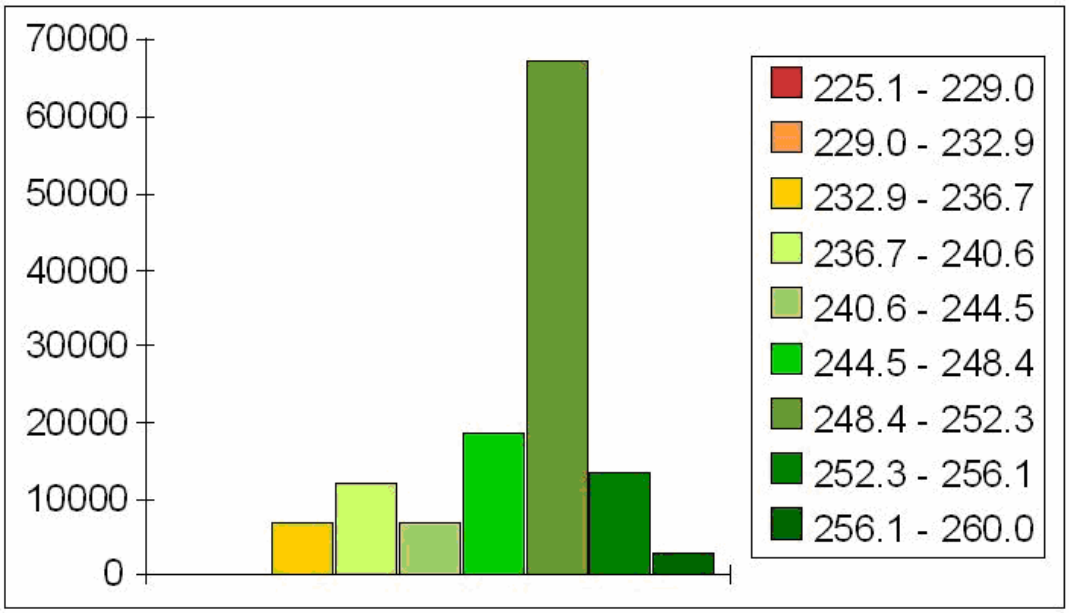
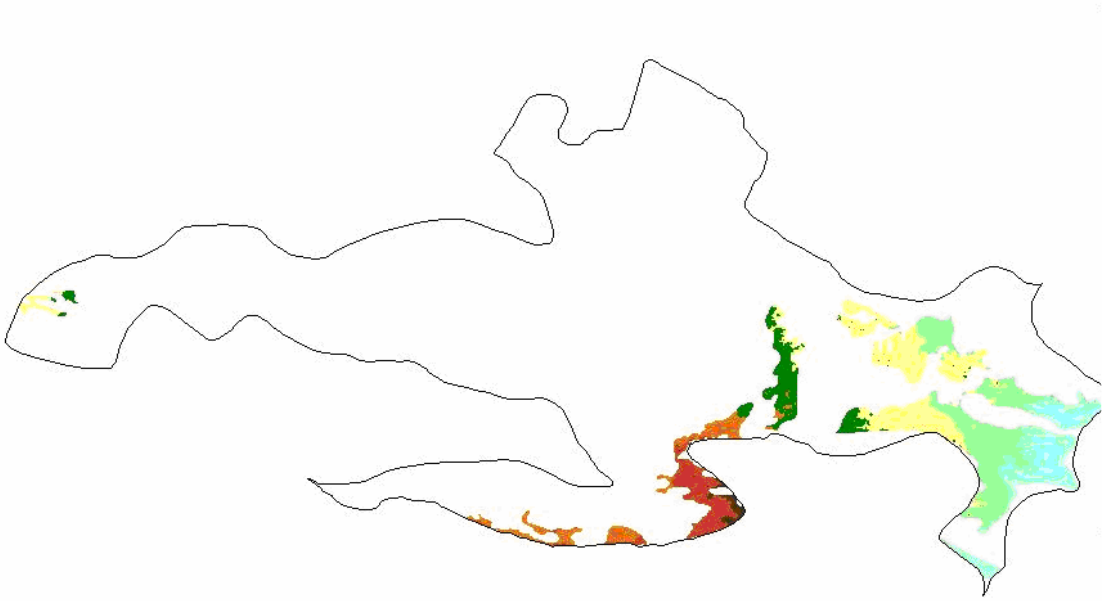


Figure 4.22 Elevation for the Burt Plain bioregion for Vegetation Community 59



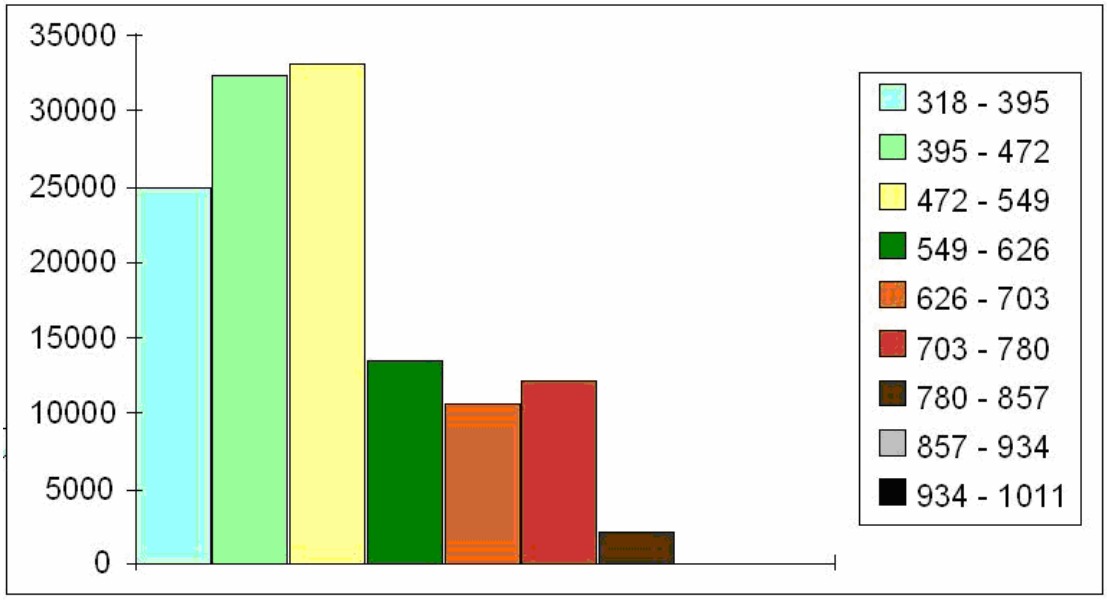
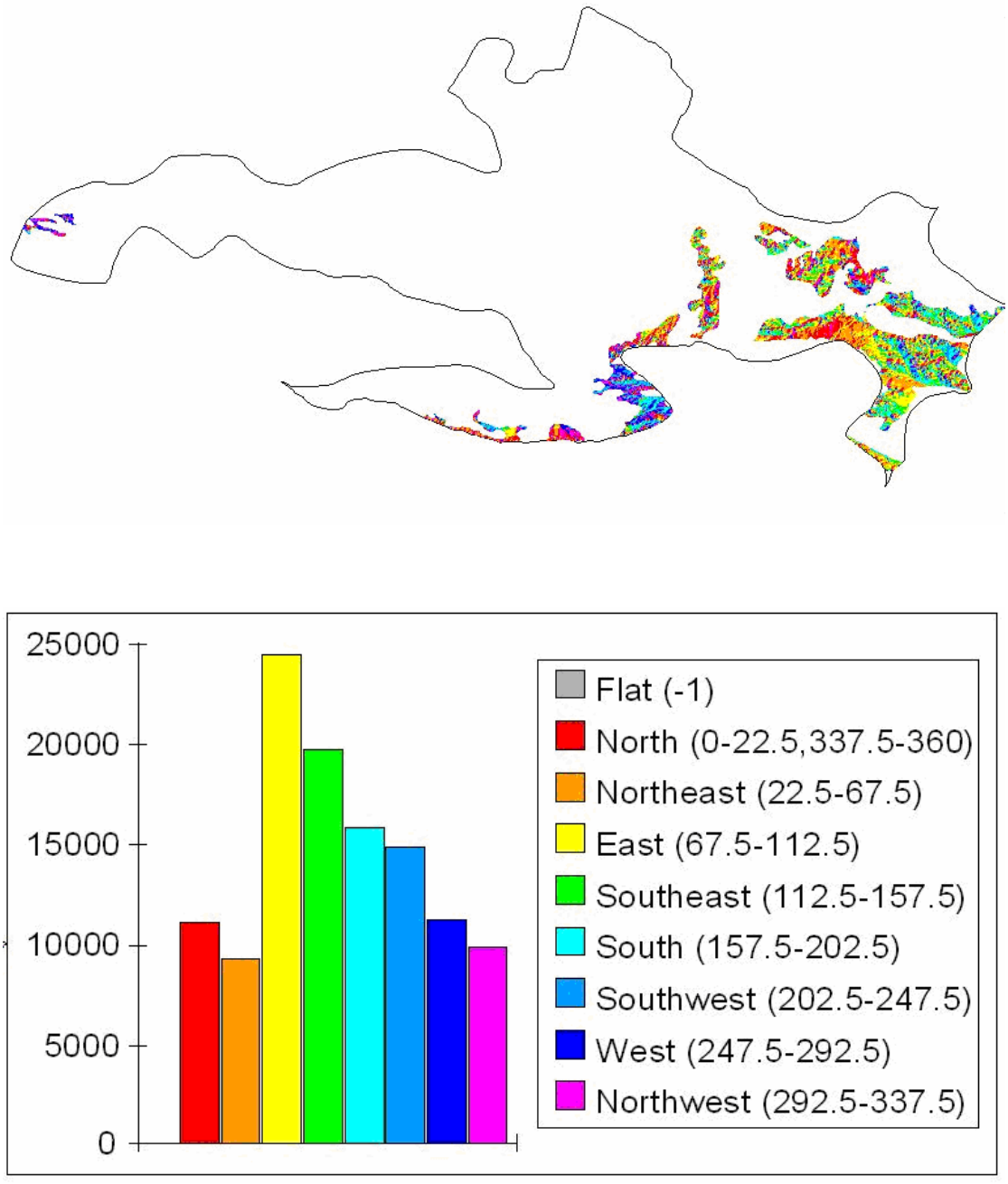


Figure 4.23 Aspect for the Burt Plain bioregion for Vegetation Community 59



Vegetation Community 65

Vegetation community 65 (or mapping unit 65) covers 37% of the Burt Plain bioregion and covers an area of 2771054.33 hectares, comprising 49 patches (Figure 4.24). *Acacia aneura* is dominant in the upper stratum usually as a tall open-shrubland (Wilson *et al.* 1990). The ground layer is generally a mixed tussock grassland with *Eragrostis eriopoda* common (Wilson *et al.* 1990).

The tenure type is predominantly Perpetual Pastoral Lease (72%) (Figure 4.25), and land systems are:

A. Bushy Park BU (43%) - Plains; red earths; mulga in groves over short grass or woollybutt;
B. Boen BO (17%) - Plains with convex interfluves and broad shallow valleys, relief up to 6.1 m; red earths; lateritic in part; mulga in groves over short grass or woollybutt; and
C. Singleton SN (12%) - Flat or gently undulating plain; red clayey sands and sands, in north-west some sandy red earths, in part lateritic; spinifex.

The predominant soils are:

A. My105 (43%) - Plains, occasionally with low rocky hills: chief soils are neutral red earths of variable degree of sandiness, and red earthy sands with lesser areas of soils. Minor areas of other soils may be included locally; and

B. Mx23 (21%) - Undulating to gently undulating plains with occasional low rises and scarps with some lateritic duricrust: chief soils are alkaline red earths, below which smooth-ped clay D horizons may occur at various depths.

The predominant geology is:

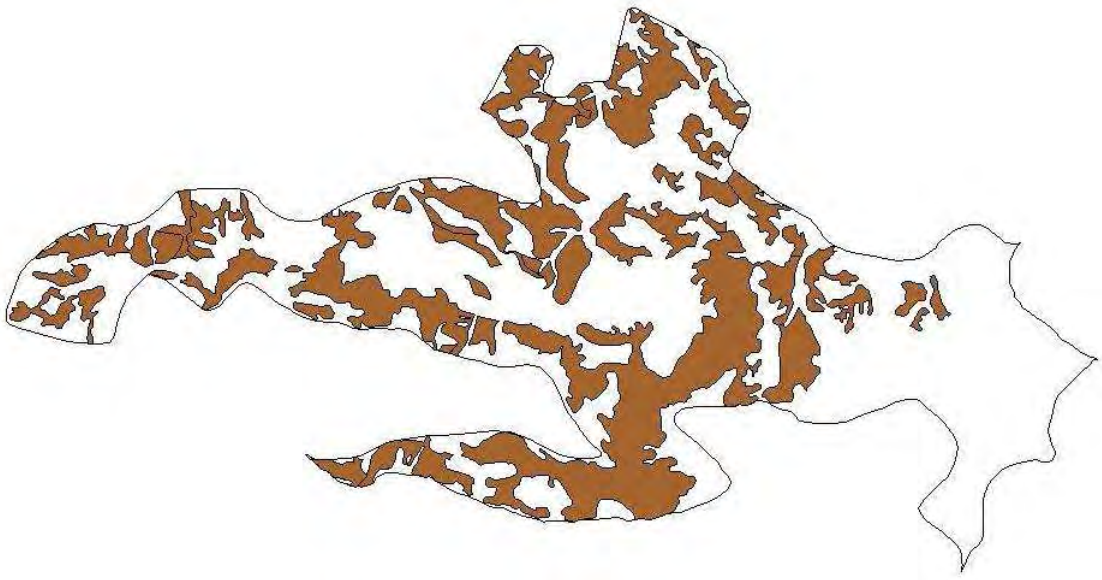
A. APA (62%) – Pre-Cambrian high-grade metamorphics, granite, gabbro in Arunta block; and
B. PCA (17%) – Pre-Cambrian granitic rocks, minor acid volcanics in Arunta block. Appendix 4 gives a full description of all geology types found in the Burt Plain bioregion.

The mean annual temperature for Vegetation Community 65 ranged from a maximum of 24.2^{o}C to a minimum of 19.0^{o}C. The maximum temperature ranged between 31.9 – 36.1^{o}C in the wet season (December – March), whereas the minimum temperature ranged between 6.2 – 12.2^{o}C in the dry season. Total annual rainfall ranged from a minimum of 254.7 mm to a maximum of 331.2 mm, with an average in the dry season between 7.9 – 14.6 mm, and in the wet season 31.8 – 42.6 mm. The number of total annual raindays ranged from a minimum of 41.8 with less days occurring in the dry season to a maximum of 55.3 total annual raindays, with more days occurring in the wet season. Total annual evaporation ranged between 2773.2 – 3321.9 mm, with a mean annual evaporation ranging between 231.1 – 276.8 mm. Elevation across Vegetation Community 65 ranged between 400.4 - 849.2 m. Mean

annual evaporation had significant positive correlations with most mean annual temperatures, both in the dry and wet seasons. Elevation was positively correlated with only one of the environmental gradients i.e. mean annual raindays.

A summary of the major gradients and associated statistics for Vegetation Community 65 are given in Tables 4.11, 4.12 (Figure 4.26-4.30). After analysis of herbarium records, 684 plant species have been recorded for Vegetation Community 65.

Figure 4.24 Spatial distribution of Vegetation Community 65 for the Burt Plain bioregion (for full descriptions of soils and geology refer to Appendices 4 and 5)



Area: 2 771 054 hectares (37% of the Burt Plain)

No. of patches: 49

Tenure: Perpetual Pastoral Lease (PPL)

Land Systems: Bushy Park (BU); Boen (BO); Singleton (SN)

Geology: APA; PCA

Soils: My105; Mx23

No. of bores: 471

Dominant species: Mulga *(Acacia aneura)* tall open-shrubland with Woollybutt *(Eragrostis eriopoda)* open-grassland understorey.

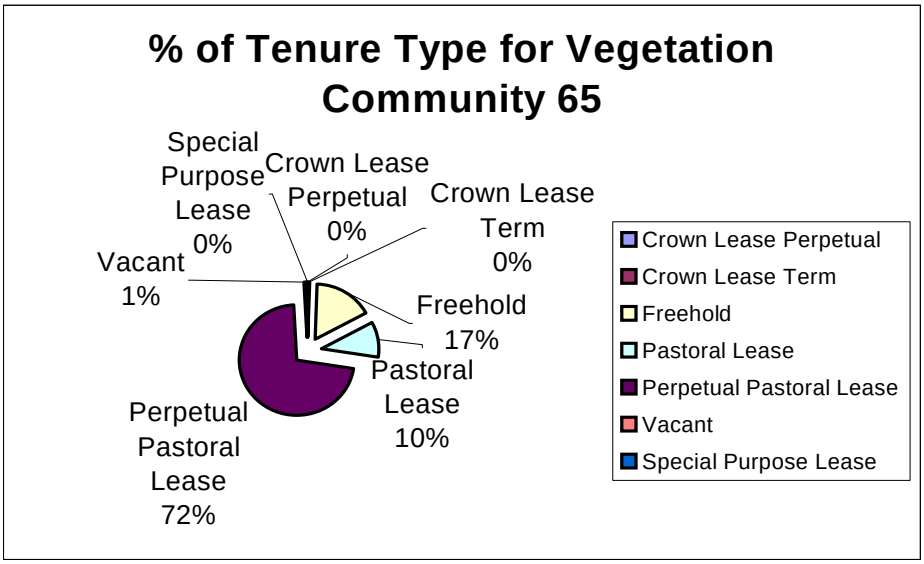


Figure 4.25 Percentage of tenure type by area for Vegetation Community 65 for the Burt Plain bioregion

Table 4.11 Summary of major climate gradients for Vegetation Community 65 for the Burt Plain bioregion, NT.

Major Gradients	Min	Max
Mean Annual Maximum Temperature (°C)	26.5	31.3
Mean Annual Minimum Temperature (°C)	11.6	17.1
Mean Annual Temperature (°C)	19.0	24.2
Average Temperature Dry Season (°C)	13.6	19.5
Maximum Temperature Dry Season (°C)	20.9	26.8
Minimum Temperature Dry Season (°C)	6.2	12.2
Average Temperature Wet Season (°C)	24.4	28.9
Maximum Temperature Wet Season (°C)	31.9	36.1
Minimum Temperature Wet Season (°C)	16.9	22.0
Total Annual Rainfall (mm)	254.7	331.2
Average Rainfall Dry Season (mm)	7.9	14.6
Average Rainfall Wet Season (mm)	31.8	42.6
Mean Annual Rainfall (mm)	21.2	27.6
Total Annual Raindays	41.8	55.3
Average Raindays Dry Season	1.6	3.6
Average Raindays Wet Season	4.9	6.1
Total Annual Evaporation (mm)	2773.2	3321.9
Average Evaporation Dry Season (mm)	150.9	213.9
Average Evaporation Wet Season (mm)	309.7	339.8
Mean Annual Evaporation (mm)	231.1	276.8
Elevation	400.4	849.2

Table 4.12 Summary of environmental gradient statistics for Vegetation Community 65 for the Burt Plain bioregion

Covariance Matrix									
	Xraind65m	Xmxtmp65m	Xmintmp65m	Xevap65m	Dem65mask	Xanrainf65m	Xallwtmp65m	Xalltmp65m	Xalldtmp65m
Xraind65m	0.0288149	-0.107069	-0.124776	-0.969771	11.8314	0.0416226	-0.100123	-0.115922	-0.131722
Xmxtmp65m	-0.107069	0.809875	0.96158	6.29011	-48.173	0.246895	0.743977	0.885728	1.02748
Xmintmp65m	-0.124776	0.96158	1.2763	8.25405	-59.5236	0.516891	0.92456	1.11894	1.31333
Xevap65m	-0.969771	6.29011	8.25405	57.7658	-459.05	2.57188	6.01222	7.27208	8.53194
Dem65mask	11.8314	-48.173	-59.5236	-459.05	5080.8	7.83395	-45.6635	-53.8483	-62.0331
Xanrainf65m	0.0416226	0.246895	0.516891	2.57188	7.83395	1.07522	0.270845	0.381893	0.49294
Xallwtmp65m	-0.100123	0.743977	0.92456	6.01222	-45.6635	0.270845	0.69839	0.834268	0.970147
Xalltmp65m	-0.115922	0.885728	1.11894	7.27208	-53.8483	0.381893	0.834268	1.00234	1.1704
Xalldtmp65m	-0.131722	1.02748	1.31333	8.53194	-62.0331	0.49294	0.970147	1.1704	1.37066

Correlation Matrix									
	Xraind65m	Xmxtmp65m	Xmintmp65m	Xevap65m	Dem65mask	Xanrainf65m	Xallwtmp65m	Xalltmp65m	Xalldtmp65m
Xraind65m	1	-0.700884***	-0.650645*	-0.751667***	0.977828****	0.236467*	-0.705791**	-0.682106**	-0.662803**
Xmxtmp65m	-0.700884***	1	0.9458****	0.919631****	-0.75098***	0.264578*	0.989239****	0.983071****	0.975212****
Xmintmp65m	-0.650645**	0.9458****	1	0.96129***	-0.739173***	0.441237**	0.979284****	0.989291****	0.992958****
Xevap65m	-0.751667***	0.919631****	0.96129****	1	-0.847342***	0.326336*	0.946565***	0.955689****	0.958843****
Dem65mask	0.977828****	-0.75098***	-0.739173***	-0.847342***	1	0.10599	-0.766574***	-0.75457***	-0.74335***
Xanrainf65m	0.236467*	0.264578*	0.441237**	0.326336*	0.10599	1	0.312552*	0.367863*	0.406051*
Xallwtmp65m	-0.705791***	0.989239****	0.979284****	0.946565****	-0.766574***	0.312552*	1	0.997127****	0.991571****
Xalltmp65m	-0.682106**	0.983071****	0.989291****	0.955689****	-0.75457***	0.367863*	0.997127****	1	0.998537****
Xalldtmp65m	-0.662803**	0.975212****	0.992958****	0.958843****	-0.74335***	0.406051**	0.991571****	0.998537****	1

**** Very Strong correlation > 0.9; *** Strong correlation 0.7 to 0.9; ** Moderate correlation 0.4 to 0.7; * Weak, low correlation (not very significant) 0.2 to 0.4; Very weak to negligible correlation 0.0 to 0.2

Figure 4.26 Mean Annual Temperature (°C) for the Burt Plain bioregion for Vegetation Community 65

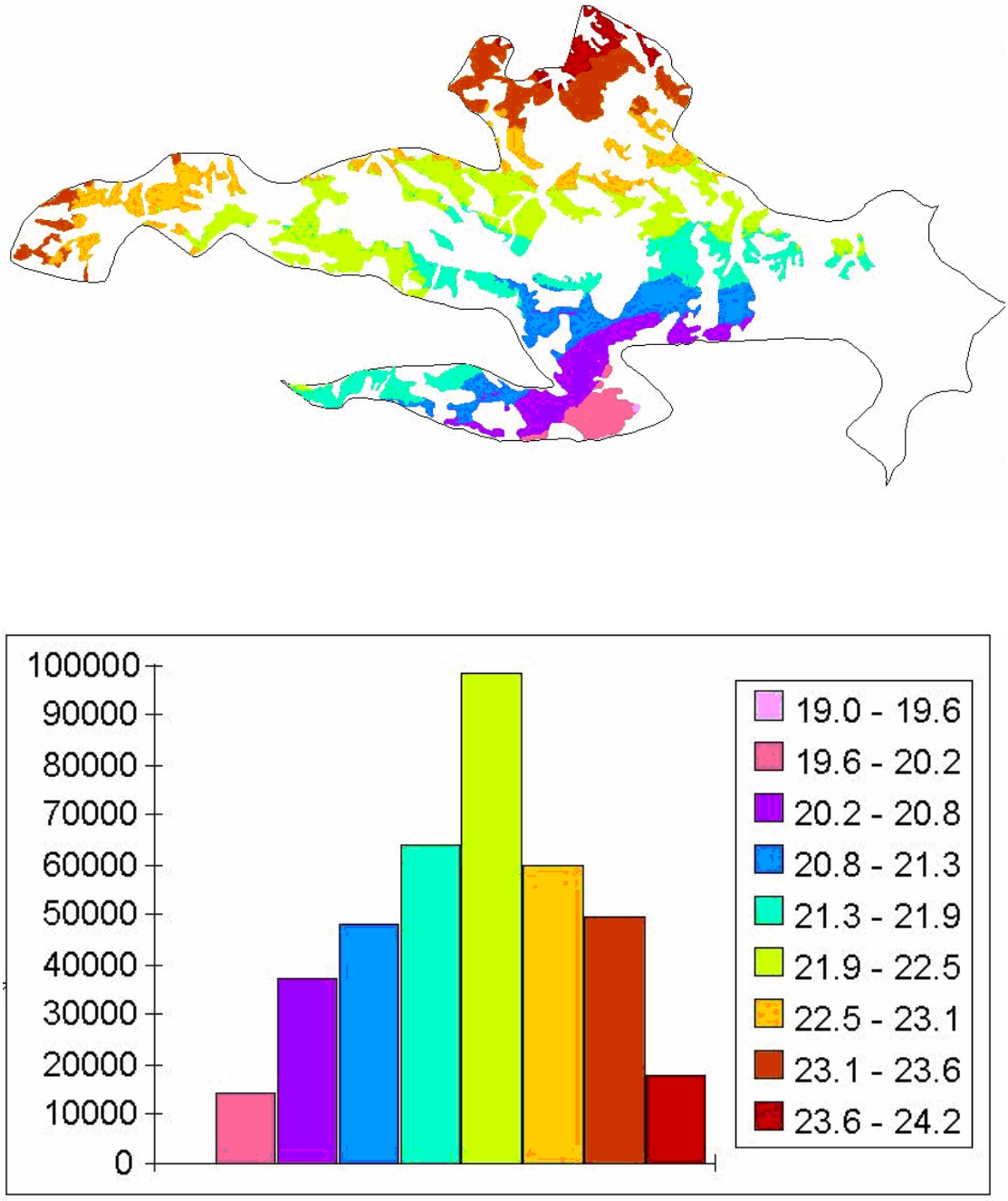


Figure 4.27 Mean Annual Rainfall (mm) for the Burt Plain bioregion for Vegetation Community 65

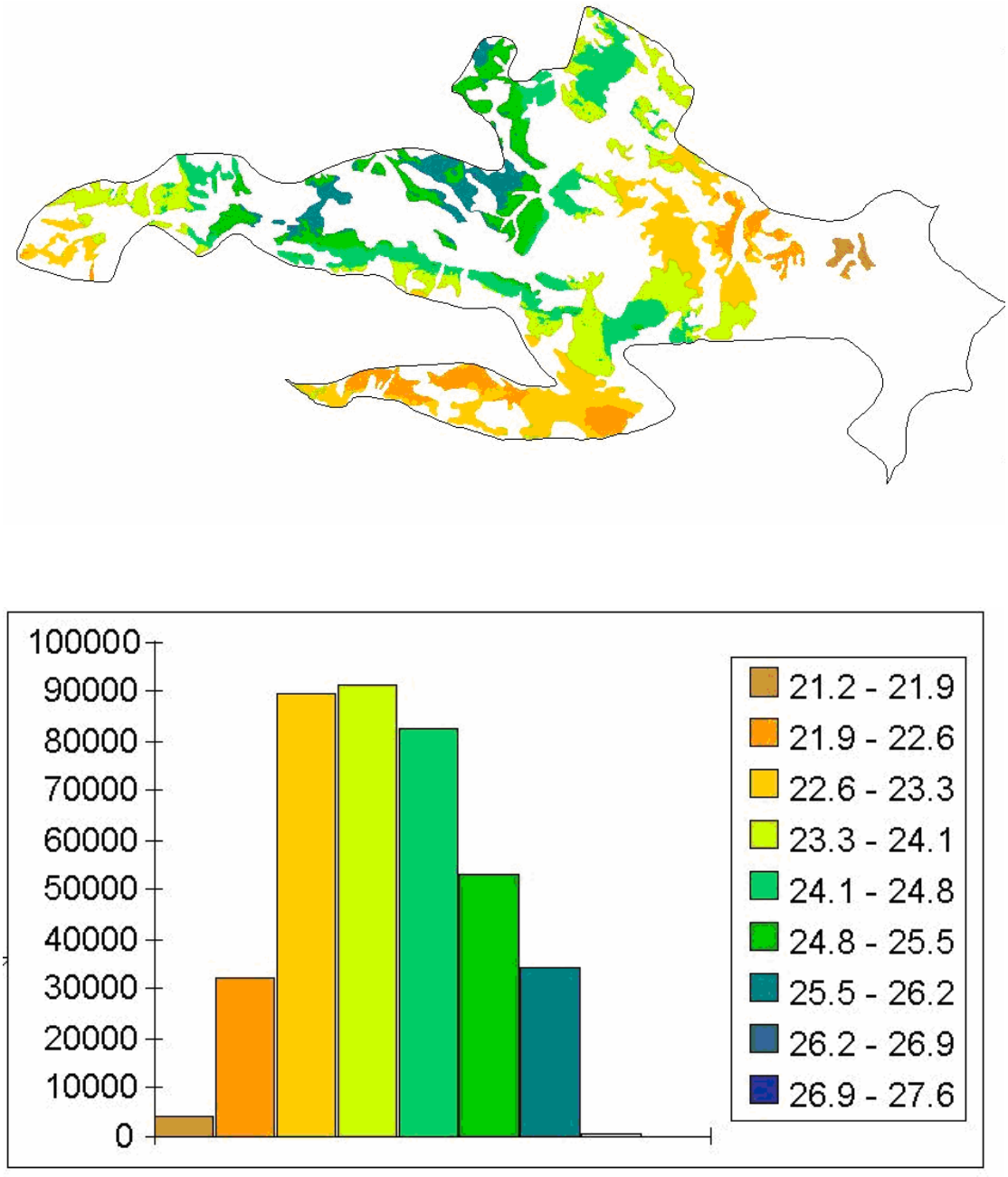


Figure 4.28 Mean Annual Evaporation (mm) for the Burt Plain bioregion for Vegetation Community 65

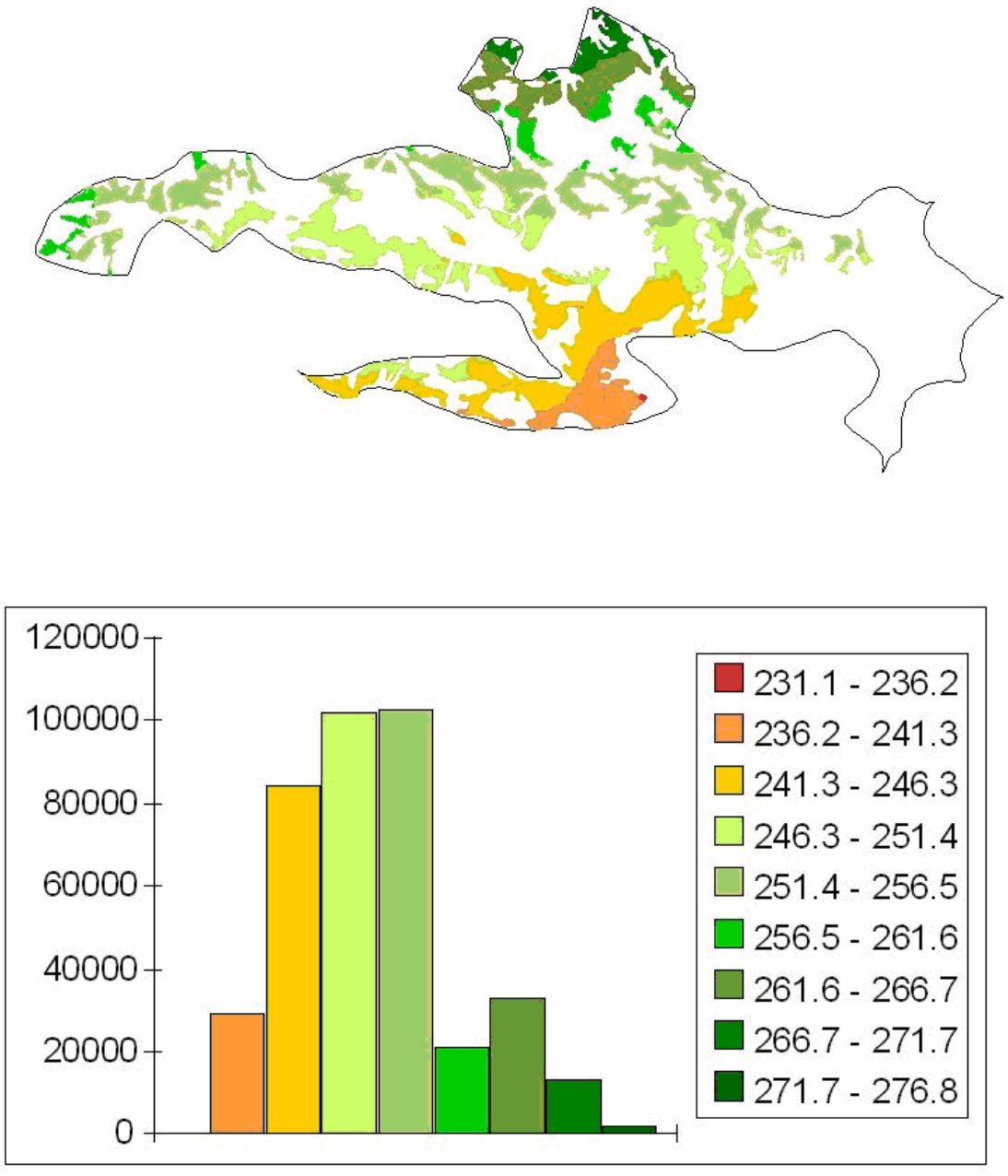
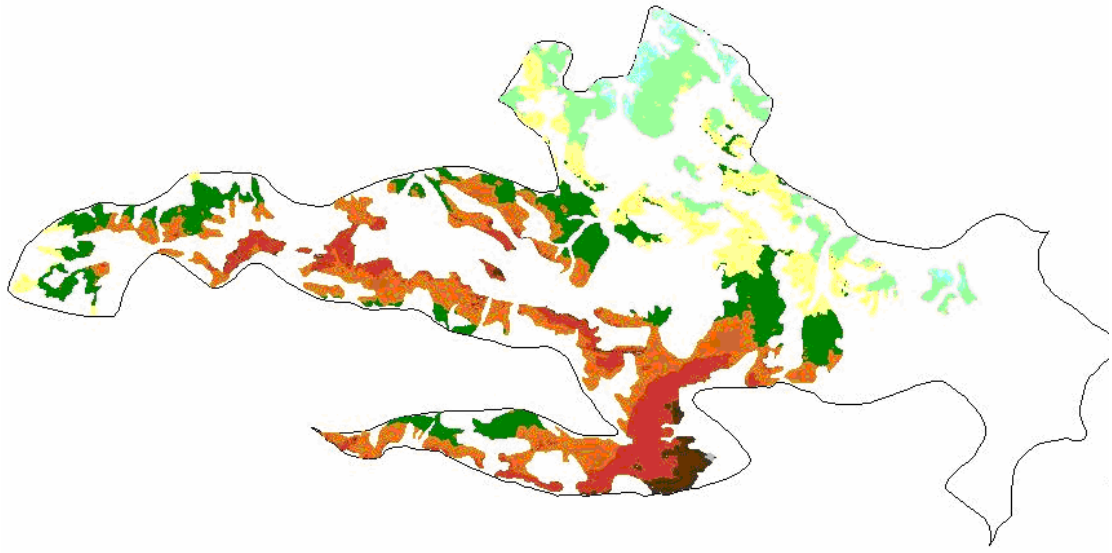


Figure 4.29 Elevation (m above sea level) for the Burt Plain bioregion for Vegetation Community 65



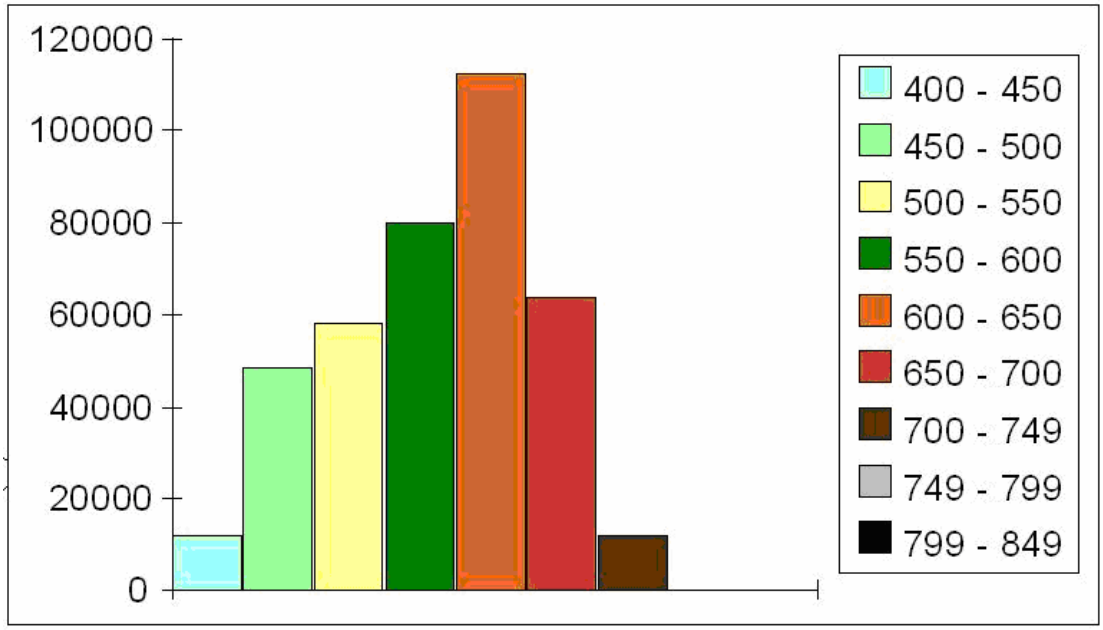
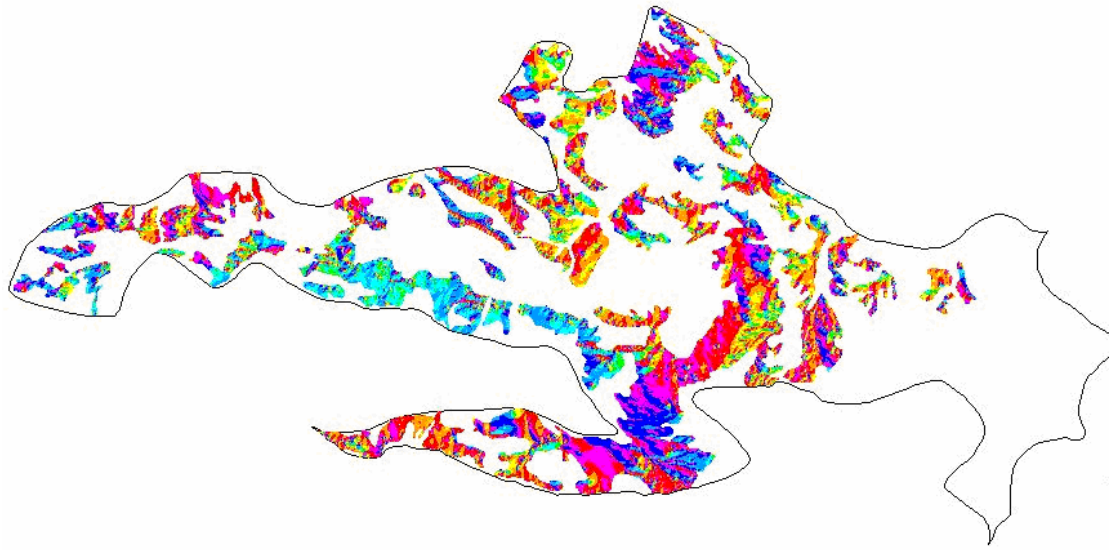
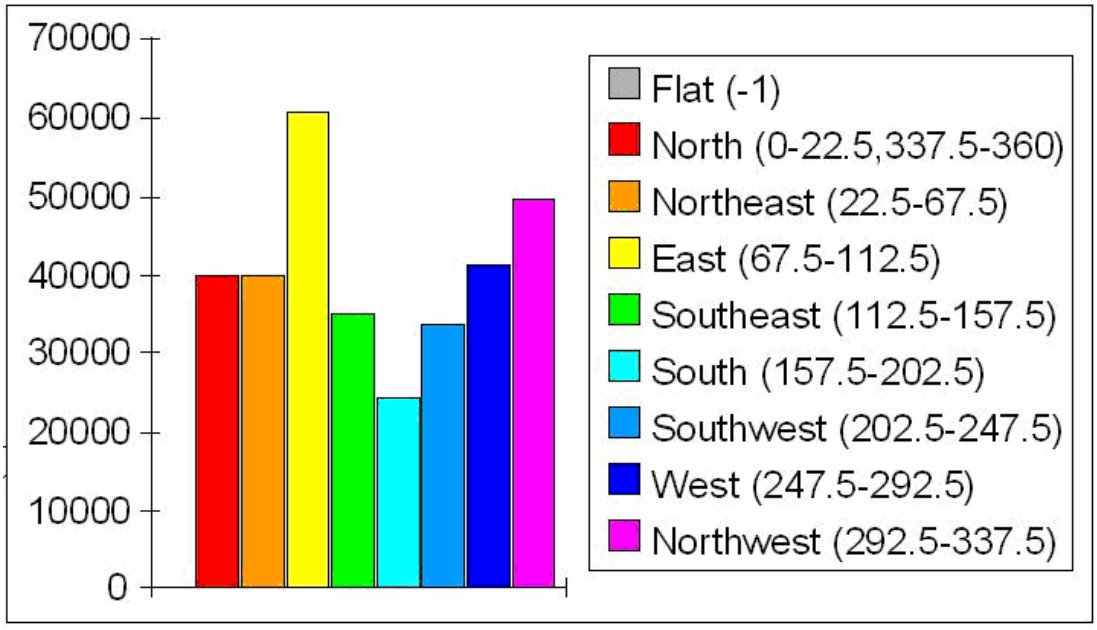


Figure 4.30 Aspect for the Burt Plain bioregion for Vegetation Community 65





Vegetation Community 76

Vegetation community 76 (or mapping unit 76) covers 14.7% of the Burt Plain bioregion and covers an area of 1098704.82 hectares, comprising 60 patches (Figure 4.31). *Triodia pungens* is the dominant species in the ground layer, and has a shrub layer consisting mainly of *Acacia* and *Hakea* species such as *Acacia coriacea*, *Acacia dictyophleba* and *Hakea macrocarpa* with occasional low tree/mallee eucalypts such as *Eucalyptus opaca* or *E. gamophylla* (Wilson *et al.* 1990).

The tenure type is predominantly Perpetual Pastoral Lease (79%) (Figure 4.32), and land systems are:

A. Singleton SN (66%) Flat or gently undulating plain; red clayey sands and sands, in north-west some sandy red earths, in part lateritic; spinifex; and
B. Bushy Park BU (15%) - Plains; red earths; mulga in groves over short grass or woollybutt

The predominant soils are:

A. Ab31 (63%) - Flat to gently undulating sand plains with some low broad sand rises and intervening swales; some small alluvial flats; some clay pans; and some stone-covered ridges: chief soils are red earthy sands on the plains and swales. Associated are red siliceous sands on the sand rises. Small areas of sandy red earths occur on the plains, in the swales, and on the alluvial flats. Other soils include shallow (< 12 in.) stony on the stone-covered ridges; and

B. My105 (17%) - Plains, occasionally with low rocky hills: chief soils are neutral red earth of variable degree of sandiness, and red earthy sands with lesser areas of soils. Minor areas of other soils may be included locally.

The predominant geology is:

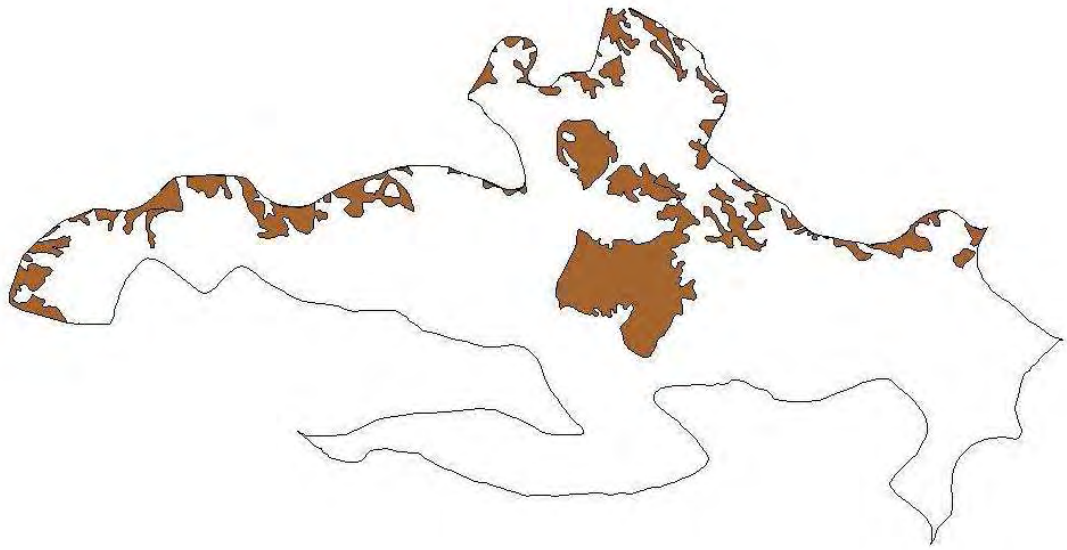
A. APA (61%) – Pre-Cambrian high-grade metamorphics, granite, gabbro in Arunta block;
B. PAP (16%) – Pre-Cambrian sediments such as sandstone, siltstone, shale, tillite, dolomite in Kimberley, Victoria River, Georgina, Ngalia and Amadeus Basins and Mt Isa Block; and
C. PCA (13%) – Pre-Cambrian granitic rocks, minor acid volcanics in Arunta block. Appendix 4 gives a full description of all geology types found in the Burt Plain bioregion.

As calculated using ESOCLIM, the mean annual temperature for Vegetation Community 76 ranged from a maximum of 24.2^{o}C to a minimum of 20.1^{o}C. The maximum temperature ranged between 33.0–36.2^{o}C in the wet season (December – March), whereas the minimum temperature ranged between 8.2–12.2^{o}C in the dry season (June – August). Total annual rainfall ranged from a minimum of 235.8 mm to a maximum of 342.7 mm, with an average in the dry season between 7.9–14.0 mm, and in the wet season 29.1–43.3 mm. The number of total annual raindays ranged from a minimum of 39.4 with less days occurring in the dry season to a maximum of 55.2 total annual raindays, with more days occurring in

the wet season. Total annual evaporation ranged between 2890.7–3324.2 mm, with a mean annual evaporation ranging between 240.1–277.0 mm. Based on the DEM the elevation across Vegetation Community 76 ranged between 354.5–836.3 m. Mean annual evaporation had significant positive correlations with mean annual temperature, mean annual minimum temperature and in the average temperature for the dry season. Elevation was positively correlated with only one of the environmental gradients i.e. mean annual raindays.

A summary of the major gradients and associated statistics for Vegetation Community 76 are given in Tables 4.13, 4.14 (Figure 4.33 - 4.37). 217 plant species have been recorded for Vegetation Community 76.

Figure 4.31 Spatial distribution of Vegetation Community 76 for the Burt Plain bioregion (for full descriptions of soils and geology refer to Appendices 4 and 5)



Area: 1 098 705 (14.7% of the Burt Plain)

No. of patches: 60

Tenure: Perpetual Pastoral Lease (PPL)

Land Systems: Bushy Park (BU); Singleton (SN)

Geology: APA; PAP; PCA

Soils: Ab31; My105

No. of bores: 213

Dominant species: Soft Spinifex *(Triodia pungens)*, Curly Spinifex *(Plectrachne schinzii)* hummock grassland with Acacia tall sparse-shrubland overstorey.

Figure 4.32 Percentage of tenure type by area for Vegetation Community 76 for the Burt Plain bioregion

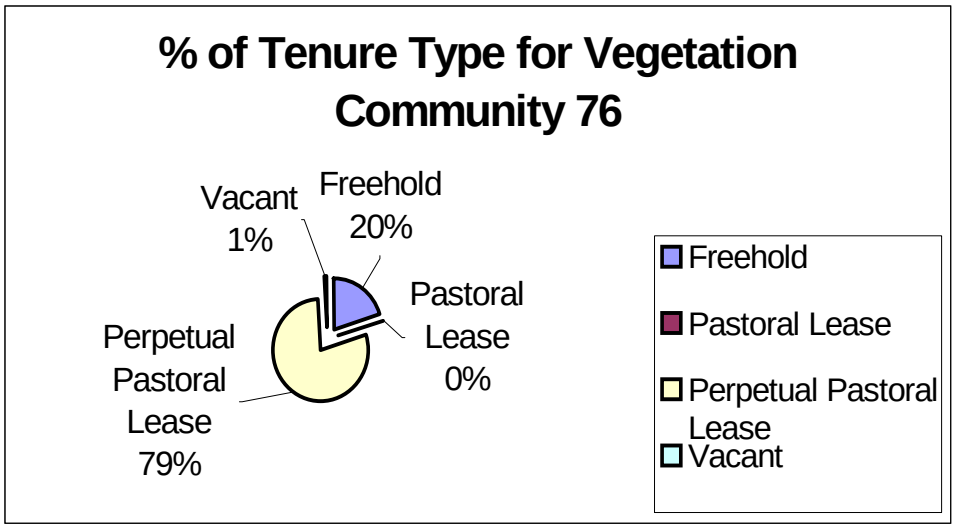


Table 4.13 Summary of major climate gradients for Vegetation Community 76 for the Burt Plain bioregion, NT.

Major Gradients	Min	Max
Mean Annual Maximum Temperature (°C)	27.9	31.3
Mean Annual Minimum Temperature (°C)	13.5	17.1
Mean Annual Temperature (°C)	20.1	24.2
Average Temperature Dry Season (°C)	15.7	19.5
Maximum Temperature Dry Season (°C)	22.9	26.8
Minimum Temperature Dry Season (°C)	8.2	12.2
Average Temperature Wet Season (°C)	26.1	28.9
Maximum Temperature Wet Season (°C)	33.0	36.2
Minimum Temperature Wet Season (°C)	18.8	22.0
Total Annual Rainfall (mm)	235.8	342.7
Average Rainfall Dry Season (mm)	7.9	14.0
Average Rainfall Wet Season (mm)	29.1	43.3
Mean Annual Rainfall (mm)	19.7	28.6
Total Annual Raindays	39.4	55.2
Average Raindays Dry Season	1.6	2.9
Average Raindays Wet Season	4.7	6.2
Total Annual Evaporation (mm)	2890.7	3324.2
Average Evaporation Dry Season (mm)	167.1	214.1
Average Evaporation Wet Season (mm)	308.2	339.9
Mean Annual Evaporation (mm)	240.1	277.0
Elevation	354.5	836.3

Table 4.14 Summary of environmental gradient statistics for Vegetation Community 76 for the Burt Plain bioregion

Covariance Matrix									
	Xraind76m	Xmxtmp76m	Xmintmp76m	Xevap76m	Dem76mask	Xanrainf76m	Xallwtmp76m	Xalltmp76m	Xalldtmp76m
Xraind76m	0.0246176	-0.0528909	-0.0470428	-0.540061	9.5598	0.12025	-0.0469429	-0.0499668	-0.0529907
Xmxtmp76m	-0.0528909	0.472516	0.450938	3.6205	-24.8912	-0.0667816	0.400683	0.461727	0.522771
Xmintmp76m	-0.0470428	0.450938	0.619814	4.60942	-26.1209	0.214123	0.444557	0.535376	0.626195
Xevap76m	-0.540061	3.6205	4.60942	38.4506	-269.762	0.524109	3.44563	4.11496	4.7843
Dem76mask	9.5598	-24.8912	-26.1209	-269.762	3877.14	38.461	-22.9073	-25.506	-28.1047
Xanrainf76m	0.12025	-0.0667816	0.214123	0.524109	38.461	1.15756	0.00723008	0.0736706	0.140111
Xallwtmp76m	-0.0469429	0.400683	0.444557	3.44563	-22.9073	0.00723008	0.362096	0.42262	0.483144
Xalltmp76m	-0.0499668	0.461727	0.535376	4.11496	-25.506	0.0736706	0.42262	0.498552	0.574483
Xalldtmp76m	-0.0529907	0.522771	0.626195	4.7843	-28.1047	0.140111	0.483144	0.574483	0.665823

Correlation Matrix									
	Xraind76m	Xmxtmp76m	Xmintmp76m	Xevap76m	Dem76mask	Xanrainf76m	Xallwtmp76m	Xalltmp76m	Xalldtmp76m
Xraind76m	1	-0.4904**	-0.380837*	-0.555097**	0.978522****	0.712347**	-0.497206**	-0.451029**	-0.413903**
Xmxtmp76m	-0.4904**	1	0.833255***	0.849394***	-0.581542**	-0.0902975	0.968681****	0.95131****	0.932017****
Xmintmp76m	-0.380837*	0.833255***	1	0.9442**	-0.532846**	0.25279**	0.938393****	0.963104****	0.974765****
Xevap76m	-0.555097**	0.849394***	0.9442****	1	-0.698672**	0.0785594	0.923431****	0.939851****	0.945557****
Dem76mask	0.978522****	-0.581542**	-0.532846**	-0.698672**	1	0.574107**	-0.611375**	-0.580139**	-0.553151**
Xanrainf76m	0.712347**	-0.0902975	0.25279*	0.0785594	0.574107**	1	0.0111676	0.0969765	0.159596
Xallwtmp76m	-0.497206**	0.968681****	0.938393****	0.923431****	-0.611375**	0.0111676	1	0.99468****	0.983979****
Xalltmp76m	-0.451029**	0.95131****	0.963104****	0.939851****	-0.580139**	0.0969765	0.99468****	1	0.99711****
Xalldtmp76m	-0.413903**	0.932017****	0.974765****	0.945557****	-0.553151**	0.159596	0.983979****	0.99711****	1

**** Very Strong correlation > 0.9; *** Strong correlation 0.7 to 0.9; ** Moderate correlation 0.4 to 0.7; * Weak, low correlation (not very significant) 0.2 to 0.4; Very weak to negligible correlation 0.0 to 0.2

Figure 4.33 Mean Annual Temperature (°C) for the Burt Plain bioregion for Vegetation Community 76

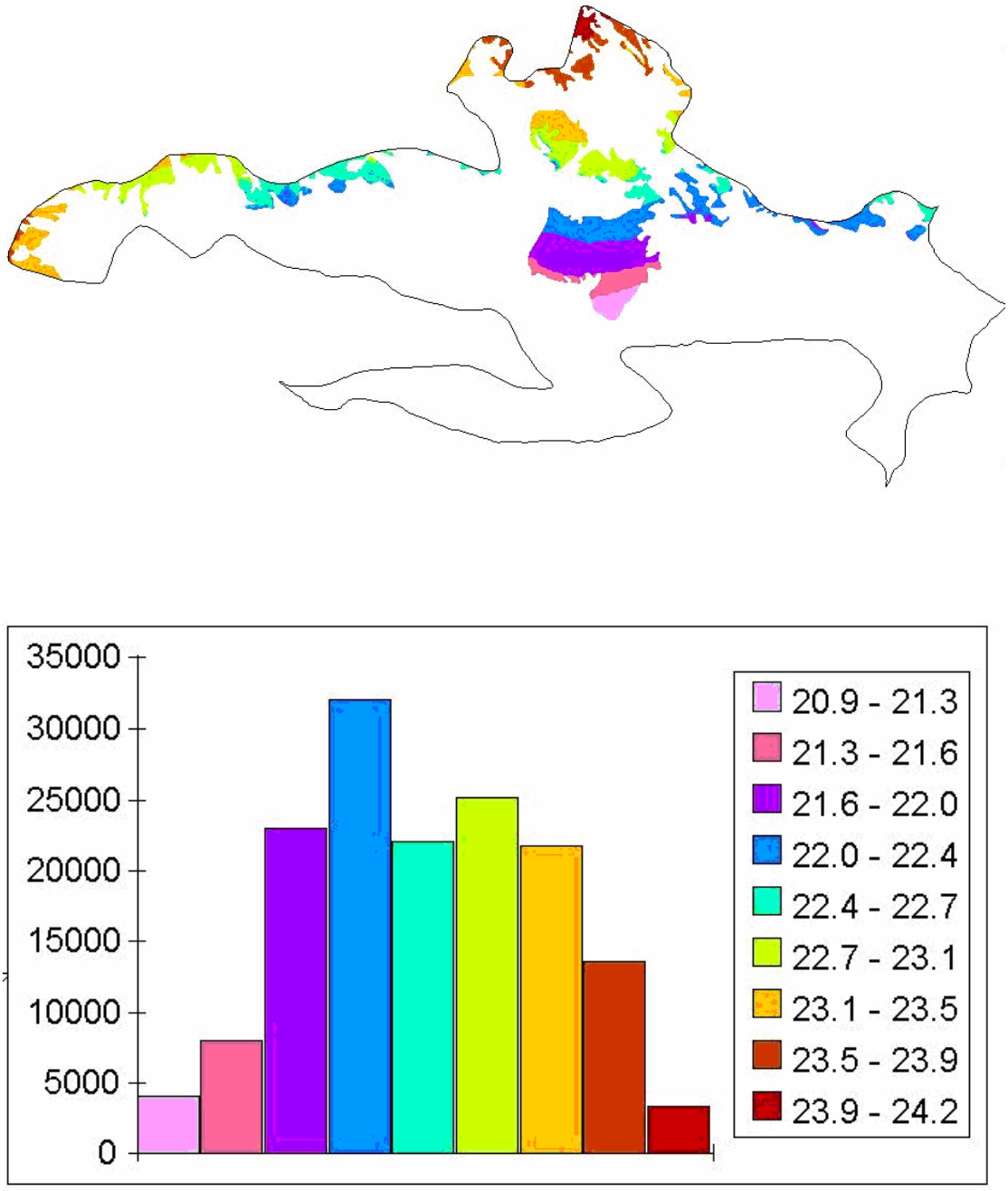


Figure 4.34 Mean Annual Rainfall (mm) for the Burt Plain bioregion for Vegetation Community 76

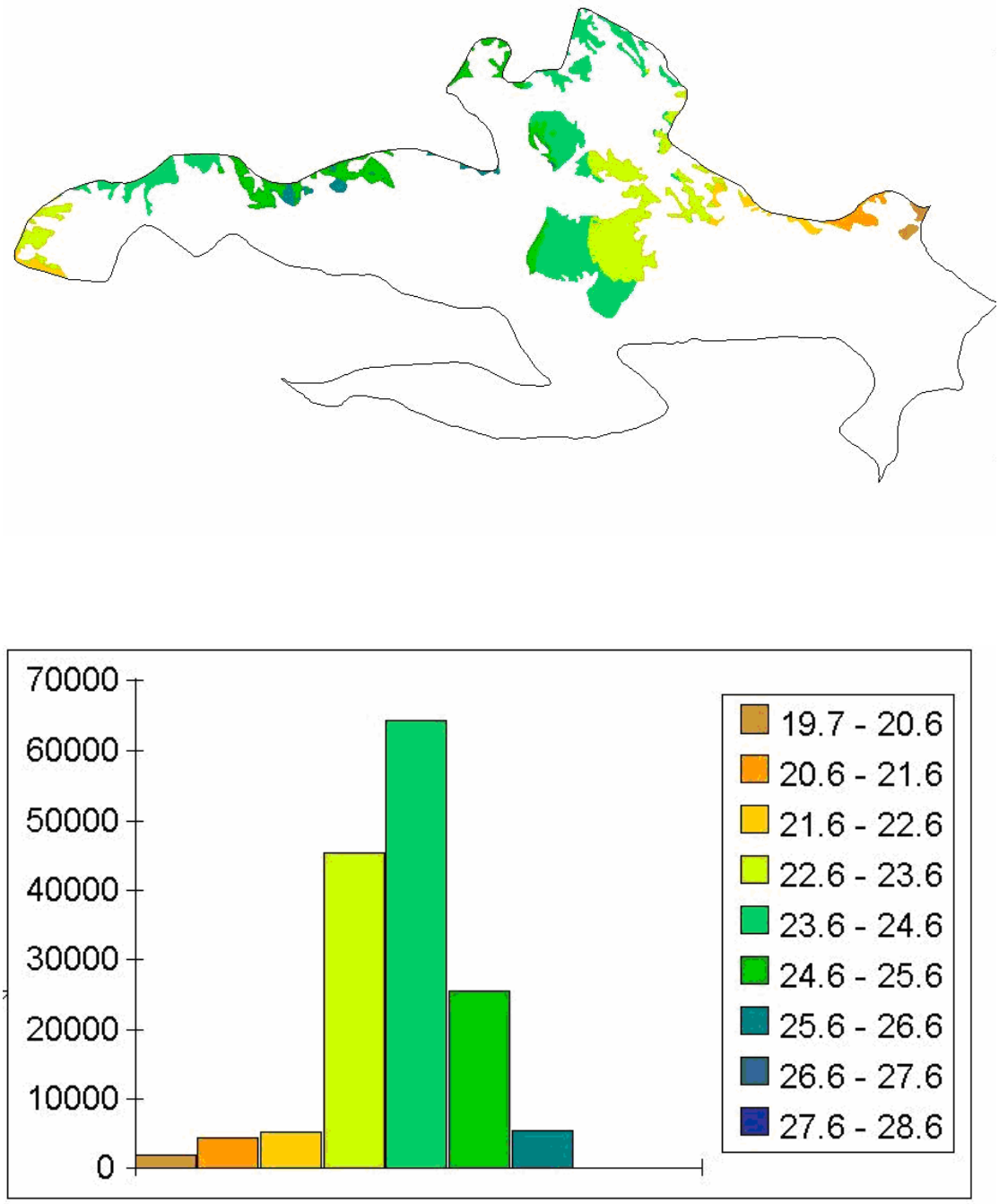
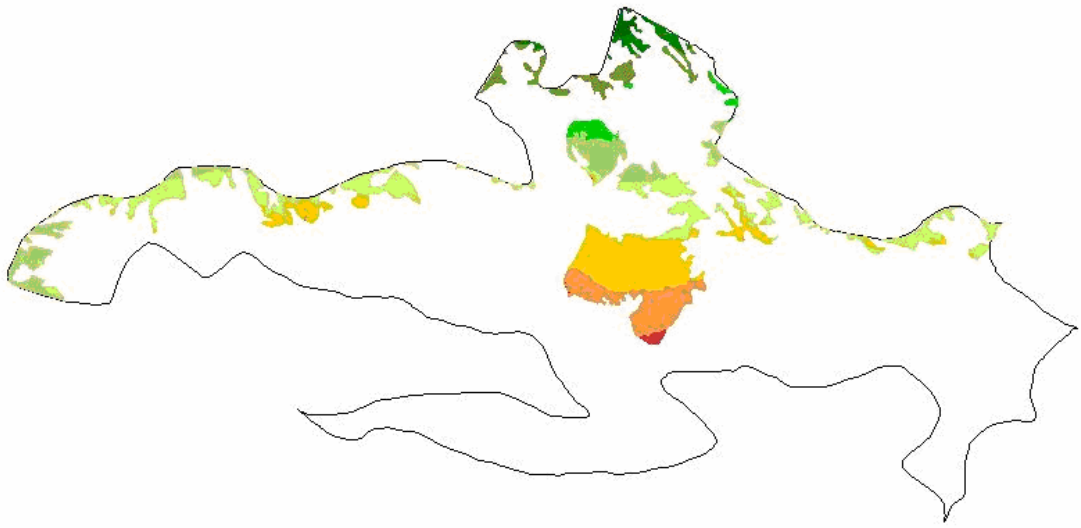


Figure 4.35 Mean Annual Evaporation (mm) for the Burt Plain bioregion for Vegetation Community 76



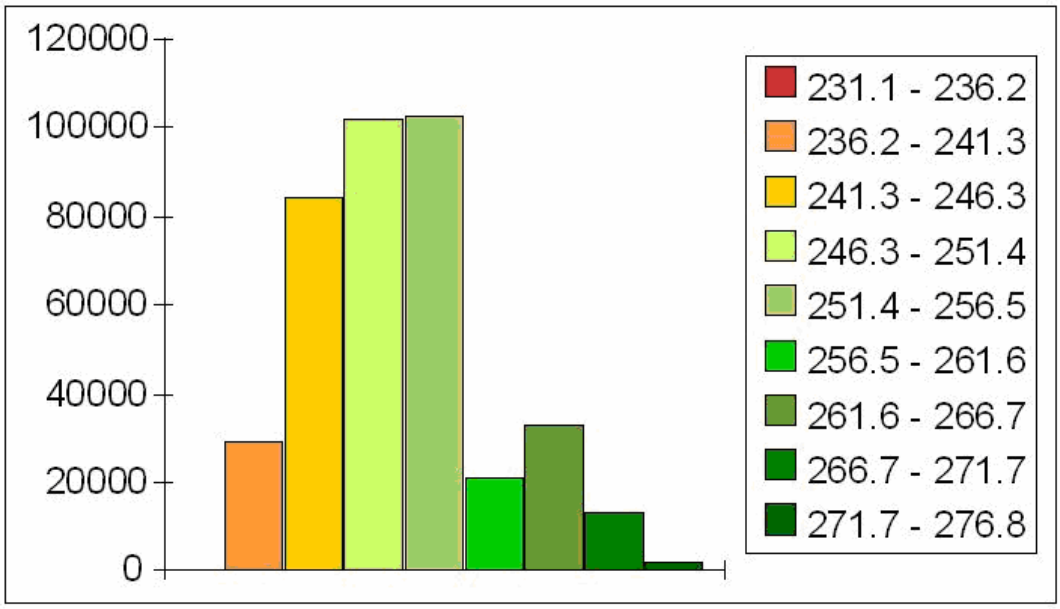
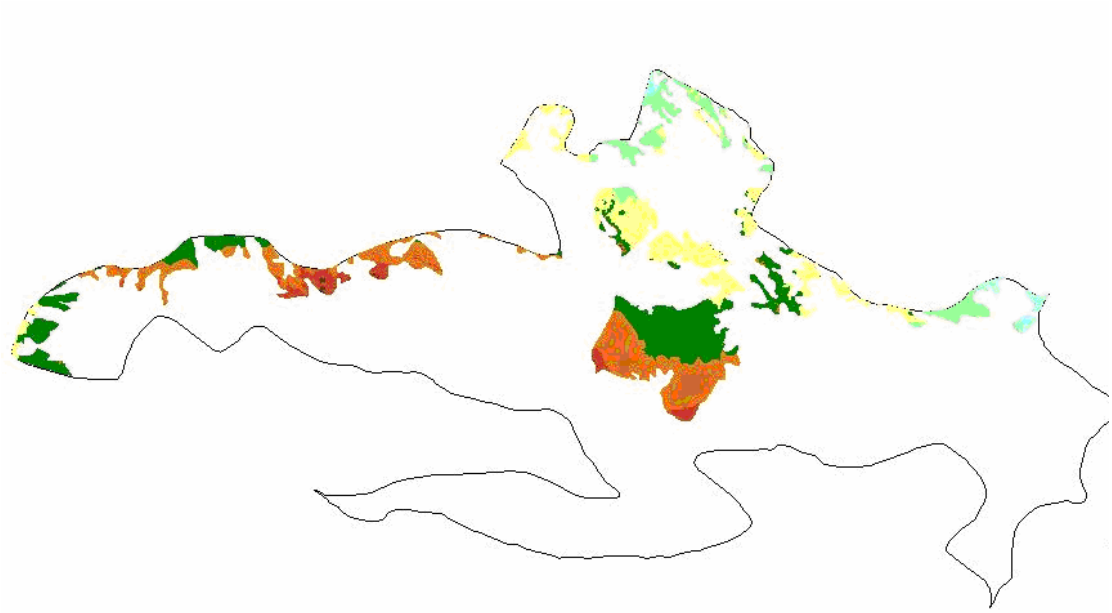


Figure 4.36 Elevation (m above sea level) for the Burt Plain bioregion for Vegetation Community 76



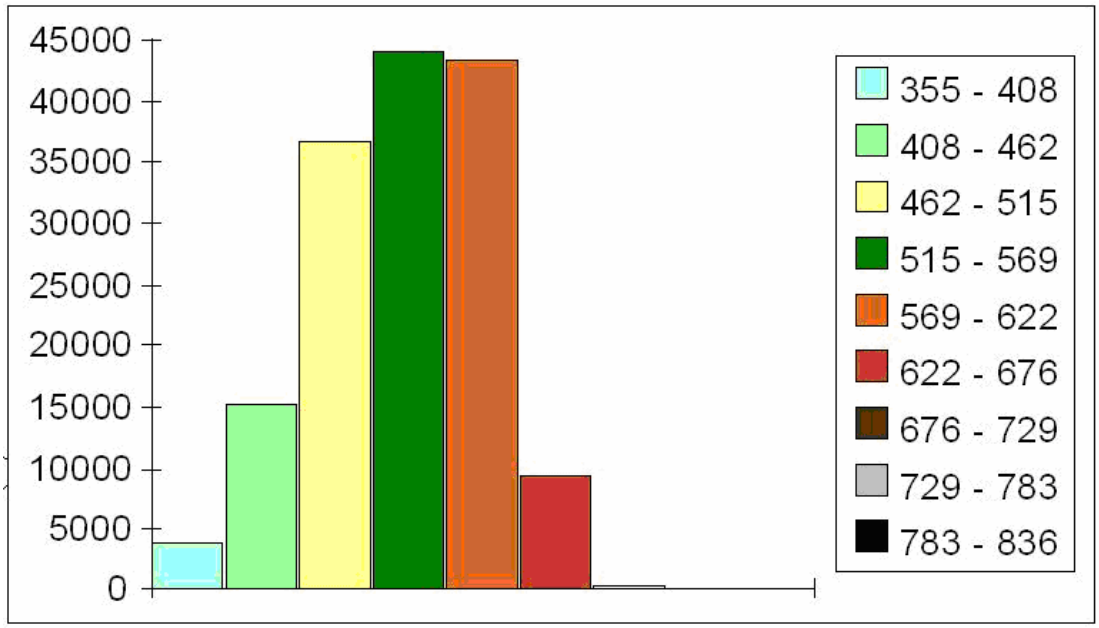
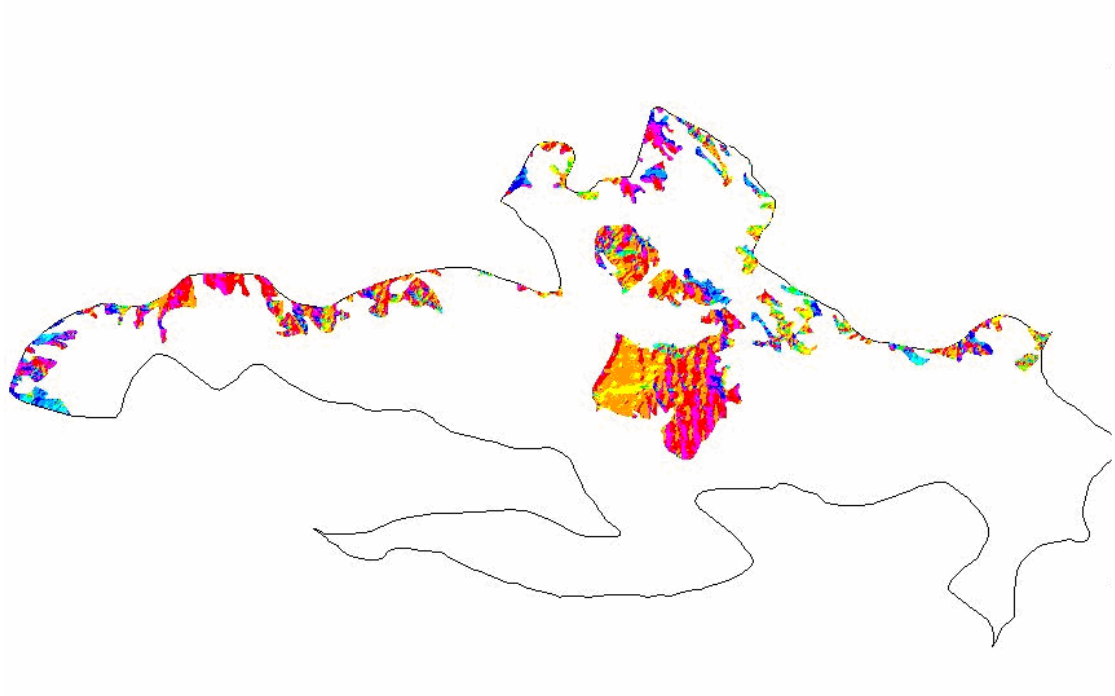
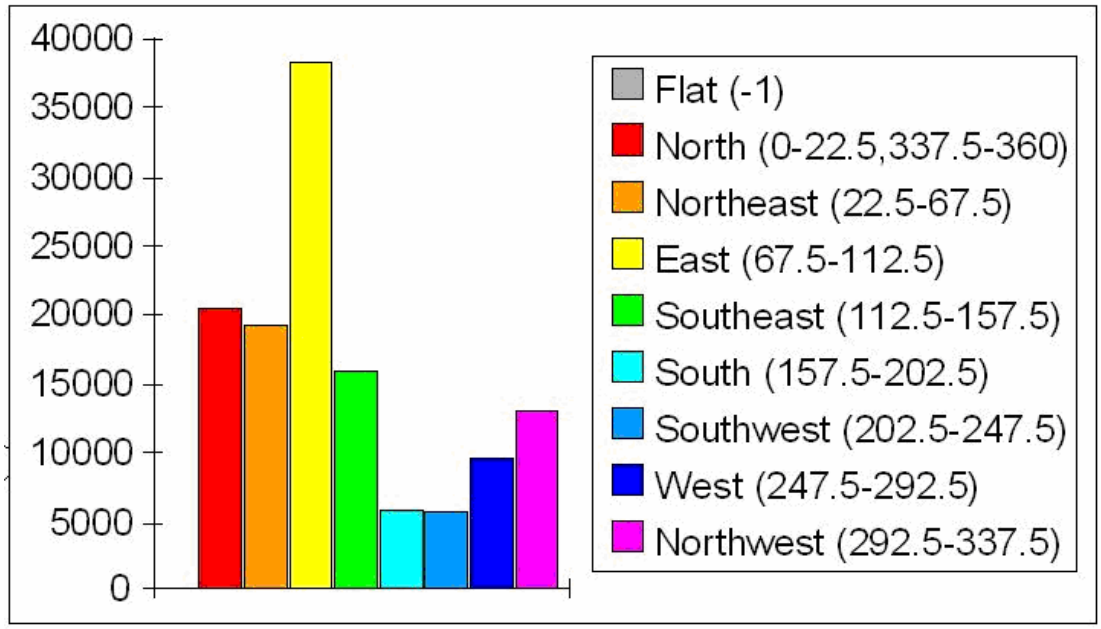


Figure 4.37 Aspect for the Burt Plain bioregion for Vegetation Community 76





4.4.2 Land Systems and Land Resource Data (Land Unit Mapping)

Of the 88 1:1000000 land system units mapped in the Northern Territory, 53 are found within the Burt Plain bioregion (Figure 4.38). Of these 53, the two most dominant land systems are Bushy Park (Bu) and Singleton (Sn) which cover 1514753 hectares (21%) and 1511780 hectares (21%), respectively (Figure 4.39). Perry (1962) described the Bushy Park land system as plains; red earths; mulga in groves over short grass or woollybutt. The Singleton land system is further described by (Perry 1962) as flat or gently undulating plain; red clayey sands and sands, in north-west some sandy red earths, in part lateritic; spinifex. The next dominant land system is Boen (Bo) which covers 6456161 hectares (9%). Thirty-five of the 53 (66%) of the land systems mapped cover less than 1% of the Burt Plain bioregion. The Boen land system is described as plains with convex interfluves and broad shallow valleys, relief up to 20 ft; red earths; lateritic in part; mulga in groves over short grass or woollybutt (Perry 1962).

Land unit mapping was also used from pastoral stations mapped within the Burt Plain bioregion (refer to methods). Tables 4.15 summarises the dominant land units found within the properties, the percentage of land unit which covers the property area, and the area (in hectares) of the dominant land units, a general description and vegetation description.

Table 4.15 Summary of dominant land units mapped for each station in the Burt Plain bioregion.

Station	Dominant	%	Area	General Description	Vegetation
	Map Units	of property	(ha)		
Amburla	7.2	25.5	54995	Low rises, merging into sandplain; red earthy sands; a low open woodland of mulga and witchetty bush over woollybutt grass.	A mid-high open woodland of mulga, merging with a tall open shrubland of witchetty bush, with broombush over pastures of woollybutt. Other species present include wire, woollybutt wanderrie, kerosens, oat and mulga grasses, lifesaver burr and potato bush.
Amburla	8.3	17.3	37323	Low rises; red earthy sands; a tall sparse shrubland of desert grevillea over hard spinifex.	A tall sparse shrubland of desert grevillea over hard spinifex. Scattered fork-leaved corkwood, bloodwood, Maitland's wattle and sandhill wattle are usually components of the shrub stratum, while kerosene grass and parakeelya grow amongst the spinifex tussocks. Relict floodout features support a tall sparse shrubland of umbrella bush with isolated bloodwoods over hard spinifex. Pink fringe myrtle is present on dune areas.
Amburla	8.1	11.9	25670	Level sandplain; red earthy sands; a tall sparse shrubland of witchetty bush over hard spinifex.	A tall sparse shrubland of witchetty bush with mulga, sandhill wattle, native currant, ironwood, silver cassia and native fuschia over hard spinifex with kerosene grass, woollybutt wanderrrie, parakeelya and woollybutt grass. In some areas, a mid-high open woodland of mulga over spinifex predominates.
Amburla	8.2	10.1	21668	Level sandplain; red earthy sands; a mid-high hummock grassland of hard spinifex with sparse fork-leaved corkwood.	A mid-high open hummock grassland of hard spinifex with scattered fork-leaved corkwood. Other common species include dogwood, Maitland's wattle, *Acacia adsurgens* and mulga. Kerosene grass is scattered amongst the hummocks of spinifex.
Atartinga	2.1	34.1	75567	Not available	Not available
Atartinga	3.1	18.7	41468	Not available	Not available
Delny	3.2	11.7	14718	Gently undulating plains; red-brown earths; a low open woodland of Georgina gidyea with scattered oval-leaf cassia and rock fuschia bush over woollyoat, eight-day and five-minute grass.	Not available
Mt Skinner	2.1	27.3	78203	Plains with deep red earth soils; dense groved mulga with wire and woollybutt grasses.	Groved mulga woodland, usually with occasional witchetty bush, or less commonly, a groved shrubland of witchetty bush. Open areas support wire grasses, woollybutt and lifesaver burr, with sparse mulga mitchell and woollyoat grasses. Cotton paic is usually present beneath the mulga canopy.
Mt Skinner	1.4	16.5	47343	Sandstone ranges, usually as slightly dipping plateaux; sparse acacias and spinifex.	A hummock grassland of hard spinifex and sparse acacias, mainly sandhill wattle.
Mt Skinner	9.1	15.1	43212	Sandplain, often as gently rising terrain; blue mallee with spinifex.	A sparse open woodland of blue mallee and red-bud mallee, with scattered sandhill wattle, umbrella wattle and desert kurrajong, over a groundcover of hard spinifex. Sparse kerosene, wire and woollyoat grasses, chocolate bush and parakeelya occur between the hummocks of spinifex.
Nawietooma	1.1	23.0	60823	Undulating rises to steep hills; lithosols to gravelly red earths; lower storey vegetation varies from weeping spinifex to annual and perennial grasses.	Not done for this map unit - at the owner's request.
Nawietooma	6.1	13.1	34513	Plains with dense mulga, witchetty bush and whitewood over woollybutt, five-minute and mulga grasses.	The upper stratum consists of a low to mid-high open woodland of mulga with witchetty bush and whitewood over a mid of tall sparse shrubland of witchetty bush, mulga, native fuschia, silver cassia and spiny saltbush. The lower stratum is a low sparse grassland of woollybutt, five-minute and mulga grasses with cotton panic grass, silky bluebush, caltrop, and munyeroo.
Pine Hill	7.2	38.6	111125	Sandplain with earthy sand to sandy red earth soil supporting isolated bloodwood, dogwood and flat-leaved banksia over sparse shrubs and feathertop spinifex hummock grassland.	Upper stratum Low isolated trees): Dominant species - Flat-leaved hakea, bloodwood, dogwood. Other species - Beefwood, desert poplar. Mid Stratum (Mid-high sparse shrubland): Dominant species - Fitzroy wattle. Lower Stratum (Hummock grassland): Dominant species - Feathertop spinifex.
Pine Hill	3.1	11.9	34214	Gently undulating plains with a low open mulga woodland, partially groved, over sparse woollybutt and annual grasses.	Upper stratum Low open woodland: Dominant species - Mulga. Other species - Witchetty bush. Mid Stratum (Mid-high sparse shrubland): Dominant species - Native fuschia. Lower Stratum (Sparse grassland): Dominant species - Woollybutt grass, dwarf mulga grass and wild parsnip.
Pine Hill	1.3	8.1	23327	Hills with shallow coarse textured skeletal soil supporting isolated trees and shrubs over soft spinifex.	Upper stratum (Sparse trees): Dominant species - Black gidgee, native pine. Mid Stratum (Sparse shrubs): Dominant species - Curry wattle. Lower Stratum (Open hummock grassland): Dominant species - Hard spinifex.
Upper Todd	4.5	11.0	945	Gentle slopes and plains with banded sheet flow drainage patterns; kandosols/calcareous red earths; a groved woodland of mulga and witchetty bush over annual grasses and grey copperburr.	Within the groves, a low woodland or open woodland of mulga with witchetty bush over a low sparse shrubland of desert fuschia, silver cassia, dead finish and oval-leaf cassia. The groundcover includes woolly copperburr, mulga grass, knottybutt neverfail, grey copperburr, five-minute grass and umbrella grass. The intergrove areas were bare at the time of survey.

Figure 4.38 Distribution of land systems in the Burt Plain bioregion (refer to Appendix 1 for full description)

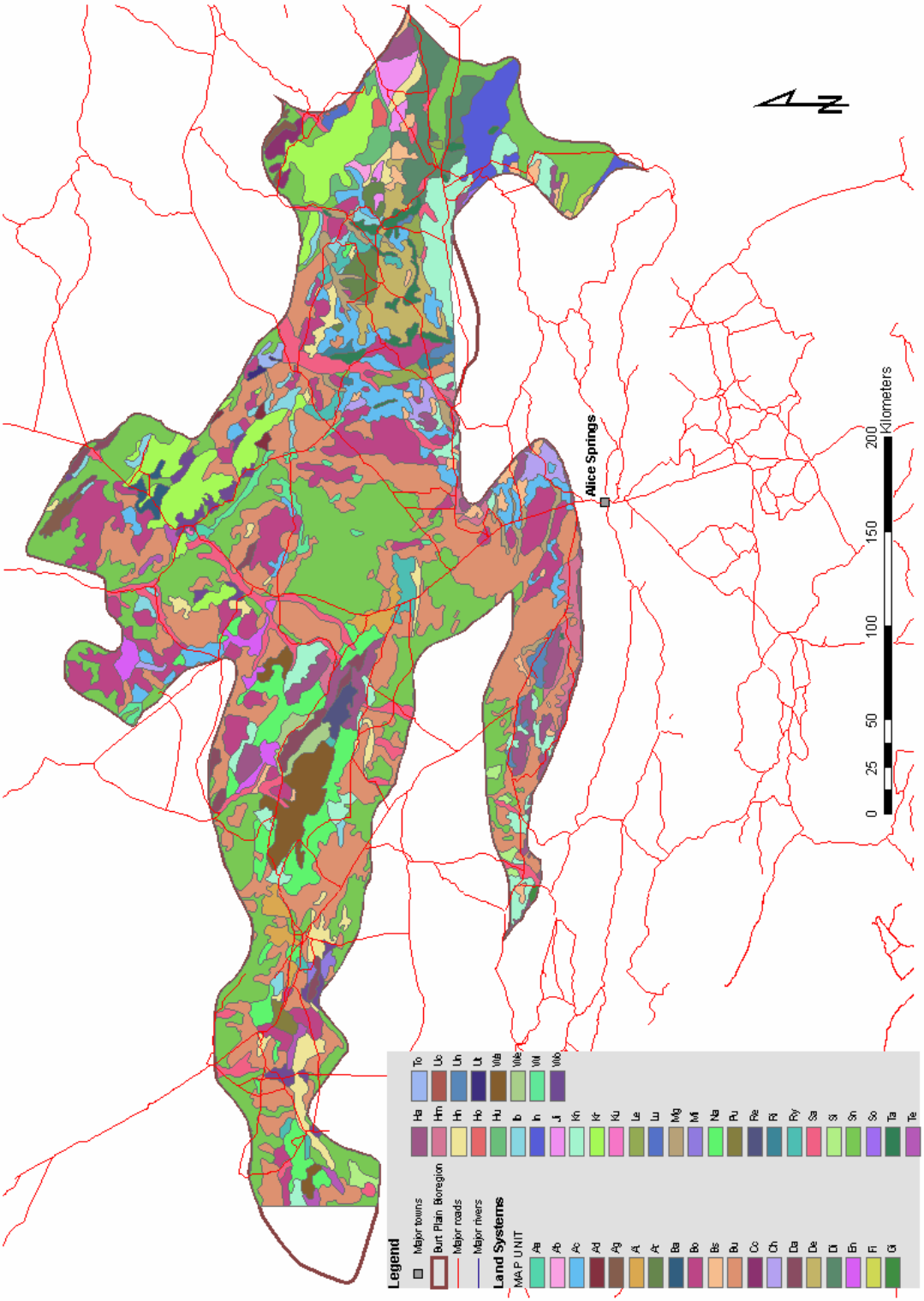
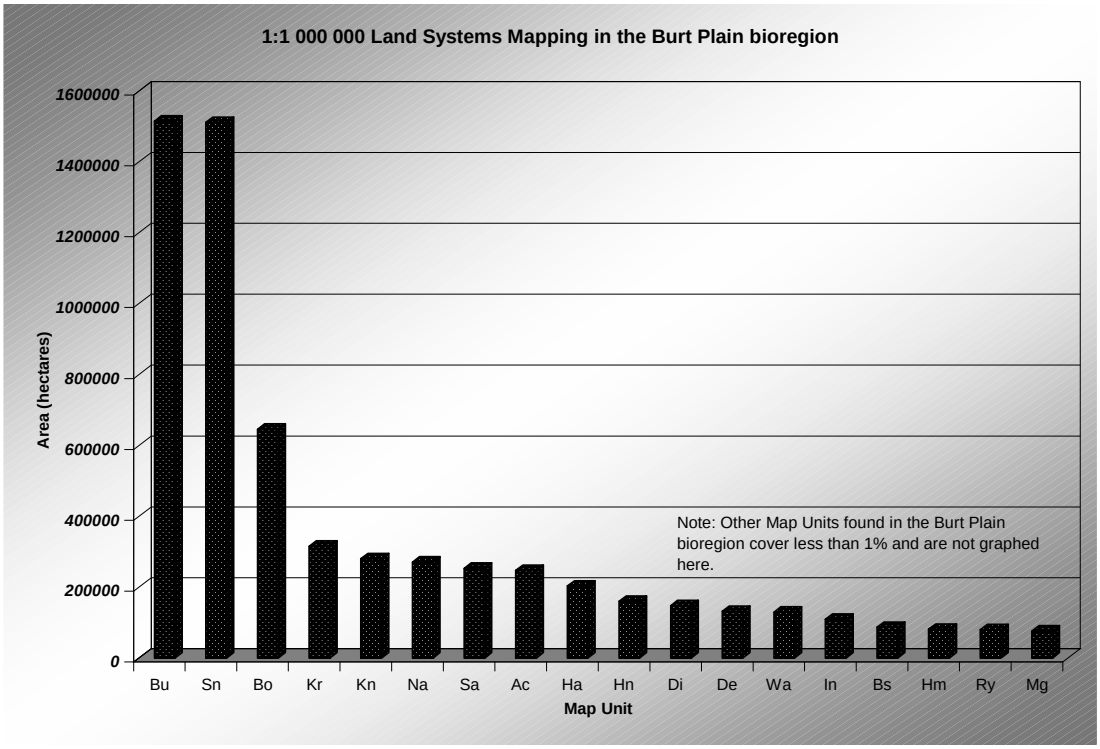


Figure 4.39 Land systems mapping in the Burt Plain bioregion (for full descriptions refer to Appendix 1)



4.5 DISCUSSION

The purpose of this chapter was to describe the regional distribution and composition of the dominant vegetation communities found in the Burt Plain bioregion and characterise the environmental gradients associated with these vegetation patterns. Twenty five vegetation communities were identified of which four comprised 75% of the bioregion by area. The four communities were tall-open and low-open shrubland and woodland characterised by a few dominant species such as *Acacia aneura* and *A. estrophiolata*, and grassland characterised by spinifex. These vegetation communities vary in distribution

within the bioregion and beyond and exhibit varying correlations with environmental gradients such as climate and geology.

Major variation in the distribution of rainfall and nutrients in the arid region of Australia is associated with dramatic differences in vegetation floristic composition and biological productivity in different parts of the landscape at different times of the year in central Australia (Ludwig *et al.* 1999; Murray 2000; Tongway & Ludwig 1997).

Tussock grasslands dominated by *Acacia aneura* in the upper stratum represent the most common vegetation in the Burt Plain bioregion. The environmental niche of this community can be generally characterised by red earths; mulga in groves over short grass or *Eragrostis eriopoda*. Plains with convex interfluves and broad shallow valleys, contain red earths; lateritic in part; with mulga in groves over short grass or *Eragrostis eriopoda*. Areas which are flat or gently undulating plains contain red clayey sands and sands, whereas in the north-west some sandy red earths, which are in part lateritic over spinifex. The vegetation community supports a number of important taxa including *Acacia aneura, Eragrostis eriopoda, Triodia pungens, and Plectrachne schinzii*. The precise ecological requirements of most of these species is poorly understood and is the subject of on-going study by Bowman *et al.* (1994), Johnson & Burrows (1994), and Williams (2002).

Vegetation community 59 represents part of a low open woodland community of mixed species including *Acacia estrophiolata*. This community type is found in 13 patches in the east and south east portion of the Burt Plain within a limited climatic range, and on a limited range of soil types predominantly AB68, AB69 and Nb11 which are characterised as deep red sandy plains. The geology is predominantly APA Pre-Cambrian high-grade metamorphics, granite, gabbro in Arunta Block. This community supports a range of significant taxa including *Atalaya hemiglauca*.

Vegetation Community 58 is dominated by species such as *Acacia aneura* and represents part of a broader complex of mulga open shrubland that occurs across central Australia (Russell-Smith *et al.* 2002). In the Burt Plain the majority of this vegetation is found within 12 patches that are predominantly on lands with a perpetual pastoral lease. The environmental niche of this vegetation community is characterised by certain soil types such as Ab31 on flat to gently undulating sand plains with some low broad sand rises and intervening swales; some small alluvial flats; some clay pans; and some stone-covered ridges: chief soils are red earthy sands on the plains and swales. Associated are red siliceous sands on the sand rises. Small areas of sandy red earths occur on the plains, in the swales, and on the alluvial flats. Other soils include shallow (<30 cm) stony on the stone-covered ridges. The other predominant soil type is My105 which occurred on plains, occasionally with

low rocky hills: chief soils are neutral red earth of variable degree of sandiness, and red earthy sands with lesser areas of soils.

An association of mulga with red-earth soils in other parts of central Australia has been reported elsewhere (Dawson & Ahern 1973; Dunkerley 2002; Tongway & Ludwig 1990). Bowman *et al.* (1994) reported that edaphic variables were of primary importance in the patterning of *Acacia aneura* shrublands on the Brouwer conglomerate near Alice Springs. Soil acidity and landform profile have also been related to the distribution of mulga in north-western Western Australia (Fox & van Leeuwen 1985; van Leeuwen *et al.* 1995b). *Acacia aneura* is considered a "fire sensitive" species (Fox 1986; Latz 1995; Start 1986; Woinarski 1999; Woinarski *et al.* 1996), with adult plants generally being killed if the entire canopy is burnt. However, there is evidence that *A. aneura* is adapted to occasional fires (Gill 1975), with the result of enhanced seedling establishment (Griffin & Friedel 1984; Lay 1986). The regional distribution of this community was correlated with a limited range in mean annual evaporation. Notably, the majority of the regional distribution of this community fell within a 5 mm range of this variable (i.e. 247-252 mm).

van Leeuwen *et al.* (1995a) reported that many fauna and flora species were reputedly restricted to mulga woodlands and consequently any reduction of the spatial coverage of these woodlands or modification of their

structure/composition could significantly impinge on the conservation status of such ecosystems. A number of important plant and animal species (including those significant at the national level) are reported to occur in the mulga open shrublands in the Burt Plain including: *Austrostipa centralis, Cratystylis centralis, Daviesia eremaea, Eleocharis papillosa, Eragrostis subtilis, Goodenia halophila, Gossypium nelsonii, Hakea grammatophylla, Heliotropium subreniforme, Ipomoea A83192 Stirling, Isotoma luticola, Ixiochlamys integerrima, Kohautia australiensis, and Stylidium inaequipetalum.* Williams (2002) reported that the mulga systems of central Australia play a functional role in the landscape and that they are a critical resource for both indigenous and non-indigenous land mangers. Mulga provides food of many kinds, wood for utensils and weapons, and shelter in the hot summer months (Community & Baker 1996; Devitt 1986; Latz 1995; Oconnell *et al.* 1983). Appropriate management of the mulga open shrubland community on leasehold lands will be important to ensure the conservation of a range of taxa. For species such as the Dwarf Desert Spike-Rush *(Eleocharis papillosa)*, White *et al.* (2000) have listed the invasion of couch grass *(Cynodon dactylon)* as a threatening process and recommend that monitoring be undertaken to prevent further spreading and the feasibility of controlling couch grass in swamp environments.

CHAPTER 5 - CASE STUDY OF THE BURT PLAIN BIOREGION – II. MULGA AT THE LANDSCAPE LEVEL

5.1 INTRODUCTION

Mulga dominated communities together with hummock grasslands wooded with Mulga are estimated to occupy as much as 20% of the Australian continent (Williams 2002). In central Australia, Mulga dominated vegetation communities represent a significant component of the region's biodiversity and provide habitat for a number of important and threatened plants and animals (Beutel 1995; Masters 1999; Parks and Wildlife Commission of the Northern Territory 1998; Recher & Davis Jr 1997). In Chapter 4 I examined the environmental correlates of the vegetation communities dominated by Mulga in the Burt Plain bioregion. To explore these relationships in more detail, this Chapter further examines the distribution of mulga at the landscape level using a portion of the Todd River Catchment as a focus.

The following specific objectives were set to evaluate the mulga vegetation communities within the Upper Todd River catchment study region:

- to characterise the variation in mulga distributions with respect to selected environmental and management variables – latitude, longitude, climate, land systems and land units, geology, hydrography, topography, and tenure;

- to examine the floristics and structure of mulga in relation to the above variables as well as disturbance gradients such as fire, grazing and weeds; and
- to outline the major landscape processes associated with the above.

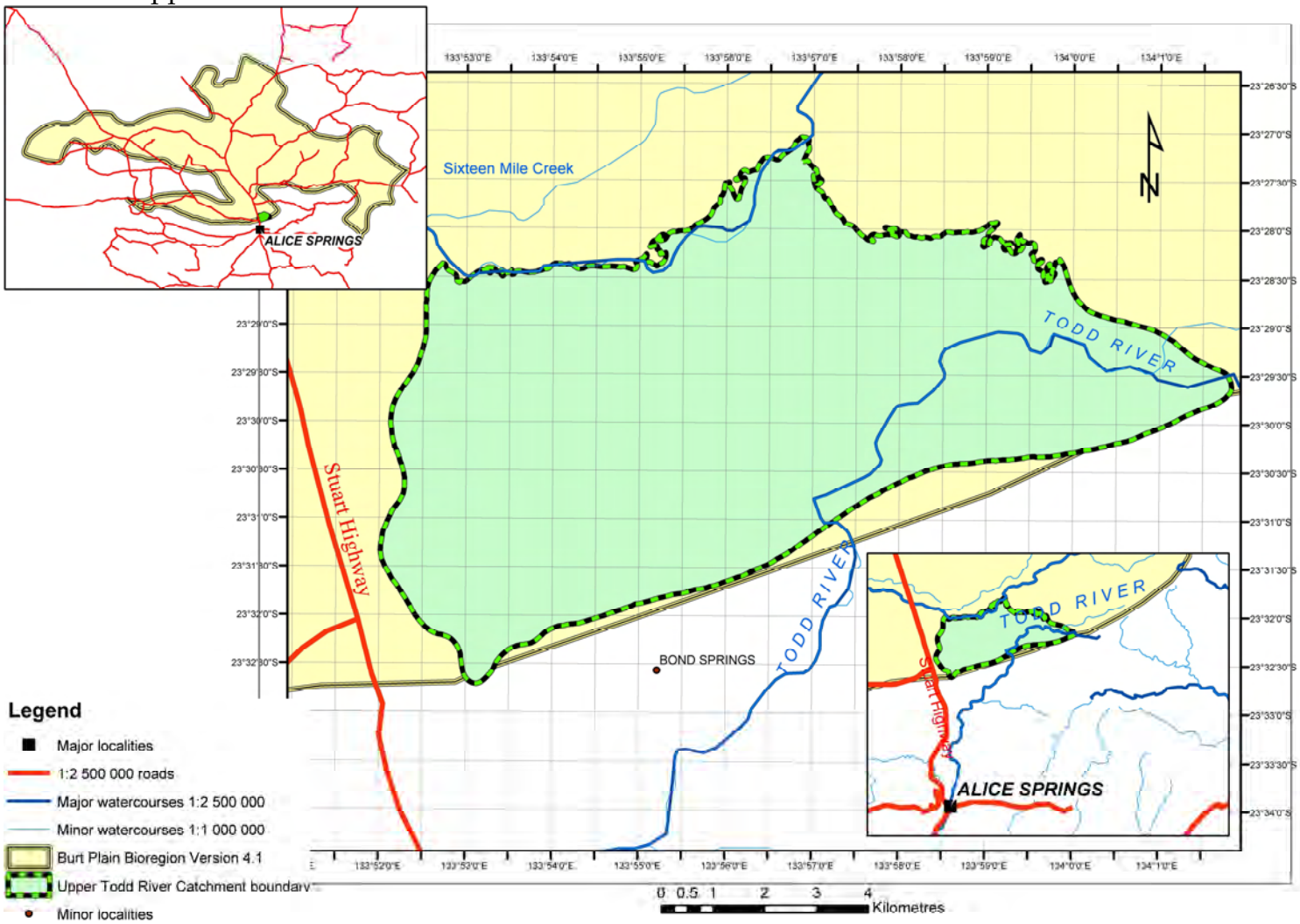
5.2 CASE STUDY AREA

5.2.1 Location and extent

The study area chosen for investigation is located in the upper reaches of the Todd River catchment 25 km north of Alice Springs on the Bond Springs pastoral lease (Figure 5.1). This area was chosen in large part because of the higher resolution scale the data was mapped at (i.e. 1:15000).

The study area covers a total area of approximately 850 sq km or 8594 ha, or about 0.1% of the Burt Plain bioregion.

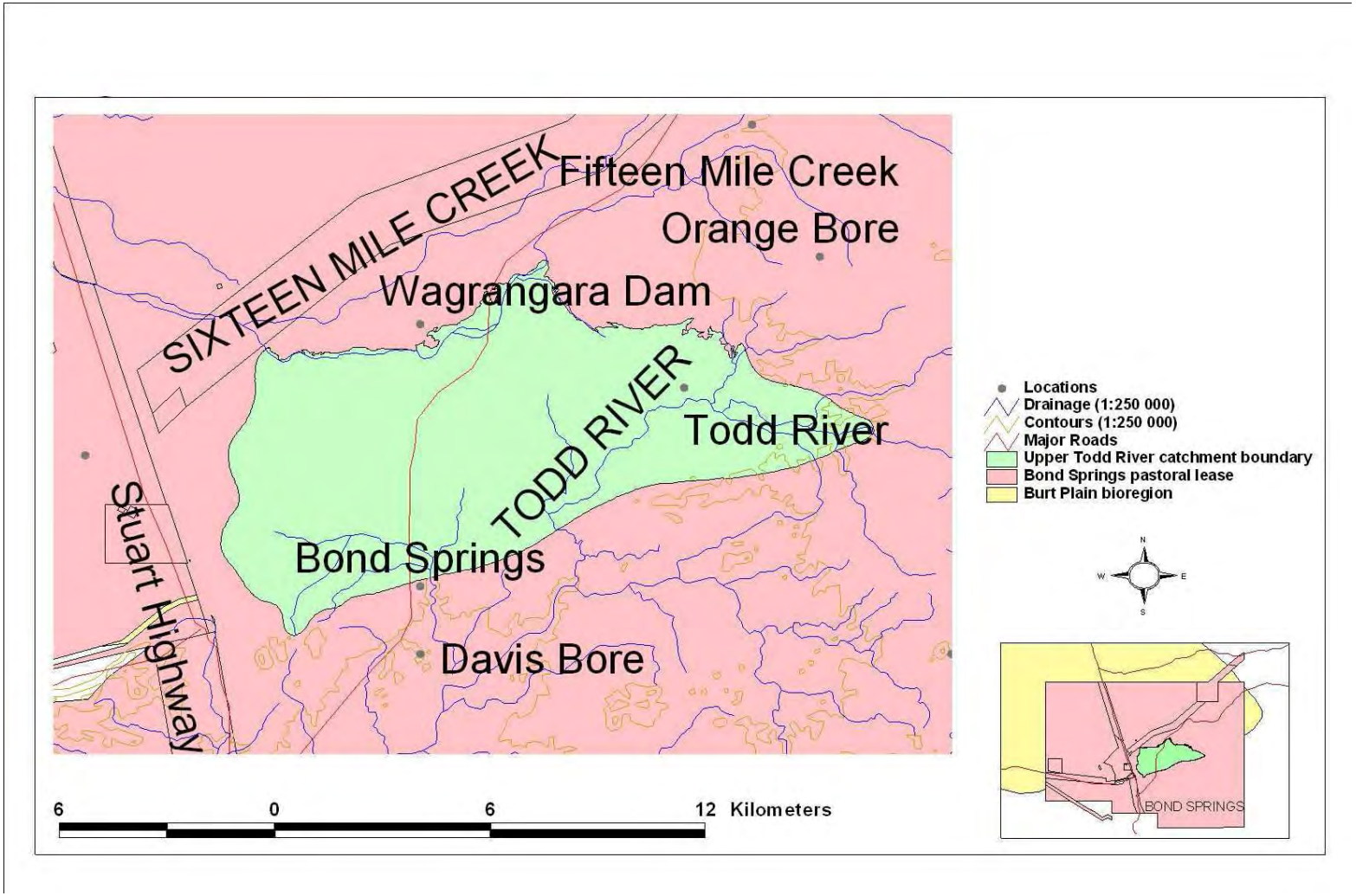
Figure 5.1 Location of Upper Todd River Catchment



5.2.2 Land Tenure and Use

The study area occurs on the Bond Springs pastoral lease managed by Grant Heaslip. The study area occupies 5.7% of the pastoral lease held by Grant Heaslip and approximately 5% of the Bond Springs tenure (Figure 5.2). Most of the land in the Upper Todd is used for cattle grazing with stocking rates less than the district average of 3 beasts/km^2 for this type of country (Grant 1994). The relatively small areas of the Broken Leg, Weaner and Plant Paddocks allow for close management of stock, while in the eastern part of the site, grazing behaviour is dictated by distance from Hijack Dam and the distribution of preferred areas of forage (Grant 1994).

Figure 5.2 Bond Springs pastoral lease and Upper Todd River Catchment



5.2.3 Climate

The study area falls within the Arid Zone, as annual median rainfall varies between approximately 250-500mm. The aridity can be attributed to the geographic location of the region in the centre of the continent remote from coastal influences, and its position in relation to the seasonal shift of pressure systems (Grant 1994). The variability in the amount of annual rainfall is demonstrated by records from Alice Springs which show a mean annual rainfall of 281 mm for the period of 1873-1980, the driest year on record (1901-02) receiving only 31 mm, whilst the wettest (1973-74) recorded 926 mm (Moore 1981).

The intrusion of large depressions associated with tropical cyclones can result in high intensity rainfall over large areas of the region. The weather system that caused the 1 in 50 year flood of the Todd River in March 1988, resulted from the merged effect of two tropical depressions that combined as they moved inland, producing the highest daily rainfall totals on record (Barlow 1988). The average catchment 6 hour rainfall intensity was 17.7 mm/hour (Barlow 1988).

5.2.4 Soils, Geology, Topography and Hydrography

The region consists of gently-undulating plains sloping generally south with some broken areas with lateritic cappings (Grant 1994).

The catchment forms an elongated basin with relief to 30 m draining via the Todd River and Station Creek, a discrete subcatchment. These watercourses exit the area via two narrow gaps in the low rocky hills, which form its southern boundary. The study area is bounded to the north by a broad gilgaied alluvial plain adjacent to the 16-Mile Creek floodplain, and to the north-west by plains supporting mulga woodland.

The rivers of the arid zone are usually dry but rise rapidly to flood levels after substantial rain. The annual average recorded flow of the Todd River is 60 Mm^3 (Hooper *et al.* 1987).

A general guide to the soils likely to occur in the study area is provided by the land system descriptions of (Perry 1962) who described red earths and texture-contrast soils as predominant on both Alcoota and Chisolm land systems. Limited occurrences of red, coarse structured clays, shallow stony soils and calcareous earths are also indicated. Moore (1981) rated all soils within the upper catchment as having a very high or extreme erosion hazard. Relief ranges from 609–807m (Figure5.3).

Figure 5.3 Relief and major drainage systems within the Upper Todd River Catchment

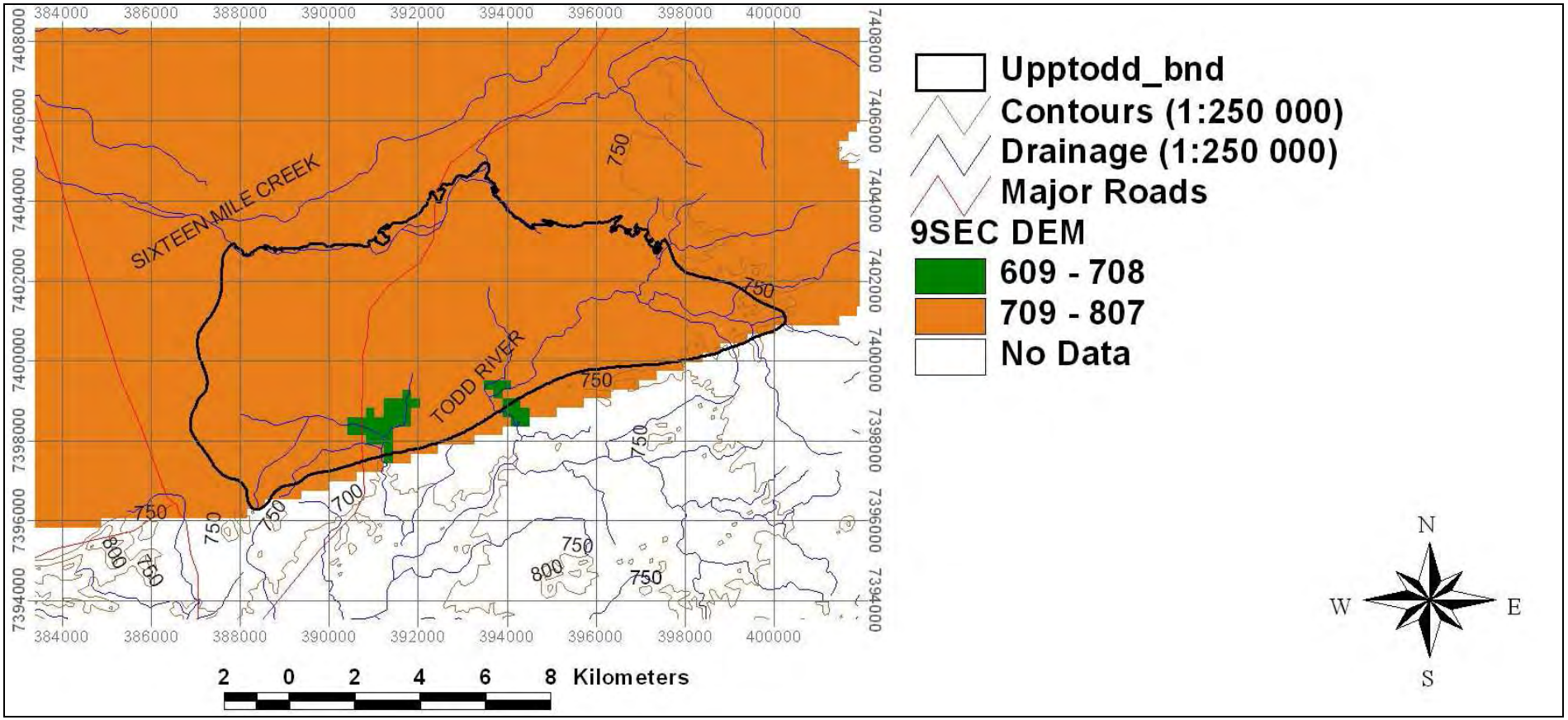
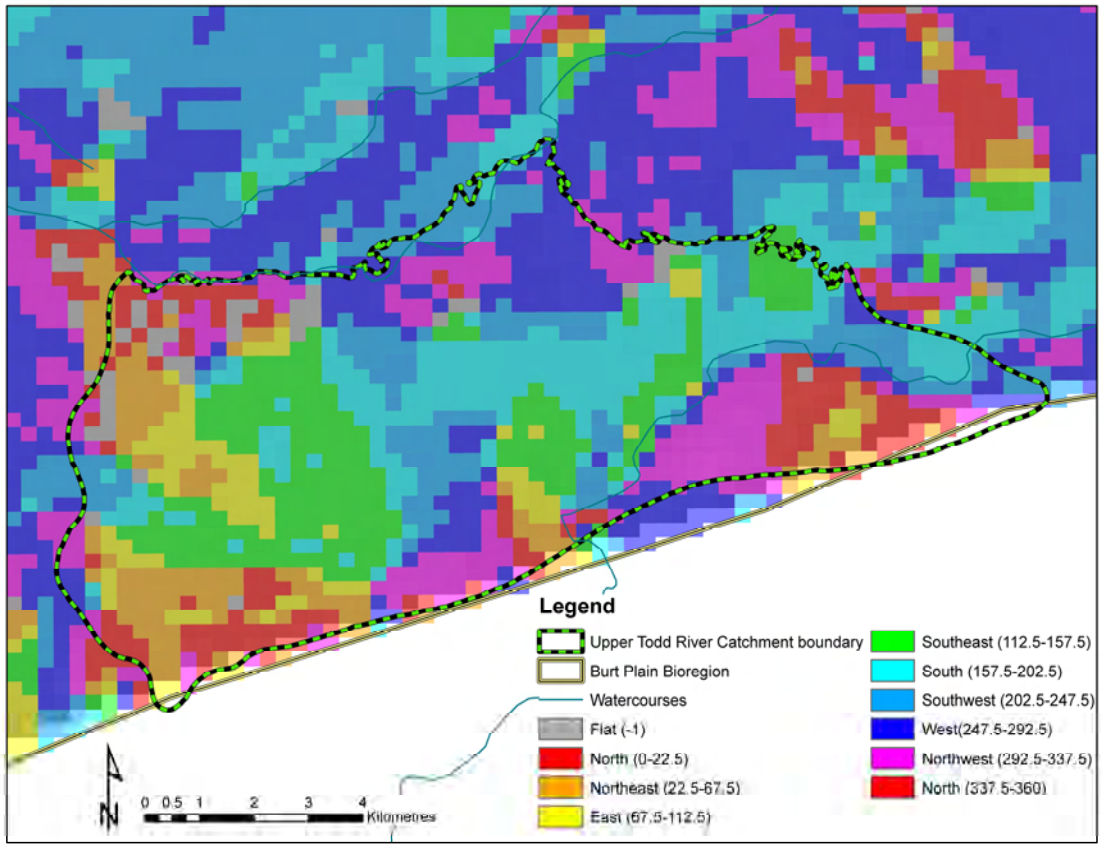


Figure 5.4 Aspect (derived from 9 SEC DEM) of topography within the Upper Todd River Catchment; aspect classes are based on the variation in degrees from true north shown in brackets.



5.1 METHODS

5.1.1 Spatial Datasets

Vegetation

Information on vegetation types is based on (Wilson *et al.* 1990), who mapped NT vegetation types at 1:1 000 000 scale, defining 112 mapping units or vegetation communities. Mapping units were interpreted after recognition of vegetation patterns on Landsat (bands 4, 5 and 7), with reference to existing vegetation and land resource maps and some 1:500000 Landsat imagery (Wilson *et al.* 1990). Modification of the mapping units were carried out after three years of field work, data analysis and re-interpretation, with further reference to geological, topographic and existing vegetation maps.

Each mapping unit was classified based on a scheme recommended by (Dickinson & Kirkpatrick 1985), and guidelines adopted by the Australian Biological Records Scheme (ABRS) in 1975, and other broad scale surveys such as (Carnahan 1976) and (Boyland 1984). The scheme is based on structure of major strata combined with dominant and/or characteristic species from each layer (Wilson *et al.* 1990).

Digital Elevation Model (DEM)[1]

The Australian Surveying and Land Information Group's (AUSLIG) standard product 'GEODATA 9 Second DEM Version 2' was used as a base Digital Elevation Model (DEM) for my research. A summary of this DEM is provided in Chapter 4, section 4.3.

Climate Surfaces

The five climate surfaces used here were derived from the software package ANUCLIM Version 5.0[2] which had been previously generated by the ANUSPLIN[3] package (Hutchinson 1999) from long-term monthly averages of the climate variables at fixed points within the region ANUCLIM is further described in section 4.3 of Chapter 4.

Land Systems and Land Resource Data (Land Unit Mapping)

The former Department of Lands, Planning and Environment (DLPE) made available Land Resource data and associated reports pertaining to the Upper Todd River catchment. A full description of the land units mapped is shown in Appendix 2. Table 5.1 summarises the metadata for the polygon coverage.

[1] A topographic surface arranged in a data file as a set of regularly-spaced x,y,z locations where z represents elevation.
[2] ANUCLIM is a software package of programs developed by the Centre for Resource and Environmental Studies (CRES) at the Australian National University (ANU) – see http://cres.anu.edu.au.
[3] The climate surface coefficient files are produced from irregular networks of actual meteorological variables by the ANUSPLIN package , a separate package to ANUCLIM.

Table 5.1 Summary of metadata for Upper Todd River catchment land unit mapping.

Upper Todd River Catchment - Bond Springs

Location	25 North of Alice Springs
Area	85 km^2
Scale	1:15 000
Method	Stereo-interpretation of 1:15 000 aerial photographs and extensive on-ground survey
Date	December 1994
Number of Land Units	32
Report	Grant 1994
Positional accuracy	Derived from 1:100,000 base maps & GPS
Lineage	Verified linework transferred from mapping on 1:15,000 aerial photography to a 1:15,000 print (on film) of 1:100,000 & 1:250,000 topographical information
Extent rectangle	Xmin = 133.87 degrees, Ymin = 23.54 degrees, Xmax = 134.03 degrees, Ymax = 23.45 degrees
Number of polygons	691 polygons
Geographics	AGD66

Tenure

The Northern Territory Tenure – 1995 spatial data were derived from the Department of Lands, Planning and Environment tenure database. Details of this database are given in section 4.3 of Chapter 4.

Geology and soils

The Bedrock Geology Theme is one of five themes or layers constituting the digital version of the 1976 edition of the 1:2500000 scale map, Geology of Australia. The Bedrock Geology Theme was derived from the black line-work on the original published hard copy map. The master cover is an ARC/INFO® double precision polygon cover with full topology, in

geographic coordinates (latitude and longitude (Double precision ARC/INFO® covers store each coordinate with up to 15 significant digits.) An ARC/INFO® single precision version is also available (in which each coordinate is stored with up to 7 significant digits). The cover is in geographic projection, DD units, Spheroid CLARKE1866. Positional accuracy is 1 km to 10 km.

Only two geological attributes are maintained in the coverage of the Bedrock Geology Theme. They are stored in the polygon attribute table (cover_name.pat) which accompanies the ARC/INFO® coverage. One of them, called 'map_unit', is essentially the same as the map unit code which appeared on the published hard copy map - minor differences being the result of avoidance of non-ASCII characters. The other, called 'map_code', is a numerical equivalent of the first. There is a one to one correspondence between the values of map_unit and the values of map_code. Additional attributes are provided in a lookup table, cover_name.lut.

The lookup table (cover_name.lut) provided with the ARC/INFO® coverage includes information about the map units published in the geological legend on the original hard copy map. Specifically, it gives the radiometric age in million years ('age'), the geological age ('period') and the geological description ('text'). In addition, there is a broad grouping of map units by geological age and rock type ('geology') and a numerical equivalent of this

summary item which could be used to shade a simple, small scale, hard copy map ('symbol').

The Digital Atlas of Australian Soils (the 'Digital Atlas') is a digital version of the set of ten maps, compiled by K H Northcote *et al.* and published in 1960 - 68 by CSIRO and Melbourne University Press in Melbourne, known as the 'Atlas of Australian Soils, Sheets 1 to 10, with explanatory data'. The Digital Atlas was created by the National Resource Information Centre (NRIC), now Advanced Research and Development Centres (ARDC)* in 1991 from scanned tracings of the published hardcopy maps.

The published hard copy maps were at a scale of 1:2000000 although it is known that original compilation work was done at 1:250000 and 1:500000 scales. The use of the hardcopies was necessary, as the original printer's separates could not be located. This introduced a source of error due to paper stretch and errors due to drafting accuracy but extensive cross-checking, editing and error tracking were performed to limit the effects of these errors. If required, the 'rms' errors can be supplied.

The digital maps derived from the separate hard copy maps constituting the Atlas of Australian Soils were merged to form a single, topologically structured, Australia-wide polygon coverage. Attribution (map labelling) inconsistencies were remedied, for example, where upper and lower case

characters or l's and 1's had been confused. The earliest hard copy maps were provided in polyconic projection and the later ones in simple conic, however the Digital Atlas is maintained using geographical coordinates (longitude/latitude). The Digital Atlas is available as a double precision ARC/INFO® coverage (which means that each coordinate is stored with up to 15 significant digits) but a single precision derivative is also available (in which each coordinate is stored with up to 7 significant digits). The notional scale of the data set is 1:2000000. Consideration of this limitation is especially necessary if the data set is used for regional analyses.

Only two soil attributes are maintained in the Digital Atlas coverage. They are stored in the polygon attribute table ('<cover_name>.pat') which accompanies the ARC/INFO® coverage. One of them, called 'map_unit', is the soil landscape alphanumeric identifier which appeared on the published hard copy maps. The other, called 'map_code', is a numerical equivalent of the first. There is a one to one correspondence between the values of map_unit and the values of map_code. Additional attributes are provided in a lookup table, '<cover_name>.lut'.

The lookup table ('<cover_name>.lut') provided with the ARC/INFO® coverage indicates, for each soil landscape, the *dominant* soil type according to the soil classification system described by K H Northcote in the various editions of his *'A Factual Key for the Recognition of Australian Soils'* (the 4th

edition of which was published by Rellim in Adelaide, South Australia, in 1979). More specifically, the lookup table gives the dominant soil types by their class, section and principal profile form ('ppf') according to Northcote's classification. The lookup table also gives a shading symbol ('symbol') that can be tailored accordingly using GIS to produce a simple plot showing the Northcote sub-division level for the dominant soil type of each soil landscape.

It is stressed that the mapped units in the Digital Atlas are soil landscapes and that each soil landscape typically comprises a number - usually more than one - of soil types. The lookup table provided with the coverage only gives one soil type for each landscape (the dominant one). Associated soils in the mapped units can be as important as the dominant soil, or more so, depending on the application.

5.1.2 Software and Hardware

Details of software and hardware used here are given in section 4.3 of Chapter 4.

5.1.3 Data Analysis

Before any further analysis could be undertaken, a number of steps had to be taken to amend the data righto an appropriate format for ARC/INFO. Firstly, the majority of the data was supplied in ARC/INFO export format (*.e00) or

ArcView shapefiles, with the exception of the climate surfaces (as described in Section 4.3.1) and the Landsat TM7 image files which were in ER Mapper (v6.0) format. To create ARC/INFO coverages from the *.e00 files for further use and analysis the ARC: IMPORT command was used. ArcView shapefiles were also converted to ARC/INFO coverages using the ARC command SHAPEARC. All of the data was already projected in a geographical coordinate system 1966 Australian Geodetic Datum (AGD-66) spheroid, that is, with latitudinal and longitudinal values.

Using ARC/INFO the majority of coverages were clipped to the Burt Plain bioregion (using the ARC command CLIP), as subsetting the data would save on processing time in further spatial analyses. Once clipped, various topological overlays were performed. Using the IDENTITY command, the output coverage from this process preserved all the input features plus those portions of the polygon coverage that overlapped the input coverage (Figure 4.3.1). Input features, preserved in the output data set, also received attribute of the polygons they intersect.

5.4 RESULTS

5.1.1 Nature and distribution of mulga

There are three broad vegetation communities in the Upper Todd River Catchment (as delineated by the 1:1000000 Northern Territory Vegetation

Types Map (Wilson *et al.* 1990)) (Figure 5.5, Table 5.2). The three broad vegetation communities are:

A. Mapping Unit 65 - *Acacia aneura* (Mulga) tall open-shrubland with *Eragrostis eriopoda* (Woollybutt) open-grassland understorey, which covers an area of 130 hectares or 1.5% of the catchment;

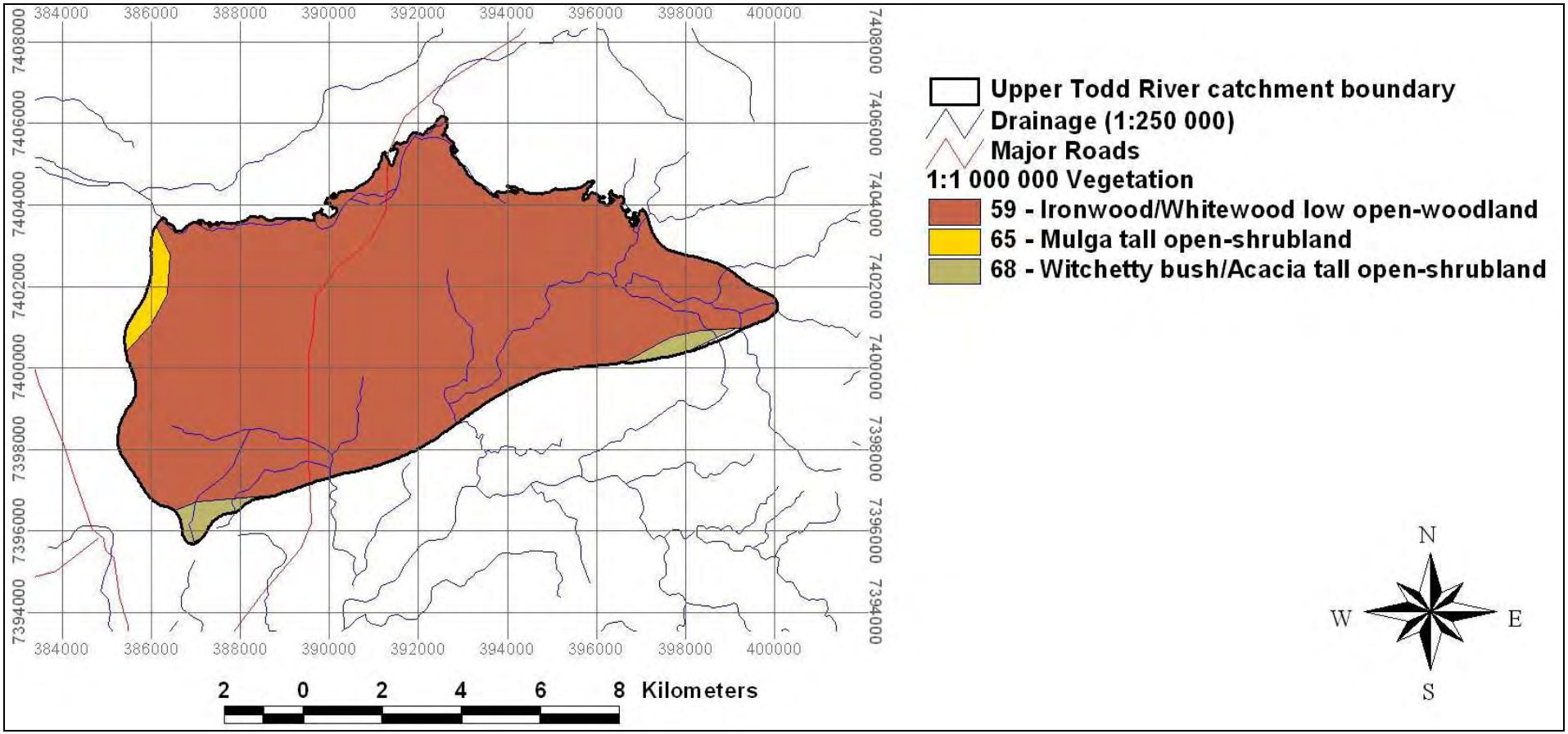
B. Mapping Unit 59 – *Acacia estrophiolata* (Ironwood), *Atalaya hemiglauca* (Whitewood) low open-woodland with open-grassland understorey, which covers an area of 8274 hectares or 96.4% of the catchment; and

C. Mapping Unit 68 – *Acacia kempeana* (Witchetty bush) Acacia tall open-shrubland with Cassia, *Eremophila* spp. (Fuschia) open-shrubland understorey, which covers an area of 180 hectares or 2.1% of the catchment.

Table 5.2 Distribution of broad vegetation communities found in the Upper Todd River catchment

Map Unit	Area (ha) in Upper Todd	%	% in Burt Plain	Area (ha) in Burt Plain
59	8274	96.4	12.3	919 927.5
65	130	1.5	37.0	2 771 054.3
68	180	2.1	2.7	202 942.0

Figure 5.5 Broad vegetation communities found within the Upper Todd River catchment



5.4.2 Climate

The study area was analysed against major climatic gradients listed in Table 5.3. Major climatic gradients were then compared with the entire Burt Plain bioregion. The average rainfall and average raindays, total annual raindays and elevation were all greater than the Burt Plain mean, whereas all other climatic gradients were less than the Burt Plain mean (Table 5.3). Figures 5.6 – 5.17 on the following pages further display the distribution of climate across the study area.

Table 5.3 Summary of climatic gradients across the Upper Todd River catchment

Major Gradients	**Min**	**Max**	**Mean**	**Burt Plain comparison**
Mean Annual Maximum Temperature (°C)	26.9	27.3	27.2	-
Mean Annual Minimum Temperature (°C)	11.8	12.2	12.1	-
Mean Annual Temperature (°C)	19.4	19.7	19.6	-
Average Temperature Dry Season (°C)	13.9	14.3	14.2	-
Maximum Temperature Dry Season (°C)	21.5	21.9	21.8	-
Minimum Temperature Dry Season (°C)	6.4	6.7	6.6	-
Average Temperature Wet Season (°C)	24.7	25.1	25.0	-
Maximum Temperature Wet Season (°C)	32.3	32.7	32.6	-
Minimum Temperature Wet Season (°C)	17.2	17.6	17.5	-
Total Annual Rainfall (mm)	263.5	275.6	267.9	-
Average Rainfall Dry Season (mm)	12.2	12.9	12.3	+
Average Rainfall Wet Season (mm)	31.7	33.2	32.3	-
Mean Annual Rainfall (mm)	21.9	22.9	22.3	-
Total Annual Raindays	50.8	53.0	51.6	+
Average Raindays Dry Season	3.1	3.3	3.2	+
Average Raindays Wet Season	5.3	5.5	5.3	+/-
Total Annual Evaporation (mm)	2817.4	2859.0	2845.1	-
Average Evaporation Dry Season (mm)	154.2	157.0	156.3	-
Average Evaporation Wet Season (mm)	315.3	319.5	317.9	-
Mean Annual Evaporation (mm)	234.8	238.2	237.1	-
Elevation	700.5	773.5	726.1	+

\+ Greater than Burt Plain bioregion mean
\- Less than Burt Plain bioregion mean
+/- Same as Burt Plain bioregion mean

Figure 5.6 Mean Annual Evaporation (mm) for the Upper Todd River Catchment

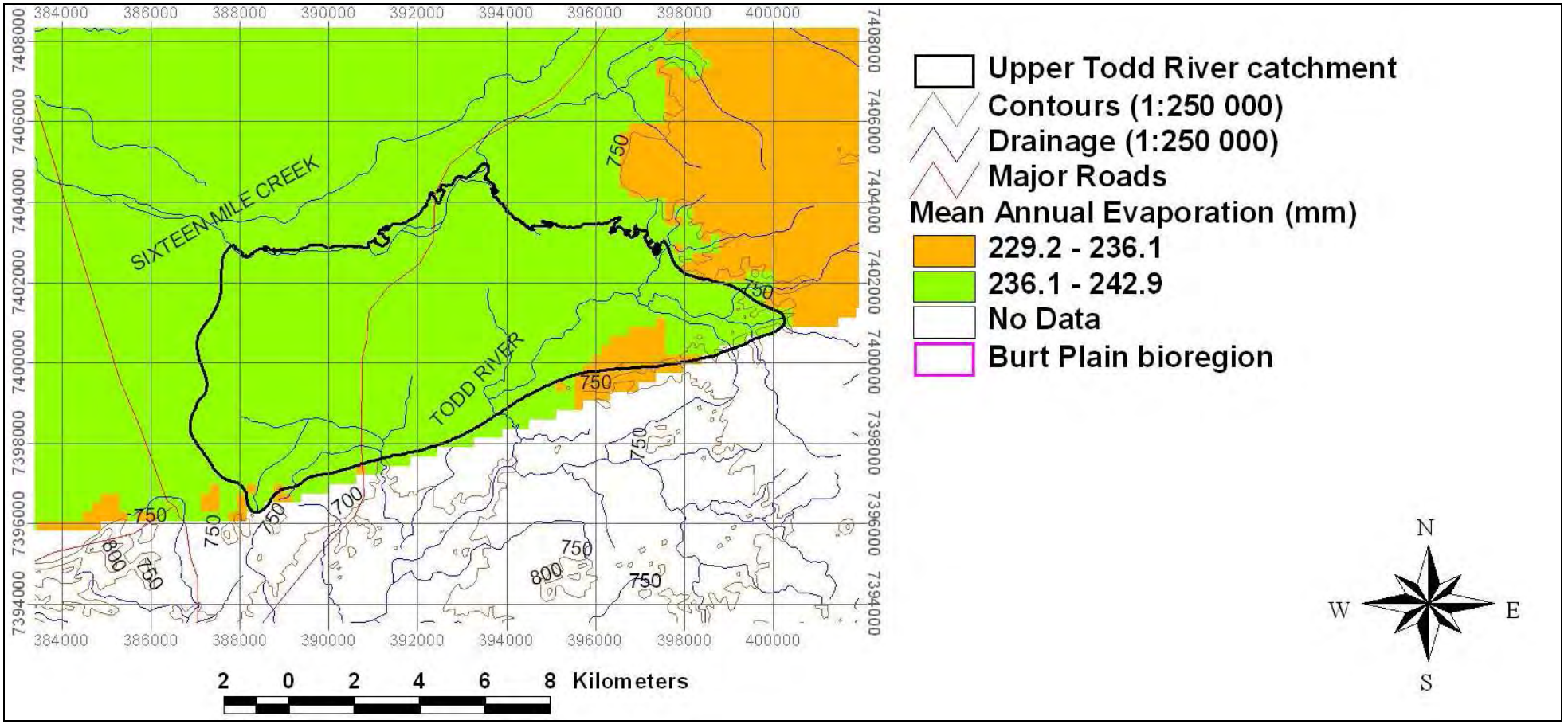


Figure 5.7 Mean Evaporation (mm)– Wet Season (October – March) for the Upper Todd River Catchment

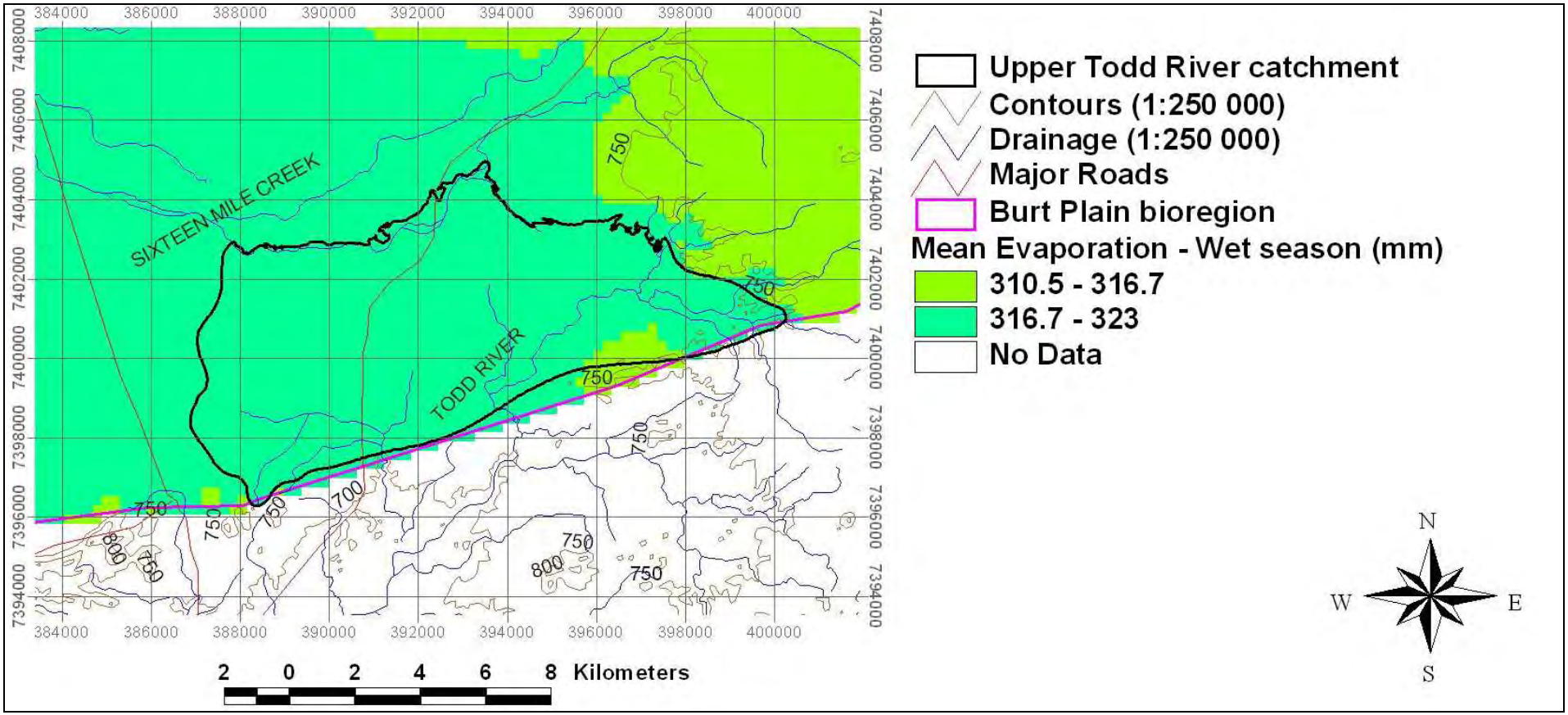


Figure 5.8 Mean Evaporation (mm) – Dry Season (April – September) for the Upper Todd River Catchment

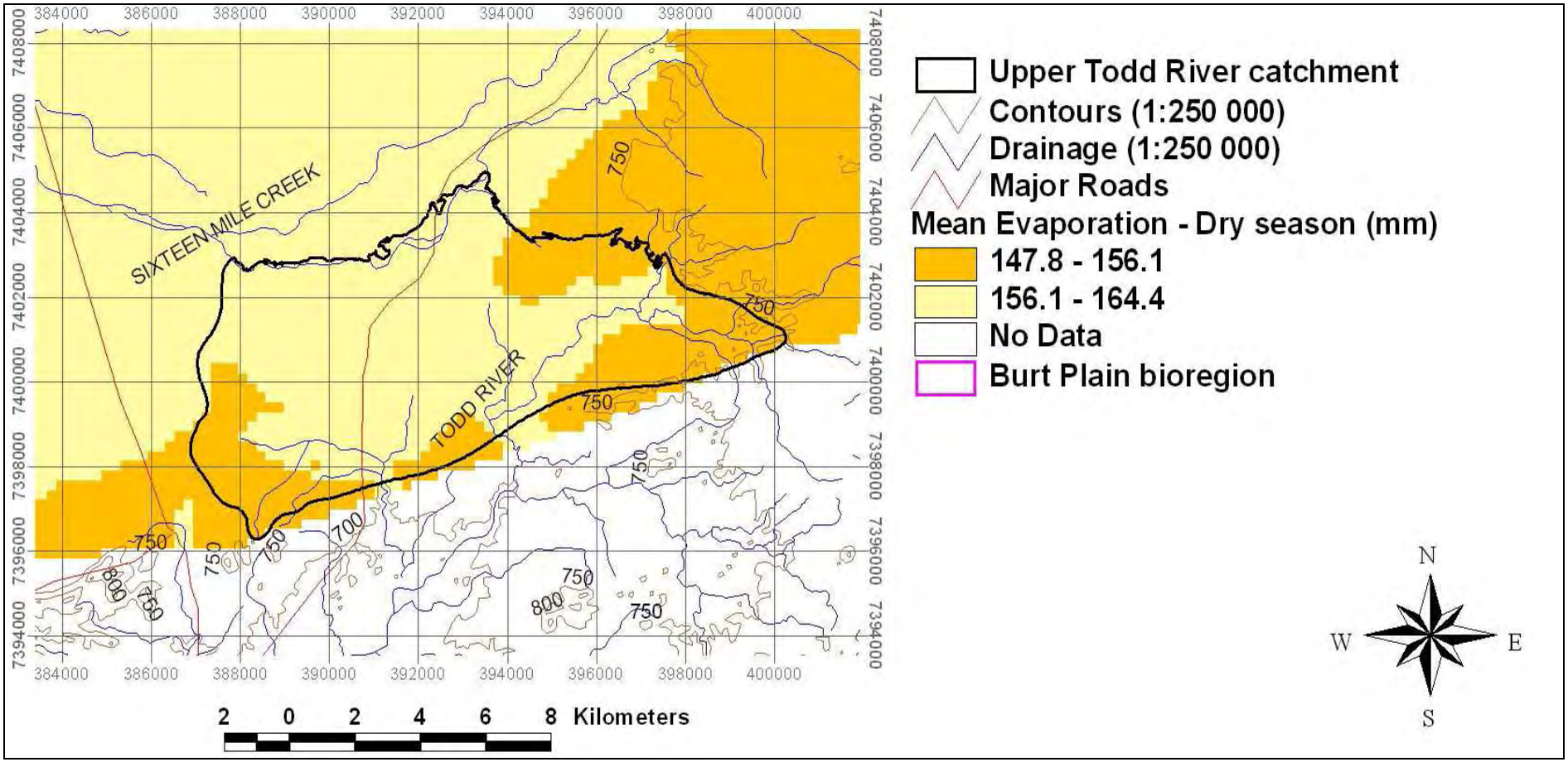


Figure 5.9 Mean Annual Raindays for the Upper Todd River Catchment

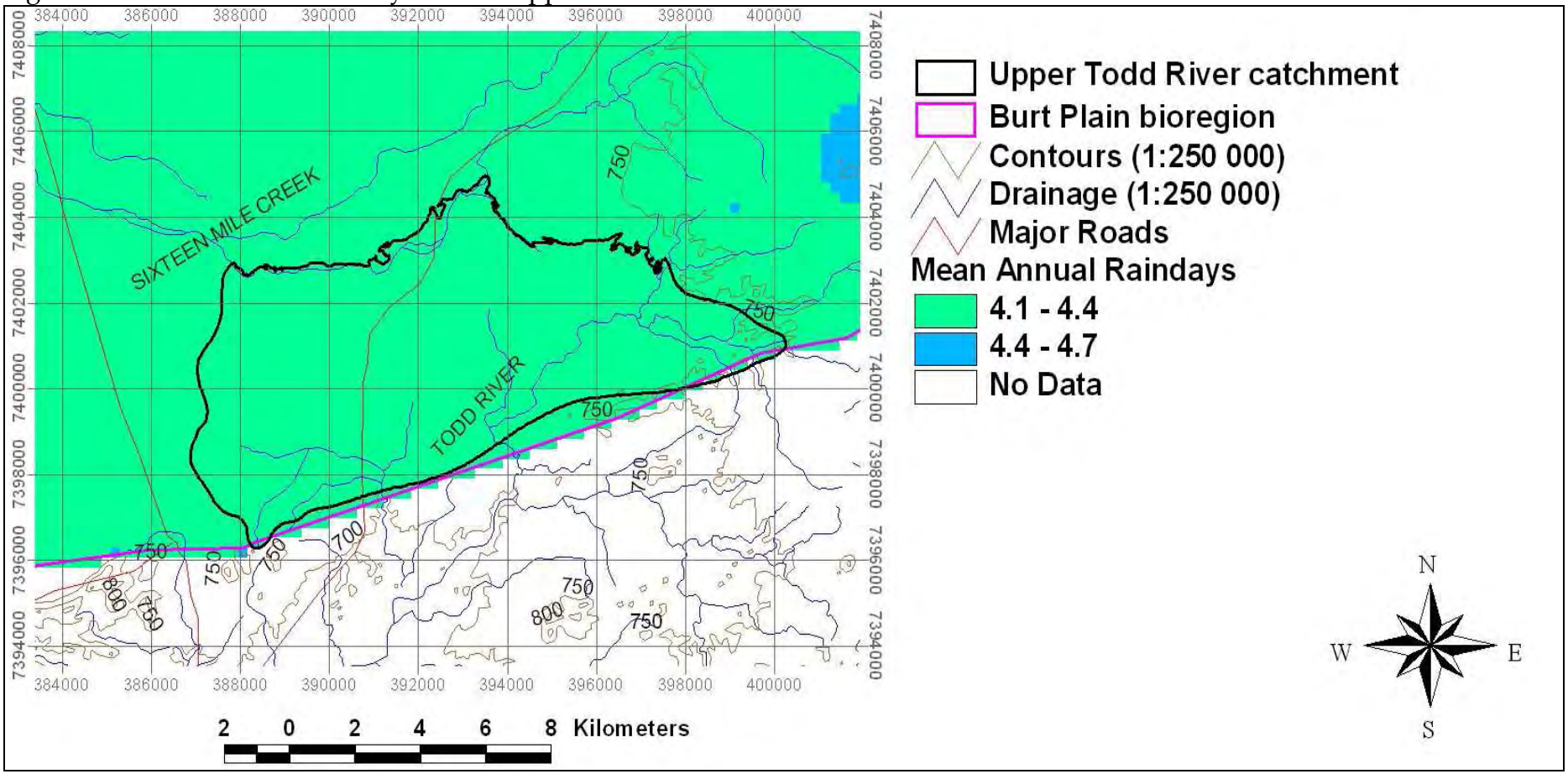


Figure 5.10 Mean Raindays – Wet Season (October – March) for the Upper Todd River Catchment

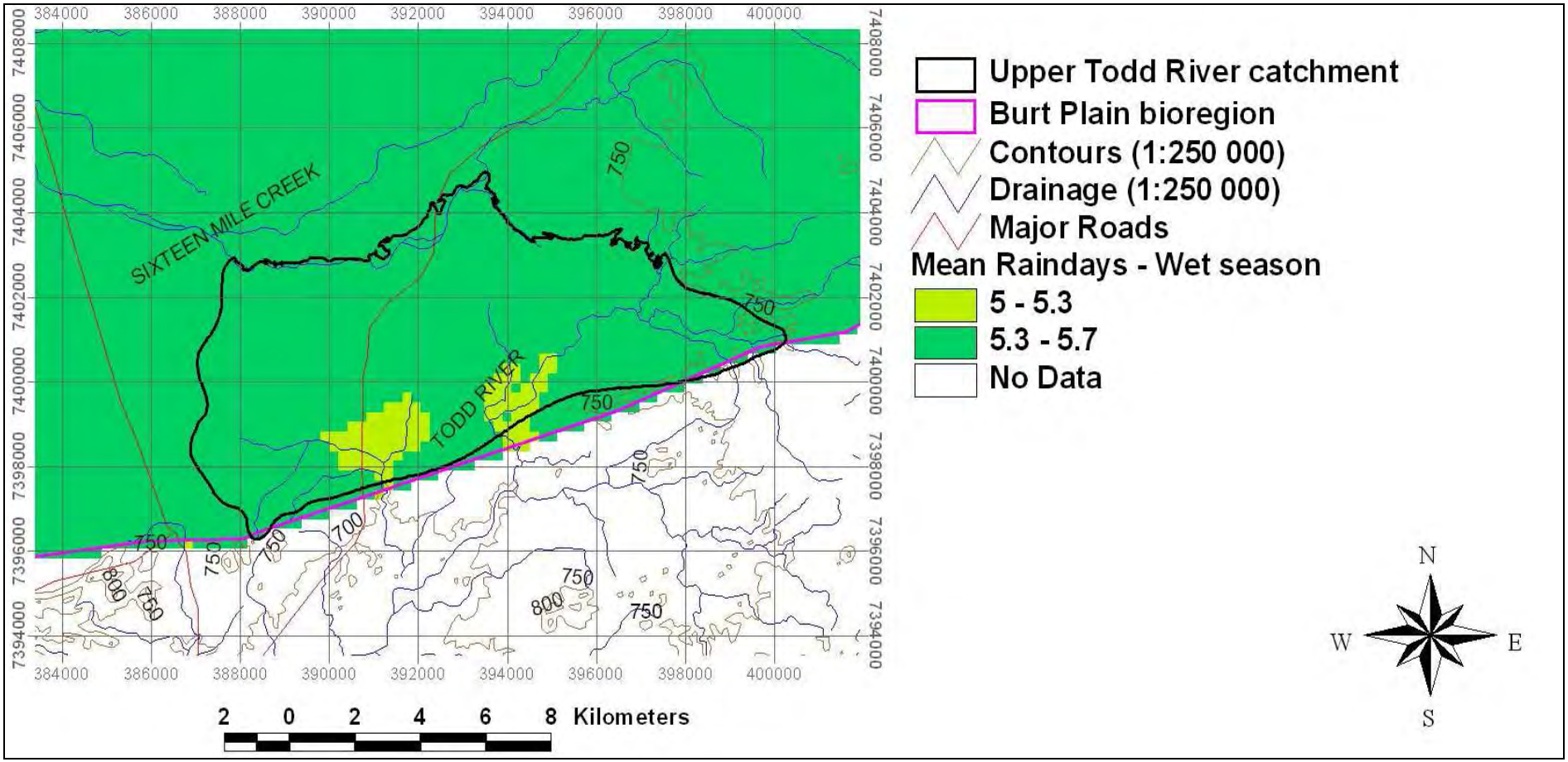


Figure 5.11 Mean Raindays – Dry Season (April – September) for the Upper Todd River Catchment

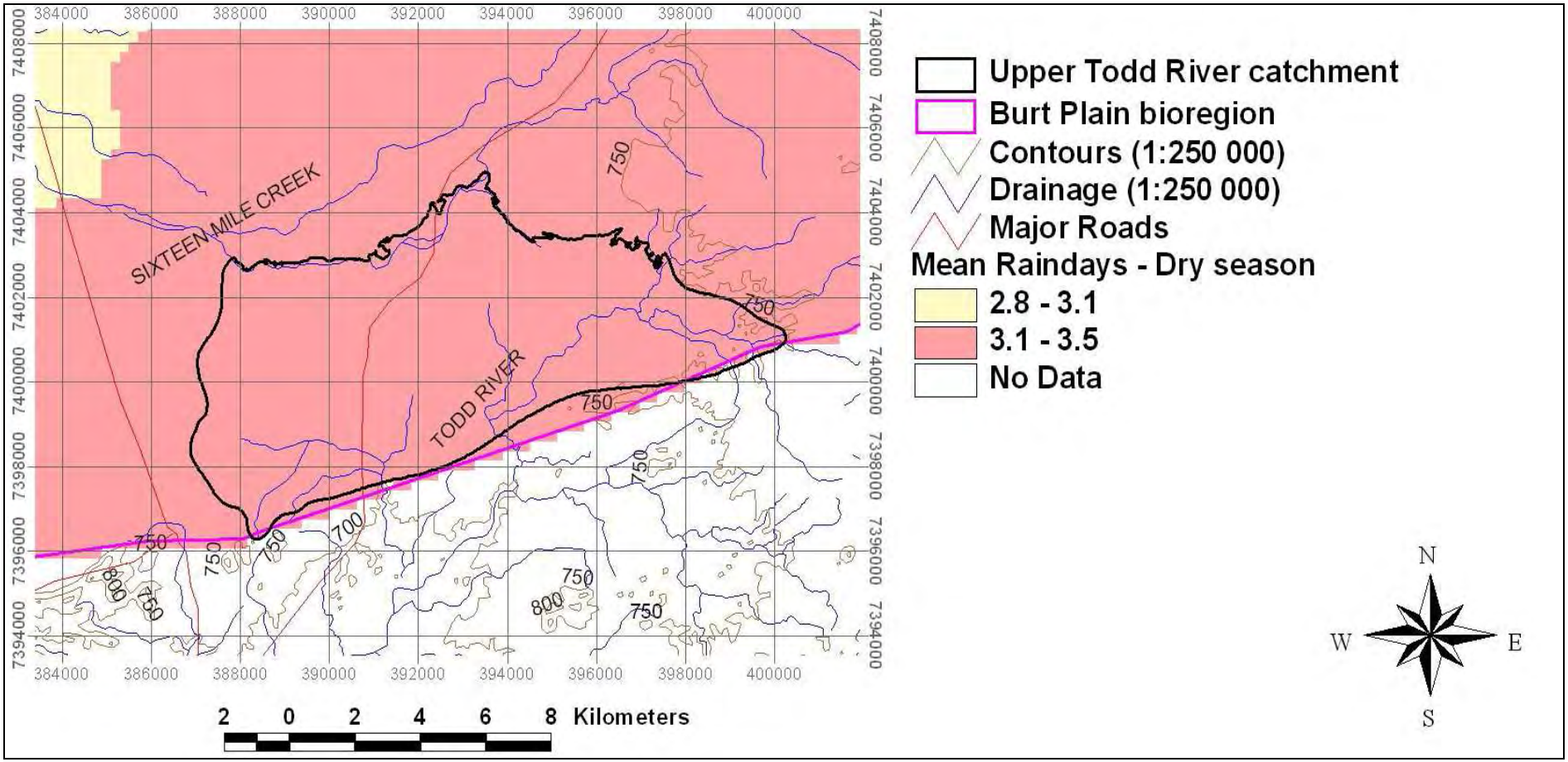


Figure 5.12 Mean Annual Maximum Temperature (°C) for the Upper Todd River Catchment

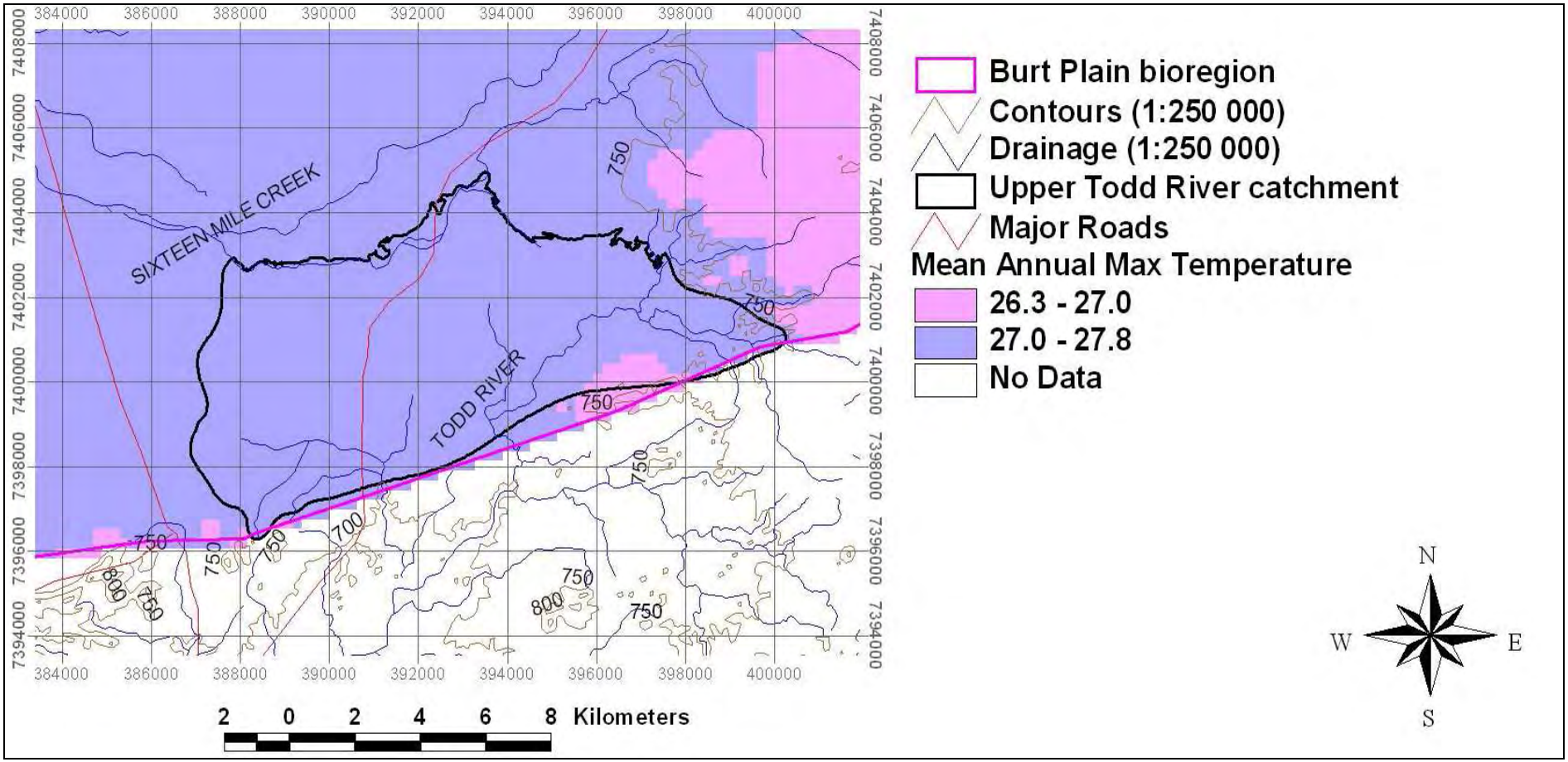


Figure 5.13 Mean Maximum Temperature (°C) – Wet season (October – March) for the Upper Todd River Catchment

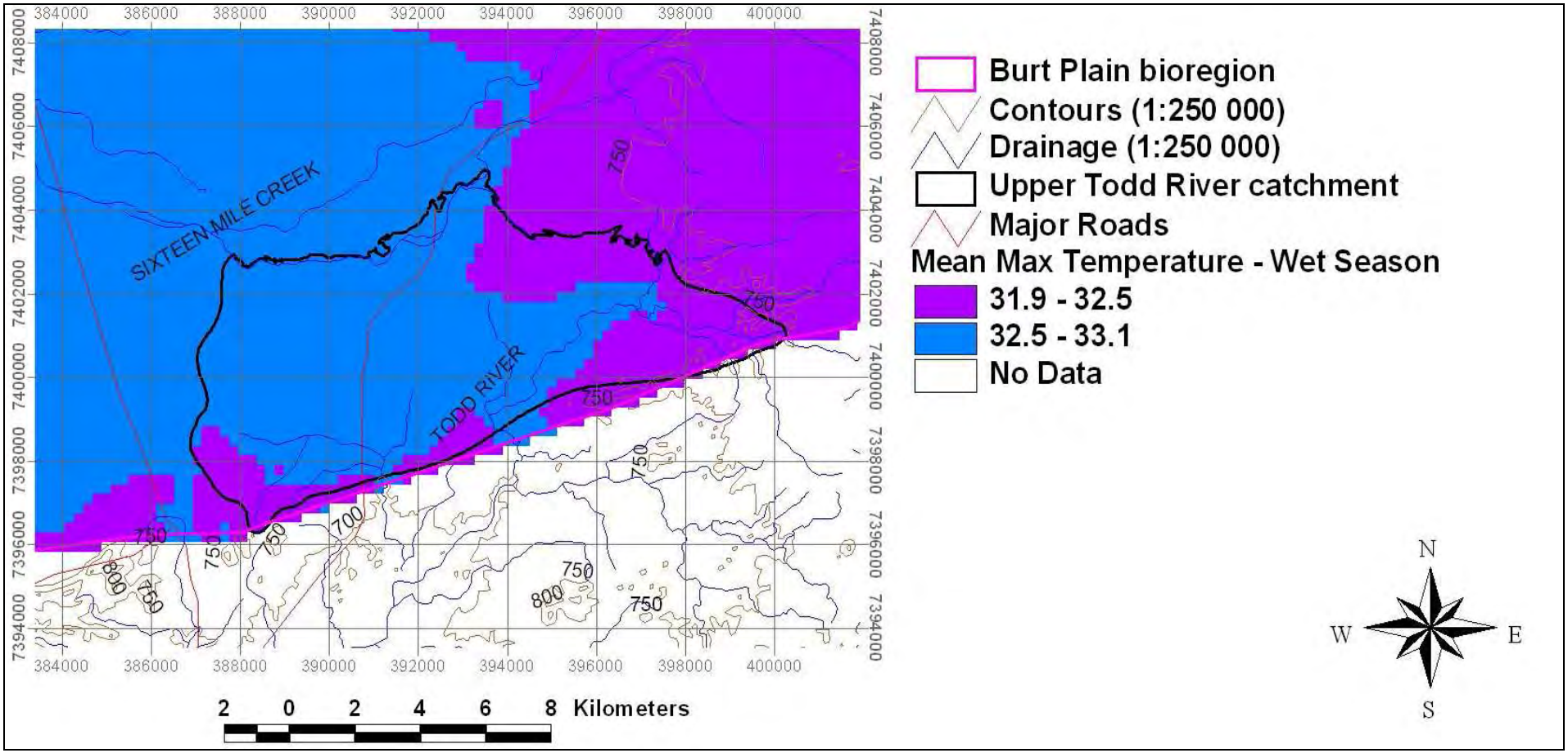


Figure 5.14 Mean Maximum Temperature (°C) – Dry season (April – September) for the Upper Todd River Catchment

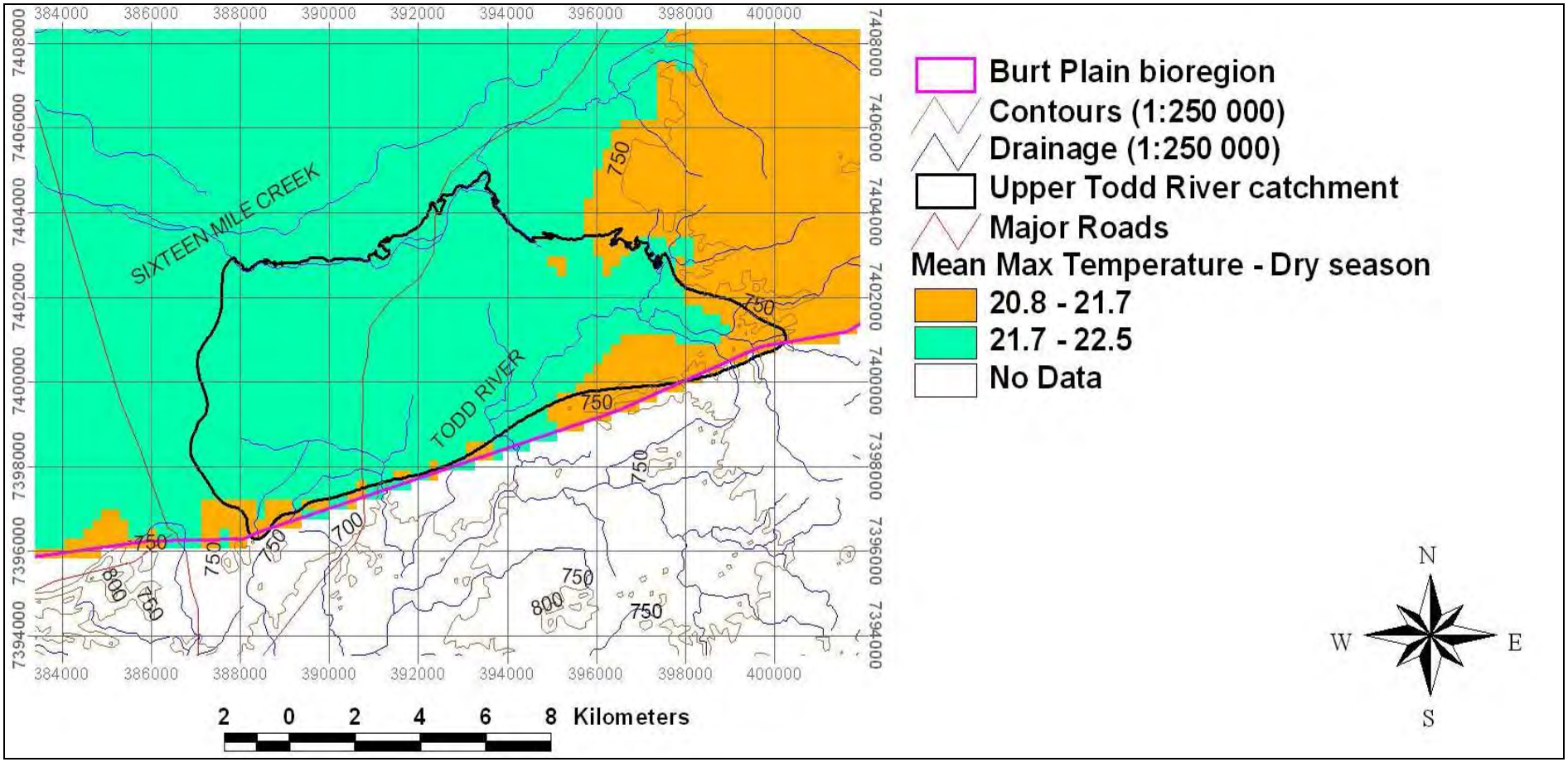


Figure 5.15 Mean Annual Minimum Temperature (°C) for the Upper Todd River Catchment

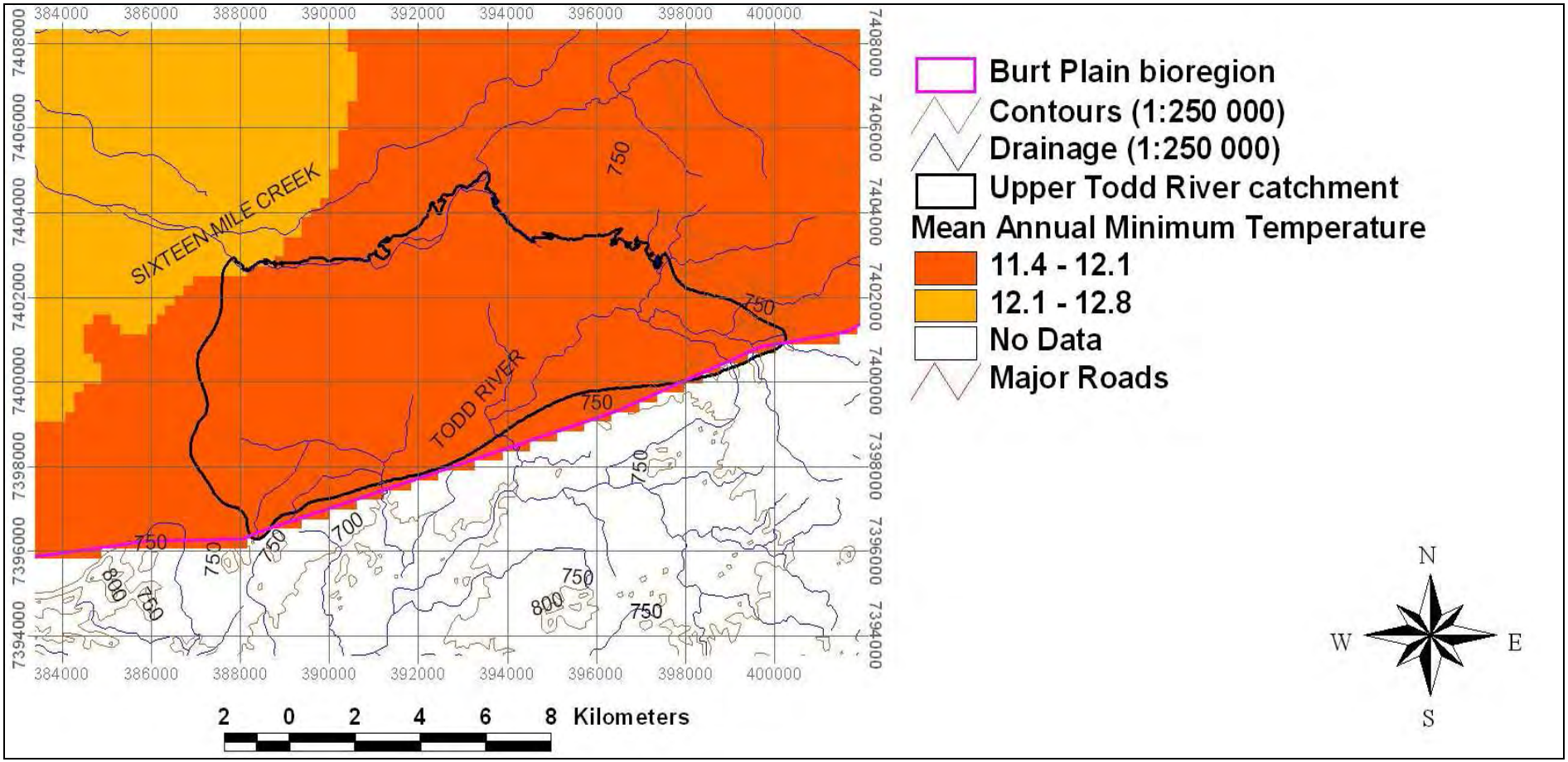


Figure 5.16 Mean Minimum Temperature (°C) – Wet season (October – March) for the Upper Todd River Catchment

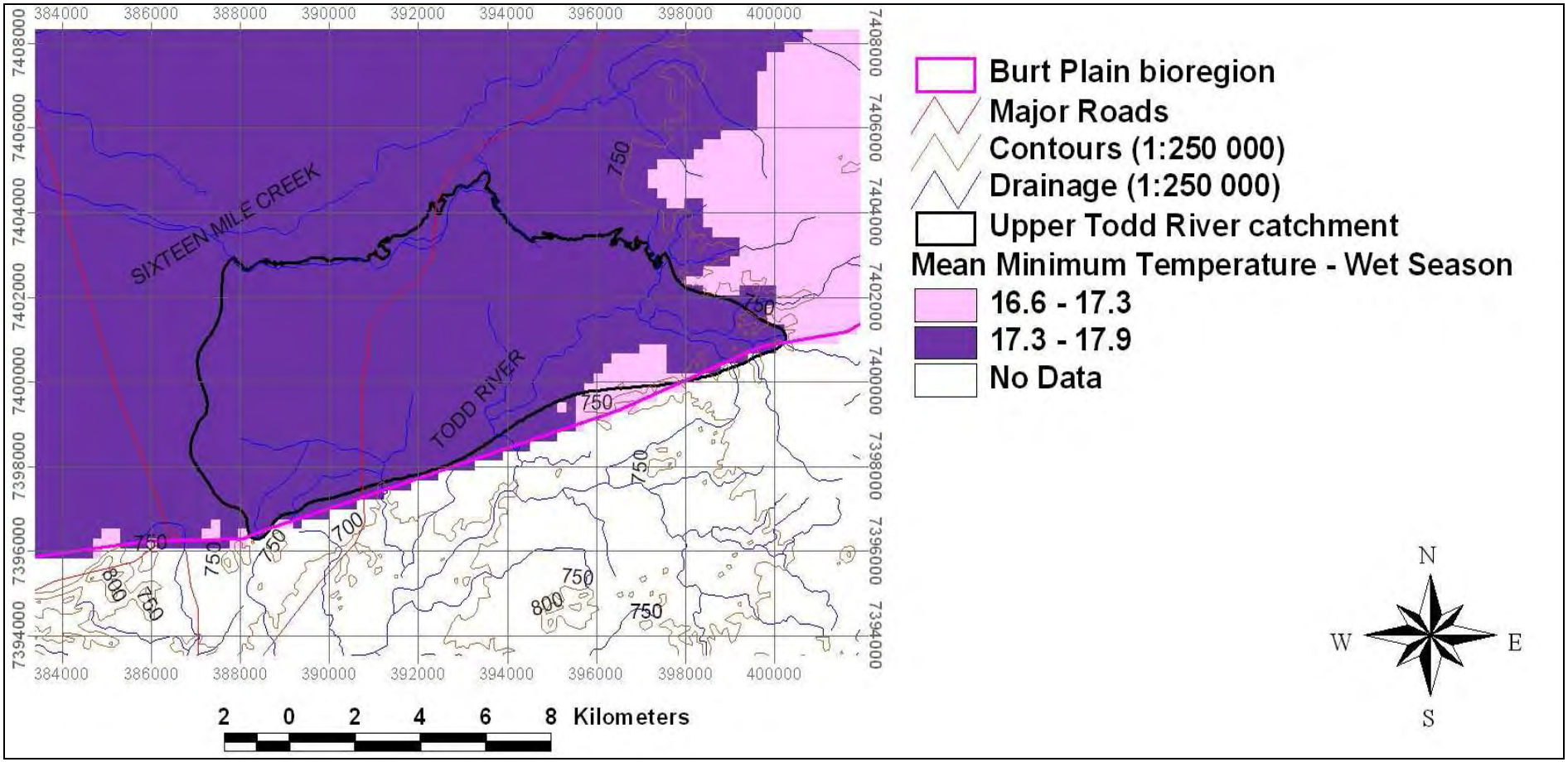
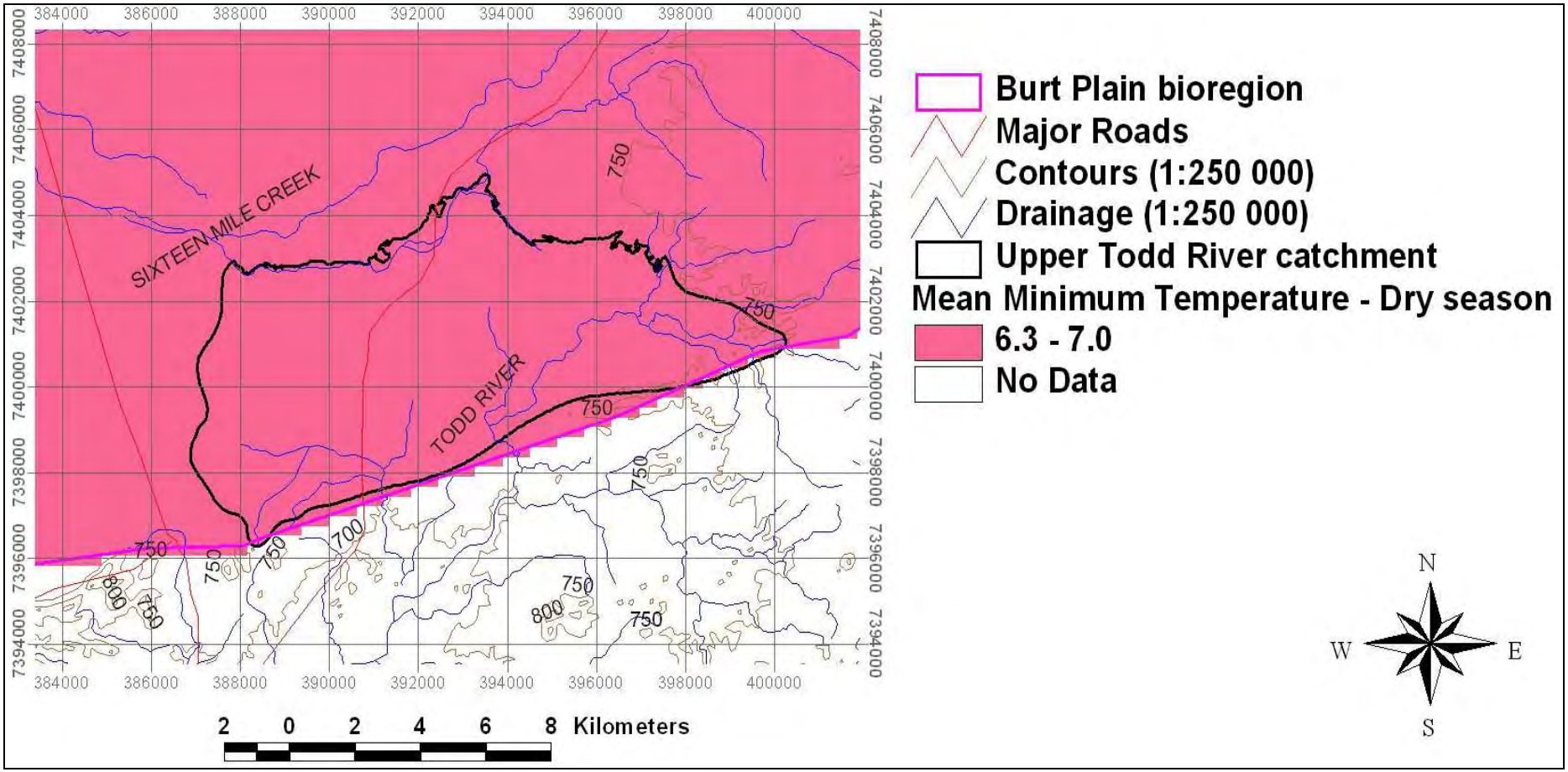


Figure 5.17 Mean Minimum Temperature (°C) – Dry season (April – September for the Upper Todd River Catchment



5.4.3 Soils and Geology

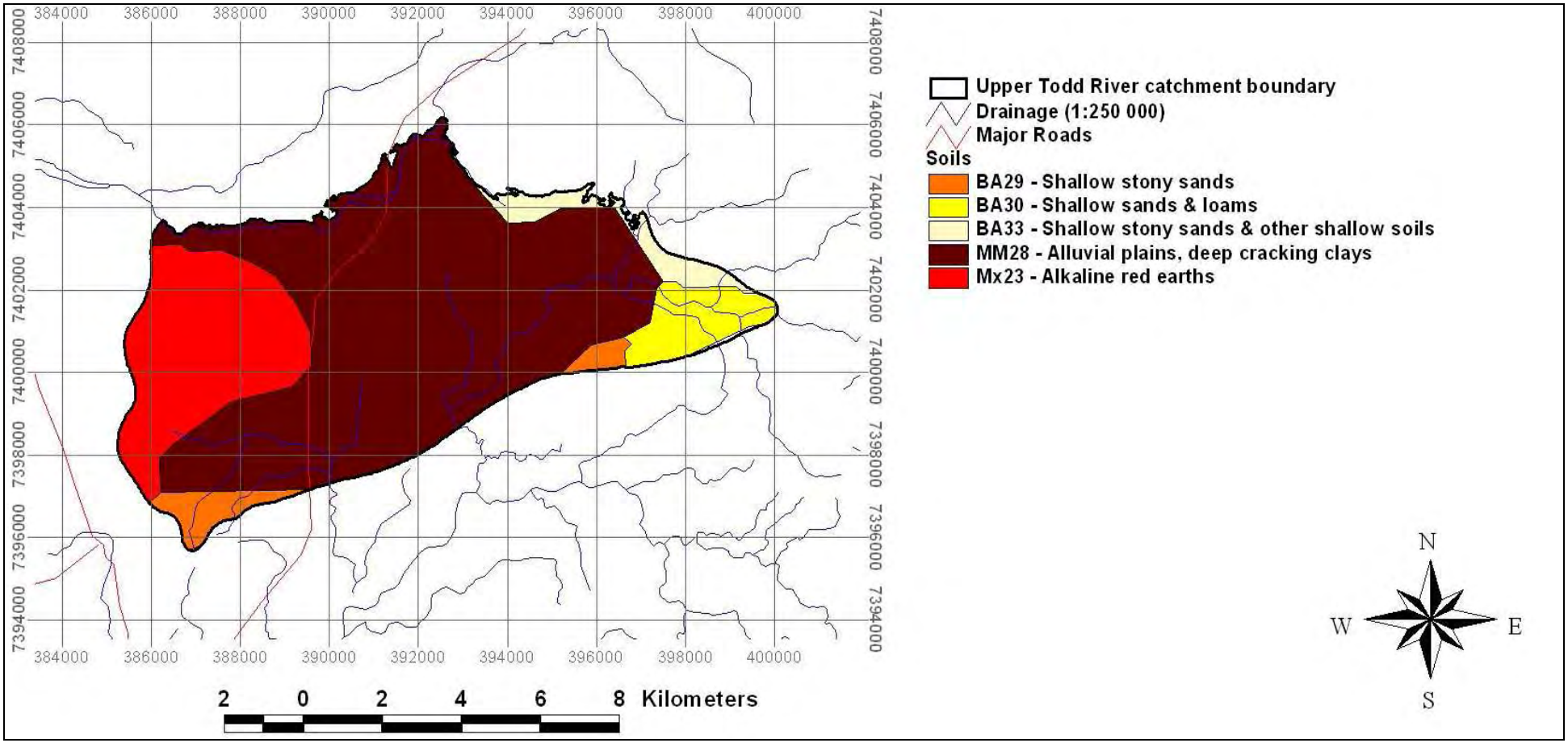
The study area contained five soil units (Table 5.4, Figure 5.18). The dominant soil type (MM28) is described as: alluvial plains: dominant soils are deep cracking clays (Ug5.38), often in gilgai complex with (Dr1) soils such as (Dr1.33) and (Dr1.43) locally prominent. Some (Um 1) and (Uc1) soils occur also. The MM28 soil type occupied 66.9% of the study area or 5739 hectares. The next most dominant soil type (Mx23) is described as: undulating to gently undulating plains with occasional low rises and scarps with some lateritic duricrust: chief soils are alkaline red earths (Gn2.13) soils. Minor soil occurrences include (Dr1) and (Uc) soils. The Mx23 soil type occupied 20.1% or 1723 hectares of the study area.

Table 5.4 Summary of soils found within the Upper Todd River catchment

Soil Code	Area (ha)	% of study area	% of Burt Plain bioregion	Short Description*
BA29	317	3.7	2.7	Shallow stony sands
BA30	468	5.4	1.1	Shallow sands & loams
BA33	332	3.9	0.9	Shallow stony sands & other shallow soils
MM28	5739	66.9	0.7	Deep cracking clays
Mx23	1723	20.1	10.5	Alkaline red earths

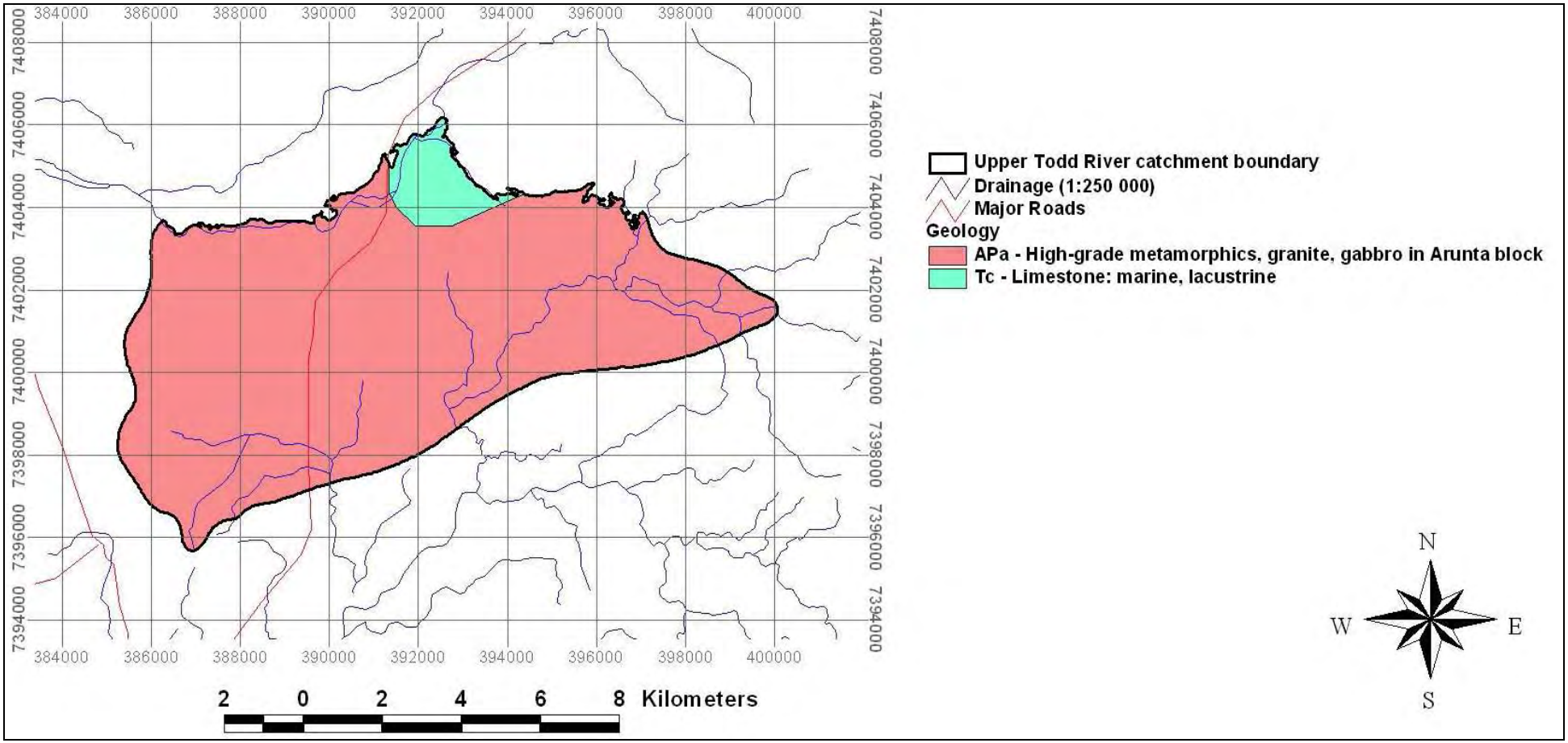
* For full description of soil codes refer to Appendix 4

Figure 5.18 Soils of the Upper Todd River catchment



The dominant geology of the study area was Apa – high-grade metamorphics, granite, gabbro in Arunta block, which covered an area of 8162 hectares or 95% of the area (Figure 5.19). The only other geology described was Tc – limestone: marine, lacustrine, which covered 432 hectares (5%) in the north of the study area.

Figure 5.19 Geology of the Upper Todd River catchment



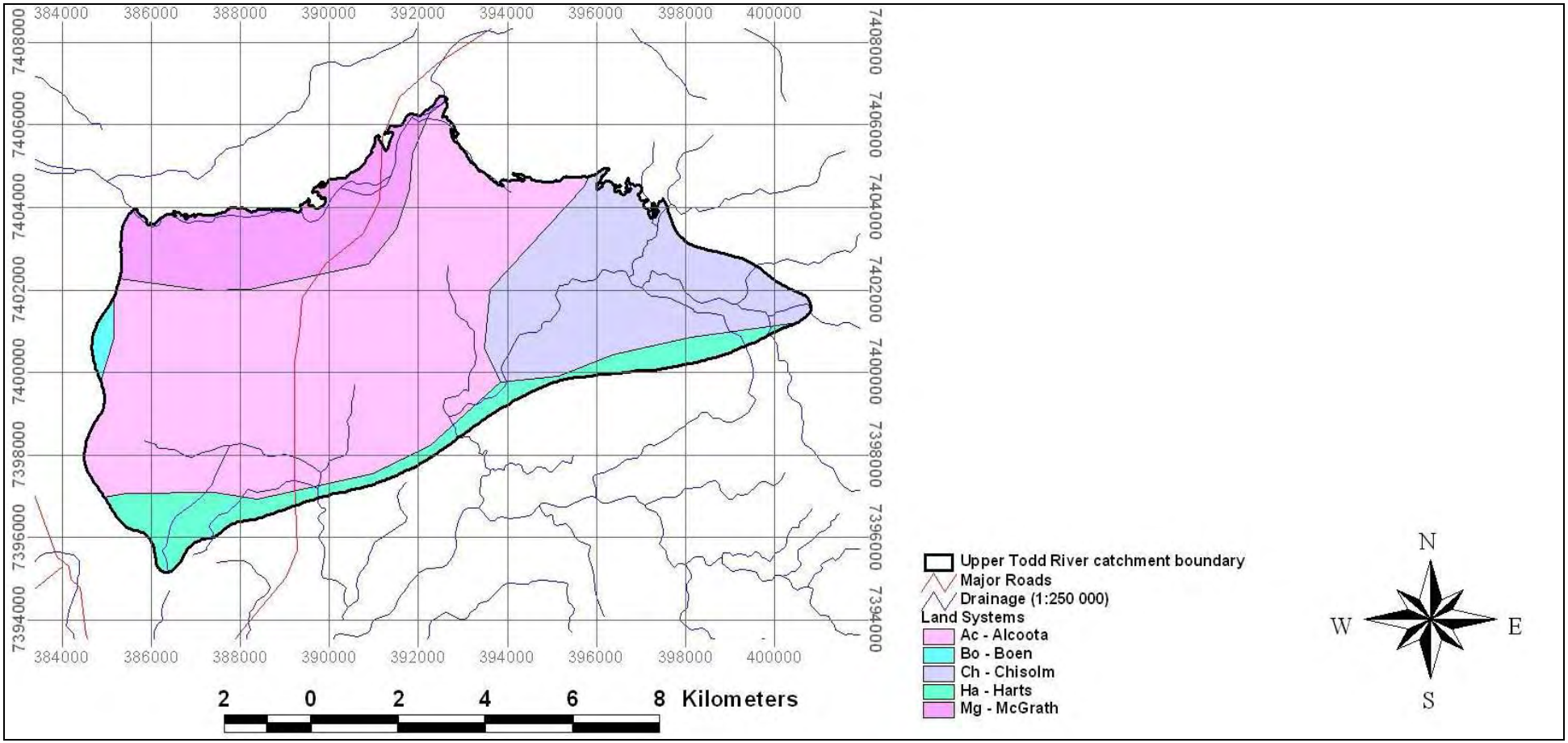
5.4.4 Land Systems and Land Resource Data

Of the 53 1:1000000 land system units mapped in the Burt Plain bioregion, five are found within the Upper Todd River Catchment (Figure 5.20) (Table 5.5). Of these five, the two most dominant land systems are Alcoota (Ac) which covers 4747 hectares (55%) and Chisolm (Ch) 1894 hectares (21%) respectively (Figure 5.21). Perry (1962) described the Alcoota land system as: undulating plains; red earths; mulga over short grasses. Erosional and alluvial slopes; texture-contrast soils, some stony; sparse low trees over short grass or woollybutt. The Chisolm land system is further described by (Perry 1962) as: peneplain; red earths; mulga and short grass. Limestone cappings; calcareous earths; spinifex. Valleys entrenched up to 25m; texture-contrast soils; open with short grass. The next dominant land system is McGrath (Mg) which covers 1198 hectares (14%). The McGrath land system is described as: flood-plains with restricted channel drainage; red earths, some layered alluvial soils, and red clay soils; open or sparse low trees over short grass (Perry 1962).

Table 5.5 Summary of Land Systems in Upper Todd River catchment

Map Unit	Short Description	Area (ha)	% of Upper Todd	% found in Burt Plain
Ac	Alcoota	4727	55	3.4
Ch	Chisolm	1844	21	1.0
Mg	McGrath	1198	14	0.7
Ha	Harts	774	9	2.8
Bo	Boen	52	1	8.9

Figure 5.20 Land systems in the Upper Todd River catchment



Land unit mapping at 1:15 000 was also analysed from DIPE mapping within the study area (refer to methods). Figure 5.22 displays the distribution of the dominant land units which were identified across the Upper Todd River catchment. Tables 5.6 below summarises the more dominant land units/geomorphic units found within the study area, the percentage of land unit which covers the property area, and the area (in hectares) of the dominant land units, a general description and vegetation description.

Table 5.6 Summary of dominant land units mapped for Upper Todd River catchment.

Dominant Map Units	% of catchment	Area (ha)	General Description	Vegetation
4.5	11.0	945	Gentle slopes and plains with banded sheet flow drainage patterns; kandosols/calcareous red earths; a groved woodland of mulga and witchetty bush over annual grasses and grey copperburr.	Within the groves, a low woodland or open woodland of mulga with witchetty bush over a low sparse shrubland of desert fuschia, silver cassia, dead finish and oval-leaf cassia. The groundcover includes woolly copperburr, mulga grass, knottybutt neverfail, grey copperburr, five-minute grass and umbrella grass. The intergrove areas were bare at the time of survey.
4.1	7.8	670	Plains with banded sheet flow drainage features; dermosols/red earths; a groved low woodland of mulga over annual grasses.	A low woodland of mulga in groves with witchetty bush and native fuschia over a low sparse tussock grassland of mulga grass with woolly copperburr, cotton panic and seasonal herbage. Intergrove areas support a low open woodland of mulga with witchetty bush and bloodwood over a sparse groundcover including mulga and wire grasses.
6.2	7.5	641	Linear drainage floors and depressions; dermosols/red earths; a mid-high woodland of mulga over a sparse grassland of annual grasses and seasonal forbs.	A mid-high closed forest of mulga over a mid high open shrubland of desert fuschia. The lower stratum includes eight-day, five-minute, neverfail, curly windmill, cotton panic, mulga, golden beard, woollyoat, kangaroo and native panic grasses together with copperburrs, spiked malvastrum, mulga fern and seasonal herbage.
1.1	6.6	569	Low hilly terrain; rudosols/lithosols; a low sparse shrubland of witchetty bush and mulga over annual grasses.	A tall sparse shrubland of witchetty bush and mulga with bloodwood and whitewood over native fuschia, rock fuschia bush and dead finish. The groundcover is sparse and includes oat, woollyoat and rough wire grass.
8.3	6.2	529	Active floodplain levees and sediment splays with well-developed incised bedload channels; rudosols/alluvial soils; a tall open woodland of ironwood and river red gum with low shrubs over a sparse tussock of creek windmill grass.	A tall open woodland of ironwood and river red gum over a tall sparse shrubland of broombush and dead finish. The lower stratum consists of sparse tussock grassland of creek windmill grass with two-gland wire grass, tall yellow top, Queensland bluegrass and seasonal herbage.
6.1	5.9	511	Broad drainage floors; sodosols/red-brown earths; a low sparse ground cover of copperburrs.	Isolated shrubs including needlebush, dead finish. Harlequin emubush, desert fuschia and spotted fuschia over a sparse low groundcover of woolly and grey copperburrs. Other species present include eight-day, five-minute, mulga, curly windmill, barley mitchell, neverfail and native panic grasses, winged chloris, three-wing bluebush and seasonal forbs.
6.3	5.8	502	Broad drainage floors; kandosols/red earths; a mid-high open woodland of mulga over desert fuschia and a sparse groundcover of annual grasses and forbs.	A low open woodland of mulga in association with a mid-high sparse shrubland of desert fuschia, dead finish, native fuschia and juvenile mulga. The lower stratum includes eight-day, five-minute, mulga mitchell, cotton panic, curly windmill and mulga grasses with mulga fern, copperburr, satiny bluebush, grey copperburr and other epherneral forbs.
4.4	5.2	450	Gentle slopes and plains; kandosols/red earths or calcarosols/solonised brown soils; a low open woodland of mulga and witchetty bush over annual grasses and copperburrs.	A low open woodland of mulga and witchetty bush with silver cassia, native fuschia, desert fuschia and dead finish over a sparse groundcover of grey and woolly copperburrs, mulga, woollyoat and five-minute grasses, as well as seasonal herbage.
4.6	4.3	372	Low rises and gentle slope; sodosols/red-brown earths with shallow A horizons; a sparse groundcover of copperburr.	A sparse groundcover of woolly and grey copperburrs, five-minute grass, barley mitchell grass, Katoora and *Ptilotus parviflora* is present in drains and rehabilitation pits.
4.2	4.2	365	Low crests with rounded profiles on catchment margins; dermosols/red clays; a sparse groundcover of annual forbs with scattered juvenile mulga.	Large tracts of this unit have no mature tree and support only very sparse juvenile mulga. Broombush, dead finish, witchetty bush and whitewood occur as isolated specimens. The groundcover is also sparse and consists of woolly copperburr, mulga grass, bindweed, satiny bluebush and violet twinleaf.
5.1	4.2	357	Gently-sloping gilgaied plains; deep vertosols/red clays; a low open tussock grassland of barley mitchell and neverfail grasses.	A low open tussock grassland of barley mitchell grass, narrow-leafed neverfail and feathertop wiregrass with goathead burr, Katoora and sensitive plant. Needlebush occurs in scattered clumps.
2.1	4.0	348	Low hills and rises with basement rock outcrop; calcarosols over mottled saprolite; a low open woodland of red mallee over buck spinifex.	A mid high open woodland of red mallee over a tall open hummock grassland of giant grey spinifex. Groundcover species are restricted to tree canopy areas and include ruby saltbush, rough wire grass and ephemeral forbs.
7.5	3.9	334	Alluvial fans; tenosols/alluvial soils; a mid-high open woodland of ironwood and mulga over sparse copperburrs and annual grasses.	A mid-high open woodland of ironwood and mulga with long-leaved corkwood, witchetty bush and prickly wattle. The mid-stratum is dominated by broombush and juvenile ironwood, while the groundcover consists of copperburrs and five-minute grasses with perennials including desert blue, curly windmill and kangaroo grasses occurring under the tree canopy and along the floodout channel.

Figure 5.21 Land Unit mapping with the Upper Todd River catchment (for the full description of geomorphic units refer to Appendix 2)

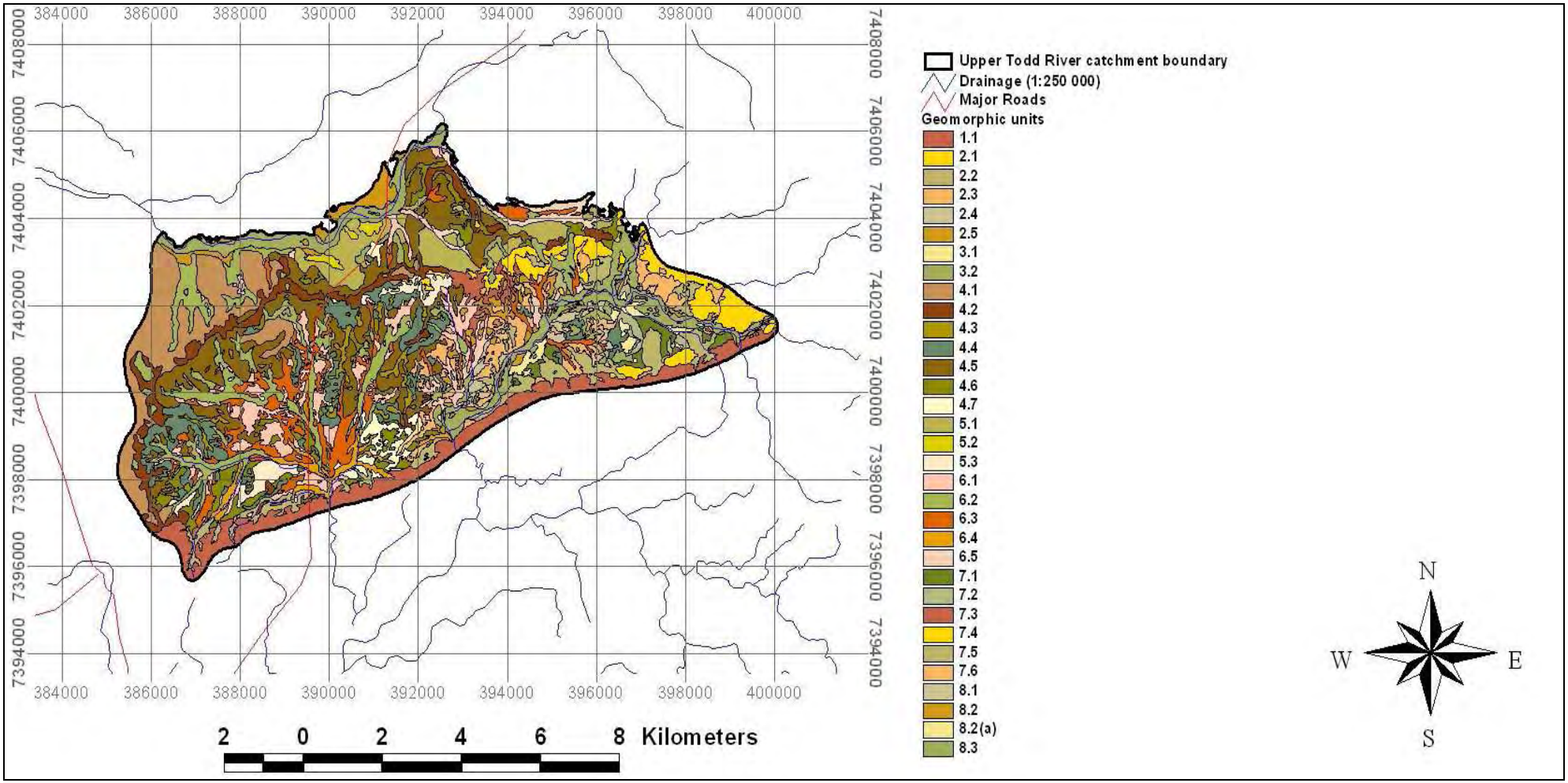
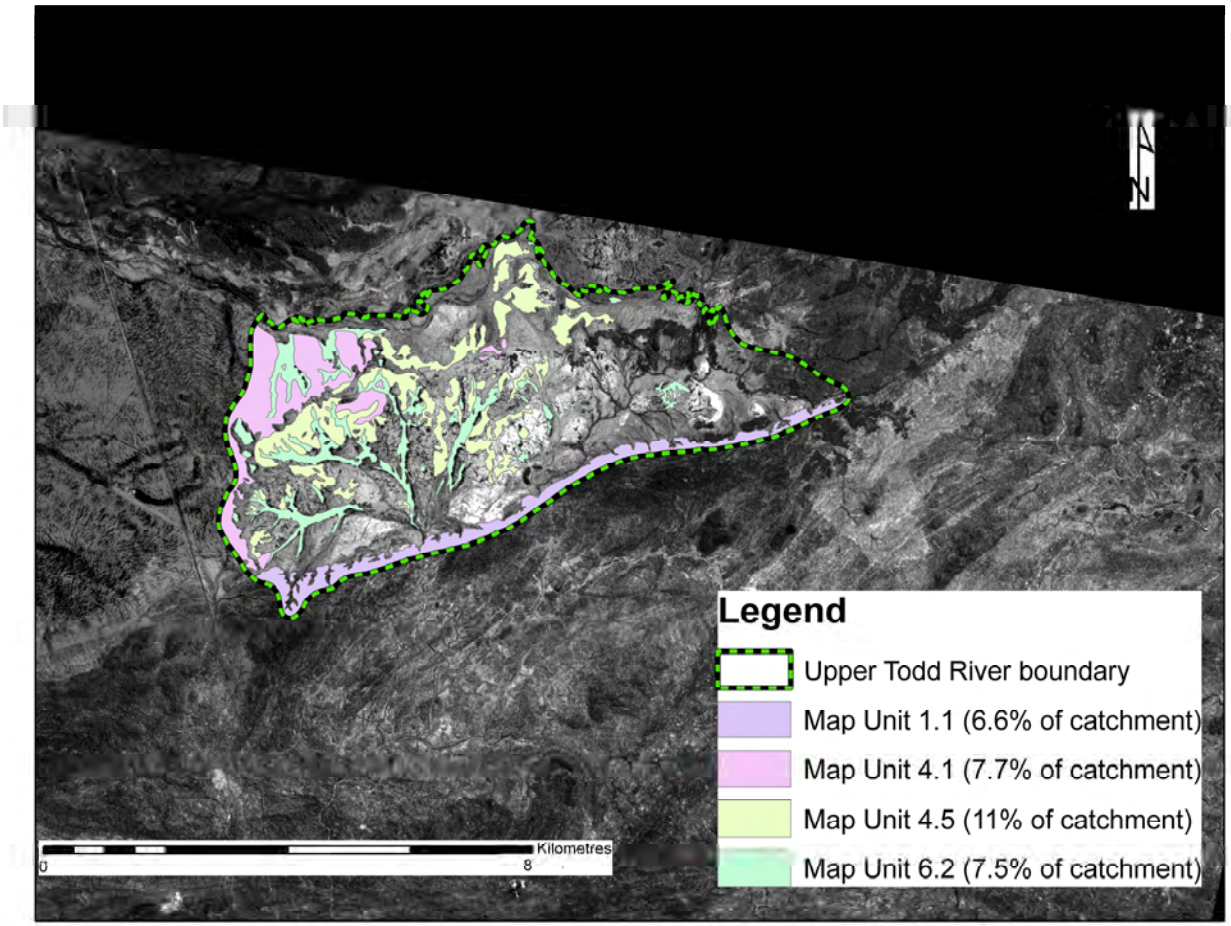


Figure 5.22 Mulga land unit mapping over SPOT image (for the full description of geomorphic units refer to Appendix 2)



5.5 DISCUSSION

The upper Todd River catchment is a spatially-diverse gently-sloping erosional landscape located just north of Alice Springs. It is pastorally productive yet visibly suffering soil erosion (Grant 1994). Landscapes in the upper catchment consist of a mosaic of well-vegetated landforms together with bare stony surfaces, scalded floodplains and active gully systems, the latter of which have been directly attributed to pastoral land use in reconnaissance surveys of catchment condition (Moore 1981). Grant (1994) described the country as consisting of gently-undulating plains sloping generally south with some broken areas with lateritic cappings. The Upper Todd catchment forms an elongated basin with relief to 30m draining via the Todd River and Station Creek, a discrete subcatchment (Grant 1994). These watercourses exit the area via two narrow gaps in the low rocky hills which form its southern boundary. The study area is bounded to the north by a broad gilgaied alluvial plain adjacent to the 16-Mile Creek floodplain, and to the north-west by featureless plains supporting mulga woodland (Grant 1994).

Vegetation communities characterised by the dominance of mulga, *Acacia aneura*, represent a significant part of the Burt Plain bioregion and support important components of its biodiversity. This chapter described the distribution and floristic composition of mulga communities at the landscape level. Three vegetation communities were identified across the Upper Todd

River Catchment. The majority (96.4%) can be characterised by Vegetation Community 59 which was widely distributed across the entire study area. It predominantly contains species such as Ironwood *(Acacia estrophiolata*) and Whitewood *(Atalaya hemiglauca*) in low open-woodlands with open-grassland understorey species such as *Eragrostis* and *Aristida* on sandier soils and Golden Beard Grass *(Chrysopogon fallax*) and Comb Windmill Grass (*Chloris pectinata)* in the wetter areas. This particular community only accounts for 12.3% of the entire Burt Plain bioregion.

Of the eighty-eight land systems mapped by Perry (1962) at 1:1 000 000 scale in the survey of the Alice Springs region, 30 are described as low relief erosional plains with varying lithology and morphology, the latter primarily in relation to their degree of drainage dissection. These plains occupy approximately 33 000 sq km (20%) of the 190 000 km² survey area. The economic significance of these plains does not lie in their extent, but in their importance to pastoralism, the predominant land use in central Australia. The peneplain landscapes described by Perry (1962) have low grazing value primarily because of their infertile soils derived from highly weathered rock. However, the younger erosional plains (or pediments) with soils developed from less weathered substrates support summer-growing annual grasslands with species such as Oat Grass (*Enneapogon avenaceus*), Woollyoat Grass (*Enneapogon polyphyllus*) and Mulga Grass (*Aristida contorta*), which are palatable, nutritious and capable of fattening stock after rains. They are very

productive, able to carry relatively high stocking rates (3-6 beasts/km^2) and support a large proportion of the region's cattle herd (Perry 1962).

Land unit mapping at a finer scale identified 32 land units with Land units 4.5, 4.1 and 6.2 making up 26.3% of the catchment. These units are generally described as plains with banded sheet flow drainage features; dermosols/red earths; a groved low woodland of mulga over annual grasses. Gentle slopes and plains with banded sheet flow drainage patterns; kandosols/calcareous red earths; a groved woodland of Mulga and Witchetty Bush *(Acacia kempeana*) over annual grasses and Grey Copperburr *(Sclerolaena diacantha)*. Within the groves, a low woodland or open woodland of mulga with Witchetty Bush *(Acacia kempeana*) over a low sparse shrubland of Desert Fuschia *(Eremophila gilesii),* Silver Cassia *(Senna artemisioides artemisioides),* Dead Finish *(Acacia tetragonophylla)* and Oval-leaf Cassia *(Cassia oligophylla)*. The groundcover includes Woolly Copperburr *(Sclerolaena lanicuspis)*, Mulga Grass *(Thyridolepis mitchelliana)*, Knottybutt Neverfail *(Eragrostis xerophila)*, Grey Copperburr *(Sclerolaena diacantha)*, Five-minute Grass *(Tripogon loliiformis)* and Umbrella Grass *(Digitaria ammophila)*. The intergrove areas were bare at the time of survey.

Climatic gradients across the Upper Todd River catchment were analysed and then compared to the entire Burt Plain bioregion. Differences were found in average rainfall during the dry season; total annual raindays, average

raindays during the dry season and elevation which were all greater than the Burt Plain bioregion mean values. The mean values for the remainder of the climatic gradients were found to be less than the Burt Plain bioregion mean. Using a 9 Second DEM and derived climate surfaces was not as useful at the landscape scale. More localised climatic records and a finer DEM would produce different and more accurate results and are recommended for further analyses at the landscape or catchment scale.

The dominant geology of the area was APA which are described as high-grade metamorphics, granite, gabbro in Arunta block. The basement geology of central Australia consists of Early Proterozoic metamorphic rocks known as the Arunta Block. This basement is unconformably overlain by several large sedimentary basin deposits, the largest being the Late Proterozoic to Palaeozoic Amadeus Basis Sequence which outcrops along and south of the east-west trending MacDonnell Ranges (Thompson 1991).

A general guide to the soils likely to occur in the study area is provided by the land system descriptions of Perry (1962) who describe red earths and texture-contrast soils as predominant on both Alcoota and Chisholm land systems. Limited occurrences of red, coarse structured clays, shallow stony soils and calcareous earths are also indicated. Red earths are also the dominant soil in Boen land system, while McGrath land system is described as having a range of fine-textured soils. While the arid climate is a major determinant of the

structure and density of plant communities in central Australia, soil properties are of primary importance in determining their floristics and distribution. Soil physical properties which determine the amount and availability of moisture for plant growth tend to have the greatest influence (Perry 1962). However, landscape processes also affect the distribution of vegetation, as suggested by Friedel *et al.* (1993) who identified a relationship between the stability of landforms and the longevity of the species they support. For instance, the longest-lived tree and shrub communities such as mulga woodlands develop on old stable floodout deposits, while currently active floodplains with unstable surfaces support no perennial upper stratum.

A significant feature of some mulga communities in the study area is a groved or banded pattern of vegetation cover. This phenomenon is widespread in central Australia and has been reported from arid landscapes in Western Australia, New South Wales and parts of Africa, and is often associated with lateritic land surfaces (Dunkerley 2002; Dunkerley & Brown 2002; Mabbutt & Fanning 1987; Perry 1962; Tongway & Ludwig 1990). The groving is characterised by the orientation of vegetation cover in regular, elongate bands aligned transverse to the slope, separated by relatively open intergrove areas, and occurs on smooth plains with low slopes where runoff dissipates as a sheet flow (Grant 1994).

The groves intercept sheet flow from the relatively bare intergrove areas through slight microrelief changes together with a higher abundance of vegetative cover and surface litter creating a hydrologic system with minimal net runoff. The vegetation of the groves is further advantaged by higher soil infiltration rates, organic and exchangeable nutrient levels and biological activity than in the intergrove areas, although other soil characteristics are essentially similar. The groving pattern dissipates where sheet flow is concentrated into defined drainage floors (Mabbutt & Fanning 1987; Tongway & Ludwig 1990).

The grove-intergrove system constitutes a geomorphic unit maintained by a process of sheet erosion from the intergrove (Tongway & Ludwig 1990). Mabbutt and Fanning (1987) noted that this process is accentuated by land degradation through excessive grazing pressure, and increasing runoff and sediment loss from the intergrove can reach a point where the capacity of the grove for interception is exceeded. The grove-intergrove sequence then fails to operate as a 'closed system' and the loss of runoff and soil leads to a breakdown of the vegetation pattern.

Free-ranging cattle are highly selective in their grazing behaviour and tend to focus their activity on land types supporting these annual grasses, avoiding less preferred areas until the most palatable feed is in short supply (Hodder & Low 1978). Consequently the detrimental effects of grazing impact, including

loss of vegetative cover and resultant soil erosion, tend to be concentrated on these areas, which are often inherently erodible. This is reflected in a survey of soil erosion and pasture degeneration in central Australia by Condon *et al.* (1969) following nine years of drought up until 1965. Their survey indicated that erosional land systems are badly affected by soil erosion, particularly on gently-sloping country where sheet erosion by water is extreme and frequently accompanied by serious rilling and gullying, especially on texture-contrast soils. The question of the impact of grazing use on accelerated erosion in the catchment was raised in an Environmental Review of the recreation lake proposal (Moore 1981) and further discussed in an Environmental Impact Statement for a flood mitigation dam proposal (Power and Water Authority PAWA 1990).

Most of the land in the study area is used for cattle grazing. The effects of trampling and grazing of native flora in the Northern Territory, from pastoral activities, are unsustainable (Landsberg *et al.* 1997a). Grazing animals are in direct competition for palatable and nutritious food sources with native herbivores of the region (James *et al.* 1995). Many native plant species are decreasing in abundance and it has been reported that there are areas at risk of losing up to 15-38% of species through grazing of rangelands, particularly if artificial water points are utilised (Landsberg *et al.* 1997b). The increase in grazing has also led to the extinction and endangerment of many small mammal species because of the lack of palatable food (Hodgkinson & Cook

1995; James *et al.* 1995; Landsberg *et al.* 1997a; Morton *et al.* 1995b). Grazing management needs to be modified so that it can be better integrated with biodiversity conservation needs of arid areas (Morton *et al.* 1995b).

CHAPTER 6 - CASE STUDY OF THE BURT PLAIN BIOREGION – III. DISTRIBUTION MODELS OF SELECTED FAUNA

6.1 INTRODUCTION

Conservation planning and management may be more effective if based on a sound ecological understanding of biodiversity and the habitat requirements of species (Clark *et al.* 1993; McCarthy *et al.* 1994). Unfortunately, no comprehensive biological surveys have been undertaken for the Burt Plain bioregion. As a result, present conservation evaluation and management is based on limited information. To help redress this limitation, in this Chapter I use selected spatial modelling techniques to examine gaps in biological survey, to examine the extent to which currently available data may be used to generate useful spatial predictions of fauna, and to use these analyses to inform future biological surveys of the bioregion.

More specifically, this chapter aims to contribute an improved understanding of habitat correlates of selected fauna in the Burt Plain bioregion. The potential for modelling the spatial distribution of species on a bioregional scale using presence data only is explored. In particular, I

- analyse how taxa have been sampled with respect to geographical and environmental space; and

- compare GLM presence-only models to GAM presence-only models produced by the software SPMODEL.

6.2 CURRENT STATUS AND DISTRIBUTION OF FAUNA

As with all other central Australian bioregions (Morton 1994), the Burt Plain bioregion has suffered substantial loss of mammal species over the last century. Mammals which have become regionally extinct or declined in the region include the Western Quoll *(Dasyurus geoffroii),* Golden Bandicoot *(Isoodon auratus),* Desert Bandicoot *(Perameles eremiana),* pig-footed bandicoot *(Chaeropus ecaudatus)*, Brush-tail Possum *(Trichosurus vulpecula),* Brush-tailed Bettong *(Bettongia pencillata),* Burrowing Bettong *(B. lesueur),* Mala *(Lagorchestes hirsutus),* and Crescent Nail-tail Wallaby *(Onychogalea lunata)* (Woinarski *et al.* in prep.).

Relatively few threatened species occur within the bioregion. For these species, the bioregion generally does not represent a major population stronghold (although this may partly reflect limited survey effort and data). Threatened species known from the bioregion include Mulgara *Dasycercus cristicauda* (Vulnerable at Commonwealth and Northern Territory level), Great Desert Skink *Egernia kintorei* (Vulnerable at Commonwealth and Northern Territory level), Black-footed Rock-wallaby (MacDonnell Ranges race) *Petrogale lateralis* (Vulnerable at Commonwealth level), Painted Snipe *Rostratula benghalensis* (Vulnerable at Northern Territory level), Common

Brushtail Possum *Trichosurus vulpecula vulpecula* (Vulnerable at Northern Territory level), Central Rock-rat *Zyzomys pedunculatus* (Endangered at Commonwealth and Northern Territory level), *Ipomoea* A83192 (Vulnerable at NT level) and *Macrozamia macdonnellii* (Vulnerable at Commonwealth and Northern Territory level). There is also some evidence that of broadscale decline of some groups of birds in this bioregion, in addition to those species currently listed as threatened (Woinarski 1992, 1999).

The mulga woodlands contain a significant array of bird species, including the Mulga Parrot *(Psephotis various),* Bourke's Parrot (*Neopsephotus bourkii),* Hooded Robin *(Melanodryas cucullate),* Red-capped Robin *(Petroica goodenovii)* and Grey Honeyeater *(Conopophila whitei)* (Kerle 1996). The birds of the mulga groves in the Burt Plain bioregion also occur in Mulga Lands to the east and west, so, in avian terms, this bioregion is not unique. For many bird species there have been increases in reporting rates, likely because of greater effort by birdwatchers. However, this causes greater concern for taxa that have declines in reported sightings, such as the Hooded Robin. The analyses of gridded data available from Birds Australia are somewhat deceptive in that the grids centred on the Burt Plain also encompassed the Alice Springs Sewage Farm. Many waterbirds that have been sighted there, but otherwise would be absent from the region. There are a few, largely ephemeral wetlands in the Burt Plain bioregion, but they do not support significant numbers of waterbirds. Pest animals include horses and donkeys and patchy

but intense rabbit infestations. Feral cats and foxes are likely to have contributed to the decline in mammal species (Woinarski *et al.* in prep.). Other pest species include feral pigeons, house mice and goats. Feral camels are also an emerging environmental and agricultural pest.

Table 6.1 Previous fauna surveys of Mulga habitat at Uluru (Source: Reid *et al.* (1993)). Nomenclature for birds follows Simpson and Day (1996).

Category	**Birds**	**Reptiles**	**Mammals**
1	Slaty-backed Thornbill *(Acanthiza robustrirostris)*		
	Redthroat *(Pyrrholaemus brunneus)*		
	Grey Honeyeater *(Conopophila whitei)*		
2	Mulga Parrot *(Psephotus varius)*	Leonhardi's Ctenotus *(Ctenotus leonhardii)*	Ooldea Dunnart *(Sminthopsis ooldea)*
	Bourke's Parrot (*Neopsephotus bourkii)*	Spiny-tailed Gecko *(Strophurus intermedius)*	Sandy Inland Mouse *(Pseudomys hermannsburgensis)*
	Red-capped Robin *(Petroica goodenovii)*	*Gehyra* sp.	One-humped Camel *(Camelus dromedarius)*
	Hooded Robin *(Melanodryas cucullata)*	Sand Monitor *(Varanus gouldii)*	Red Kangaroo *(Macropus rufus)*
	Rufous Whistler *(Pachycephala rufiventris)*		
	Grey Shrike-thrush *(Colluricincla harmonica)*		
	Crested Bellbird *(Oreoica gutturalis)*		
	White-browed Babbler *(Pomatostomus superciliosus)*		
	Splendid Fairy-wren *(Malurus splendens)*		
	Brown Thornbill *(Acanthiza pusilla)*		
	Chestnut-rumped Thornbill *(Acanthiza uropygialis)*		
	Southern Whiteface *(Aphelocephala leucopsis)*		
	Spiny-cheeked Honeyeater *(Acanthagenys rufogularis)*		
	Grey Butcherbird *(Cracticus torquatus)*		
3	Black-eared Cuckoo	Fat-tailed Gecko	Desert Dunnart(*)

	(Chrysococcyx osculans)	*(Didlodactylus conspicillatus)*	*(Sminthopsis youngsoni)*
	Willie Wagtail *(Rhipidura leucophrys)*	Beaked Gecko *(Diplodactylus damaeus)*	House Mouse *(Mus domesticus)*
	Chiming Wedgebill *(Psophodes occidentalis)*	Central Netted Dragon *(Ctenophorus nuchalis)*	
	Variegated Fairy-wren *(Malurus lamberti)*	Western Bearded Dragon *(Pogona minor minor)*	
	Western Gerygone *(Gerygone fusca)*	Helen's Ctenotus *(Ctenotus helenae)*	
	Yellow-rumped Thornbill *(Acanthiza chrysorrhoa)*	Sand Lerista *(Lerista labialis)*	
	Varied Sittella *(Daphoenositta chrysoptera)*	Interior Blind Snake *(Ramphotyphlops endoterus)*	
	Singing Honeyeater *(Lichenostomus virescens)*	Nocturnal Desert Skink	
	White-fronted Honeyeater *(Phylidonyris albifrons)*		
	Mistletoebird *(Dicaeum hirundinaceum)*		
	Zebra Finch *(Taeniopygia guttata)*		
	Black-faced Woodswallow *(Artamus cinereus)*		
	Spotted Nightjar *(Eurostopodus argus)*		

* Recently burnt, regenerating mulga communities

Table 6.2 Table 6.2 Fauna recorded from Mulga Woodlands (van Oosterzee 1995). Nomenclature for birds follows Simpson and Day (1996).

Group	**Scientific Name**	**Common Name**
Birds	White-browed Treecreeper	*Climacteris affinis*
	Bourke's Parrot	*Neophema bourkii*
	Mulga Parrot	*Psephotus varius*
	Chiming Wedgebill	*Psophodes cristatus*
	White-winged Triller	*Lalage sueurii*
	Little Button-quail	*Turnix velox*
	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
	Chestnut-rumped Thornbill	*Acanthiza uropygialis*
	Slate-backed Thornbill	*Acanthiza robustirostris*
	Southern Whiteface	*Aphelocephala leucopsis*
	Crimson Chat	*Ephthianura tricolor*
	Tawny Frogmouth	*Podargus strigoides*
Reptiles	Sand Monitor	*Varanus gouldii*
	Gilbert's Dragon	*Lophognathus gilberti*
	Leonard's Ctenotus	*Ctenotus leonhardii*
	Schomburk's Ctenotus	*Ctenotus schomburgkii*
Arthropods	Mulga Ant	*Polyrachus macropus*
	Honey Pot Ant	*Camponotus inflatus*

Morton *et al.* (1995) reported some species of Camaenid land-snails that are found only in the Region: *Montanomelon reynoldsi* in the Reynolds Range; and *Semotrachia jinkana* and *S. huckittana* in the Dulcie Ranges (Solem 1993). Other significant species include three species of fish (*Leipotherapon unicolor*, *Melanotaenia splendida*, *Ambassis agrannus agassizii*) recorded for the Dulcie Ranges (Latz & Langford 1983).

6.3 TECHNIQUES USED FOR PREDICTING THE SPATIAL DISTRIBUTION OF SPECIES

The potential for predicting the spatial distribution of faunal species on a bioregional scale across the entire Burt Plain bioregion using presence data is explored using the software 'SPMODEL'. This software has two options - generalised linear models (GLMs) and generalised additive models (GAMs). Because of the high cost of data acquisition, there is a need to investigate ways of maximising the value of existing data and prioritising areas for further survey or research. There is a large volume of literature on methods for modelling wildlife distribution including habitat suitability indices (HIS)[1], statistical methods including generalised linear models (GLMs) and generalised additive models (GAMs) (see Austin *et al.* 1995), as well as spatial and inductive (cartographic and regression trees, neural nets, Bayesian and weights of evidence) models (see Walker (1990) and Miller *et al.* 1989) – Refer to Chapter 3. GLM and their non-parametric extensions GAM today constitute the most commonly used statistical approach in the ecological field. This has resulted in my investigating the use and application of one of these tools known as 'SPMODEL' for predicting species distribution.

GAMs are mathematical extensions of linear models that do not force data into unnatural scales, and thereby allow for non-linearity and non-constant

[1] HIS models test the ability of habitat to provide life requisites for a particular species, by determining a numerical index of appropriateness and assigning that value to a given land-use category or vegetation type at a given point in time (Lenton *et al.* 2000).

variance structures in the data. GAMs are more flexible and better suited for analyzing ecological relationships which can be poorly represented by classical Gaussian distributions (Austin 1987). The strength of GAMs is their ability to deal with highly non-linear and non-monotic relationships between the response and the set of explanatory variables. GAMs are sometimes referred to as data–driven rather than model-driven (Guisan *et al.* 2002). This is because the data determine the nature of relationship between the response and the set of explanatory variables rather than assuming some form of parametric relationship (Yee & Mitchell 1991).

GLMs are composed of a random component, described by the assumed distribution of the observation data (either binomial or Poisson for many wildlife observation data), a systematic component specifying a linear combination of explanatory (or independent) variables, and a 'link' between the random and systematic components of the model that specifies how the mean response (i.e. observation) relates to the explanatory variables in the linear predictor (Agresti 1986). Wintle *et al* (2005) describes how GLMs are able to 'fit' data more closely for a given number of degrees of freedom because they are not constrained to fit predefined parametric shapes. However, for the same reasons, GAMs cannot be as easily interpreted as GLMs.

Even though GAMs tend to perform better than GLMs, the simplicity of GLMs, their broad availability in statistical packages, the ease with which they can be applied within a GIS framework, and the ready availability of prediction intervals mean that they are still useful and frequently implemented (Wintle *et al.* 2005). A further strength of GLMs is the ease with which uncertainty about coefficients and predictions can be conveyed as standard errors and prediction intervals (Wintle *et al.* 2005).

6.4 METHODS

6.4.1 Spatial Datasets

Northern Territory (NT) Fauna Atlas

The Atlas provides a comprehensive dataset of fauna observations found in the Northern Territory. The Atlas contains sighting of birds, frogs, mammals and reptiles. The Atlas is an amalgamation of records from many different sources including the Biological Records Scheme (BRS), Specimen Records Scheme (SRS), Museum records, Birds Australia (formerly RAOU), fauna surveys, scientific licenses, park monitoring activities, and sightings from the public. The records had already been pre-filtered to ensure only valid records occurred from known collectors. Historically the bulk of the records were provided via the Biological Records Scheme (BRS) which started in the early 80's and provided a means of providing incidental and survey records to a central dataset. Depending on the source of the data and the time at

which it was collected some points represent cells (e.g. the old BRS data was recorded as 1 degree cells). Some records have only been provided as occurring in a Conservation Area such as a Park or Reserve. These sightings were recorded to a central point in the Conservation Area and flagged as such. Most current data was collected by GPS.

When data was received it passed through several steps. Firstly basic edits were performed to validate individual data fields. Next checks were performed to ensure that species are observed in an appropriate environment (i.e. on land not in the sea). Lastly new observation are compared against previous sightings and if they were further away than a specified distance the records were then manually checked and verified before accepting.

The positional accuracy of sightings within the Atlas varied. An attempt has been made to indicate the accuracy and is recorded in each sighting with a distance in metres recorded which indicates a +/- distance from the provided point. This was generated based on the method of collection (i.e. gps, map, survey instrument) and scale.

The point records have then been clipped to the Burt Plain bioregion boundary for this study. 12185 records were used, but only species with greater than 10 records were used for modelling to ensure statistical integrity.

The Atlas contains presence point data only. Appendix 3 contains a full list of species available for modelling.

Environmental Data

Table 6.3 summarises the environmental data sets used in modelling the distribution of species. For further information on other spatial datasets (vegetation, elevation, Land systems, climate surfaces), refer to Chapter 5.3.1.

The grid coverage distance to water (dist) was calculated using the ARC/INFO command EUCDISTANCE with the original cover containing drainage lines and waterbodies at 1:250000 provided by the Northern Territory Parks and Wildlife Commission. This grid was calculated due to the importance of water in a desert environment for flora and fauna. The grid coverage distance to water (rddist) was calculated using the ARC/INFO command EUCDISTANCE with the original cover containing roads at 1:250000 also provided by the Northern Territory Parks and Wildlife Commission. The grid coverages: flowacc and flowdir were calculated using the ARC/INFO commands FLOWACC and FLOWDIR with the original 1:250000 hydrology covers and DEM. The grid coverages: Firegap and burnt were calculated in ARC/INFO GRID and determine for each cell the gap between last fire and the number of times each cell has been burnt using the Department of Land Information (DOLA), Western Australia NOAA AVHRR satellite derived dataset - monthly Fire scar maps (Russell-Smith *et al.* 2002).

Position in landscape 300m, 500m

The spatial setting of an ecosystem within a landscape influences many of the ecosystem's properties (Kratz *et al.* 1991). Characterising spatial variability of soil nutrients in relation to site properties, including climate, land use, landscape position and other variables, is important in understanding how ecosystems work (Wang *et al.* 2001). Fischer and Lindenmayer (2005) examined lizard distribution patterns in relation to elevation in two undulating landscapes. Generalized linear modelling was used to relate elevation to the capture rate of individual species, and to species richness. Fischer and Lindenmayer (2005) found that elevation was significantly related to the capture of seven species, and ecologically similar species replaced one another as elevation increased and concluded that lizards were highly sensitive to elevation.

As distribution patterns are being examined two layers were calculated relating to the position in the landscape. These layers provide a measure of the cell's position in the surrounding landscape within a 300m radius and 500m radius. A negative value shows that the cell has a low elevation compared with the surrounding area; a positive value, a high elevation.

Value	Interpretation
+8	At the top of a slope
+3	On an upper slope
0	Mid-slope
-3	On a lower slope
-8	At the bottom of a slope

The range of the data is from -8.4 to 8.4.

The derivation of this layer involves determining the range of elevation values in the surrounding area and then calculating the cell's relative position in the range. This is done using Arc/INFO's GRID utility (ESRI 1988) thus:

1. Calculate a grid of minimum values	*Dem3min* = FOCALMIN(*Dem*,CIRCLE,3)
2. Calculate a grid of maximum values	*Dem3max* = FOCALMAX(*Dem*,CIRCLE,3)
3. Calculate a grid representing the range	*Dem3range* = *Dem3max* - *Dem3min*
4. Calculate the grid of position values	*Pos3* = ((FLOAT(*Dem* - *Dem3min*) / FLOAT(*Dem3range*)) - 0.5) * 2.0 * LN(*Dem3range*)

Elevation Diversity 300m, 500m

Each cell in this layer contains a measure of the diversity of the elevation surrounding each cell. The measure is the standard deviation of all values within a 300m and 500m radius of each cell. The higher the value the more diverse the surrounding elevation. The range of the data is from 0 to 1330 metres above sea level (asl).

Derivation

This layer is calculated in Arc/INFO's GRID utility (ESRI 1988) using the formula:

D3std = FOCALSTD(*Dem*,CIRCLE,3)

Table 6.3 Full description of environmental grids used in analysis

Name	Description
Rddist	Euclidean Distance to roads
Dist	Euclidean Distance to hydrology feature
Firegap	Fire gap (gap between last fire)
Burnt	Frequency (number of years) cells burnt
Alldem	9Sec DEM Version 2.0
Aspect	Aspect
dem3max	Max values 300m
dem3min	Min values 300m
Dem3rang	Range 300m
Dem3std	Elevation Diversity 300m = the standard deviation of elevation in the surrounding 3 cells (300m)
pos3	Position in landscape, 300m = position relative to the extremes of elevation in the surrounding 3 cells (300m)
demd	FocalStd
ethfix	Concentration of radiometric element – thorium
eufix	Concentration of radiometric element – uranium
kfix	Concentration of radiometric element – potassium
tcfix	Total Count
Hiptc	Hi-Pass Total Count
Xevap	ESOCLIM Mean annual evaporation
Xdtmp	ESOCLIM Mean annual temperature during dry season months (Apr – Sep)
Xwtmp	ESOCLIM Mean annual temperature during wet season months (Oct – Mar)
Xrainf	ESOCLIM Mean annual rainfall
Xalltmp	ESOCLIM Mean annual temperature
Flowacc	Accumulated flow to each cell that flow into each downslope cell
Flowdir	Flow direction from each cell to its steepest downslope neighbor
Lsys	1:1 000 000 Perry Land systems
Veg	1:1 000 000 Vegetation mapping units
Geol250k1	1:250 000 Geology

6.4.2 Software and hardware

Digital Elevation Model (DEM)

The Australian Surveying and Land Information Group's (AUSLIG) standard product 'GEODATA 9 Second DEM Version 2' was used as a base Digital Elevation Model (DEM) for this research. A summary of this DEM is provided in Chapter 4, section 4.3.

Climate Surfaces

The five climate surfaces used in this research were derived from the software package ANUCLIM Version 5.0[2] which had been previously generated by the ANUSPLIN[3] package (Hutchinson 1999) from long-term monthly averages of Refer to section 4.3 in Chapter 4. The climate surfaces used with the most relevance to desert conditions were: mean annual evaporation; mean annual temperature during the dry season months (April – September); mean annual temperature during the wet season months (October - March); mean annual rainfall; and mean annual temperature.

6.4.3 Data Analysis

Data Conversion and Manipulation

Before any further analysis of the data could be undertaken, a number of steps had to be taken to have the data in right format for ARC/INFO. The majority of the data was supplied in ARC/INFO export format (*.e00) or ArcView shapefiles, with the exception of the climate surfaces (as described in Section 4.3.1) and the Landsat TM7 image files which were in ER Mapper (v6.0) format. To create ARC/INFO coverages from the *.e00 files for further use and analysis the ARC: IMPORT command was used. ArcView shapefiles were also converted to ARC/INFO coverages using the ARC command SHAPEARC. All of the data was already projected in a geographical

[2] ANUCLIM is a software package of programs developed by the Centre for Resource and Environmental Studies (CRES) at the Australian National University (ANU) – see http://cres.anu.edu.au.

[3] The climate surface coefficient files are produced from irregular networks of actual meteorological variables by the ANUSPLIN package , a separate package to ANUCLIM.

coordinate system 1966 Australian Geodetic Datum (AGD-66) spheroid, that is, with latitudinal and longitudinal values. All potentially predictive environmental variables (correlates) contained in the GIS were converted and stored at equal resolution with a pixel size of 250m by 250m. Each cell in each raster was assigned values for the data coverages that were coincident.

Analysis

The LATTICESPOT ARC command was used to compute surface values for each point (survey site) into a point coverage by interpolating from a lattice.

Species Distribution Modelling Toolkit (SPMODEL) is a companion application to the S-Plus based 'Predicted Species Modeling' package (PSM) developed by Graham Watson, Environment Australia. SPMODEL has been developed by the Environment Forest Group, Department of the Environment, Sport and Territories. Relationships between the presence of a species and mapped environment variables (Table 6.3) were generated using Generalized Linear Model (GLM) and Generalized Additive Model (GAM) regression modelling techniques. These models could then be used to predict the probability of occurrence of a species at any given location, defined in terms of its environmental attributes. Interpolating model results using selected environmental variables produced bioregional maps of the predicted probability of occurrence of species.

6.5 RESULTS

6.5.1 Distribution of fauna across major vegetation communities and analysis of records

Over 12185 vertebrate species occurrences have been recorded within the Burt Plain bioregion with 168 bird species, 10 frog species, 53 mammal species and 106 reptile species represented (Table 6.4). Of these records there are 10 species (eight of which are mammals, one bird and one reptile) which are listed as threatened fauna nationally under the *Environment Protection and Biodiversity Act* 1999 (Table 6.5).

Table 6.4 Summary of vertebrate fauna recorded in the Burt Plain bioregion.

GROUP	Total No. of records	No. of species	No. of introduced species	No. of threatened species
Birds	6807 (56%)	168 (50%)	1 (0.6%)	1 (0.6%)
Frog	480 (4%)	10 (3%)	0	0
Mammals	1373 (11%)	53 (16%)	8 (15.1%)	8 (15.1%)
Reptiles	3525 (29%)	106 (31%)	1 (0.6%)	1 (0.6%)
TOTAL	12185	337	10	10

Table 6.5 Summary of threatened fauna recorded in the Burt Plain bioregion; IUCN categories of conservation concern are shown below.

National EPBCA 2002 Conservation Status	**2002 IUCN Conservation Status**	**NT Conservation Status**	**Scientific Name**	**Common Name**	**No. of records**
Extinct	EX	EX	*Chaeropus ecaudatus*	Pig-footed Bandicoot	2 (1891)
Extinct	EX	EX	*Leporillus apicalis*	Lesser Stick-nest Rat	2 (Fossil)
Extinct	EX	EX	*Notomys longicaudatus*	Long-tailed Hopping-mouse	1 (Fossil)
Extinct	EX	EX	*Onychogalea lunata*	Crescent Nail-tail Wallaby	2 (1891)
Endangered	VU	EX (W)	*Lagorchestes hirsutus*	Rufous Hare-wallaby	6
Endangered	CE	EN	*Zyzomys pedunculatus*	Central Rock-rat	1
Vulnerable	VU	EN	*Isoodon auratus*	Golden Bandicoot	2
Vulnerable	VU	VU	*Dasycercus cristicaudata*	Mulgara	14
Vulnerable	VU	VU	*Macrotis lagotis*	Greater Bilby	13
Vulnerable			*Petrogale lateralis*	Black-footed Rock-wallaby	69
Vulnerable	VU	VU	*Egernia kintorei*	Great Desert Skink	7
	LR/NT		*Falco hypoleucos*	Grey Falcon	4
	LR/NT		*Pseudomys desertor*	Desert Mouse	6

IUCN Categories

EX	Extinct
EW	Extinct in the wild
CR	Critically endangered
EN	Endangered
VU	Vulnerable
LR/NT	Lower Risk/Near Threatened
LC	Least Concern
DD	Data Deficient
NE	Not Evaluated

Introduced Species

Ten introduced species have been recorded in the Burt Plain bioregion with a total of 224 records. This represents only 3% of the total species list of 337, and 1.8% of the 12185 records. These species are listed in Table 6.6, together with their number of recorded occurrences. The most commonly recorded species are also listed in Table 6.7.

Table 6.6 Introduced vertebrate fauna recorded in the Burt Plain bioregion.

Group	Scientific Name	Common Name	No. of records
Mammal	*Equus asinus*	Donkey	6
Mammal	*Equus caballus*	Horse	21
Mammal	*Felis catus*	Cat	28
Mammal	*Oryctolagus cuniculus*	Rabbit	65
Mammal	*Capra hircus*	Goat	4
Mammal	*Bos taurus*	Cattle	37
Mammal	*Mus musculus*	House Mouse	56
Mammal	*Vulpes vulpes*	Fox	2
Bird	*Columba livia*	Rock Dove (Feral Pigeon)	1
Reptile	*Hemidactylus frenatus*	Asian House Gecko	4
Total		**10**	**224**

* It is noted that the camel *(Camelus dromedaries)* does occur in the Burt Plain bioregion but no data or records were provided at the time of this analysis.

Table 6.7 Most commonly recorded vertebrate species recorded in the Burt Plain bioregion

Group	Scientific Name	Common Name	No. of records	% of group
Birds	*Rhipidura leucophrys*	Willie Wagtail	239	3.5
	Artamus cineurus	Black-faced Woodswallow	218	3.2
	Taeniopygia guttata	Zebra Finch	215	3.2
	Ocyphaps lophotes	Crested Pigeon	213	3.1
Frogs	*Limnodynastes spenceri*	Spencer's Frog	209	43.5
	Litoria rubella	Red Tree-frog	118	24.6
Mammals	*Macropus robustus*	Euro	153	11.1
	Pseudomys hermannburgensis	Sandy Inland Mouse	136	9.9
	Sminthopsis macroura	Stripe-faced Dunnart	136	9.9
	Macropus rufus	Red Kangaroo	106	7.7
Reptiles	*Ctenotus schomburghii*		438	12.4
	Ctenotus leonhardii		349	9.9
	Ctenophorus nuchalis	Central Netted Dragon	290	8.2

The distribution of fauna survey records was plotted firstly over 1:250 000 roads for the Burt Plain bioregion (Figure 6.1). The distribution of fauna was then plotted against the four major vegetation communities (as described in Chapter 4) (Figures 6.2-6.5). Vegetation Community 58 contained 282 bird, 40 frog, 172 mammal and 587 reptile records. Vegetation Community 59 contained 991 bird, 2 frog, 98 mammal and 82 reptile records. Vegetation Community 65 contained 2030 bird, 344 frog, 392 mammal and 1674 reptile records. Vegetation Community 76 contained 263 bird, 7 frog, 79 mammal and 201 reptile records. Figure 6.6-6.9 show the distribution of fauna with less than 10 records across the Burt Plain bioregion, with records on threatened species noticeably low.

Figure 6.1 Distribution of faunal survey records for the Burt Plain bioregion compared to the major road network.

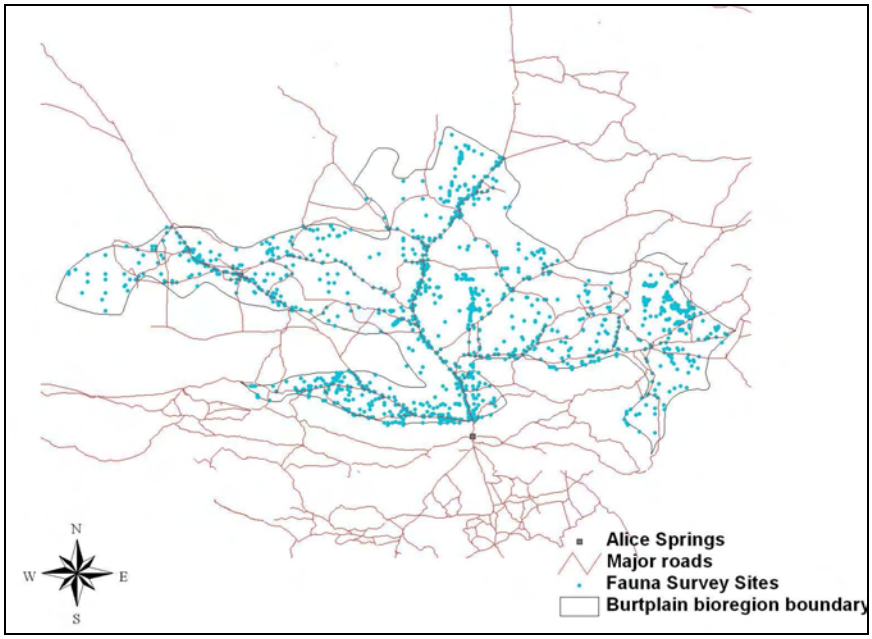


Figure 6.2 Distribution of fauna across Vegetation Community 58

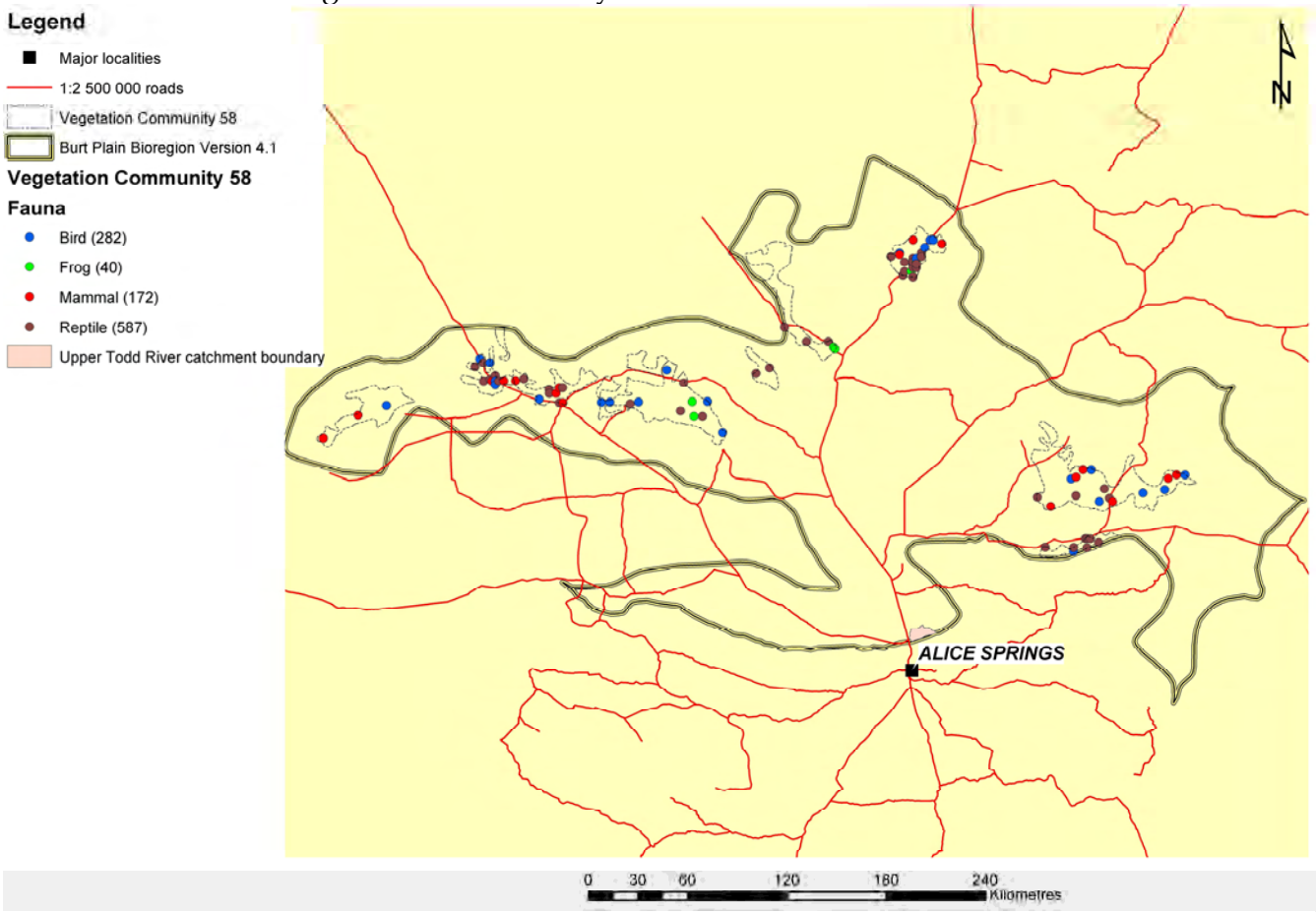


Figure 6.3 Distribution of fauna across Vegetation Community 59

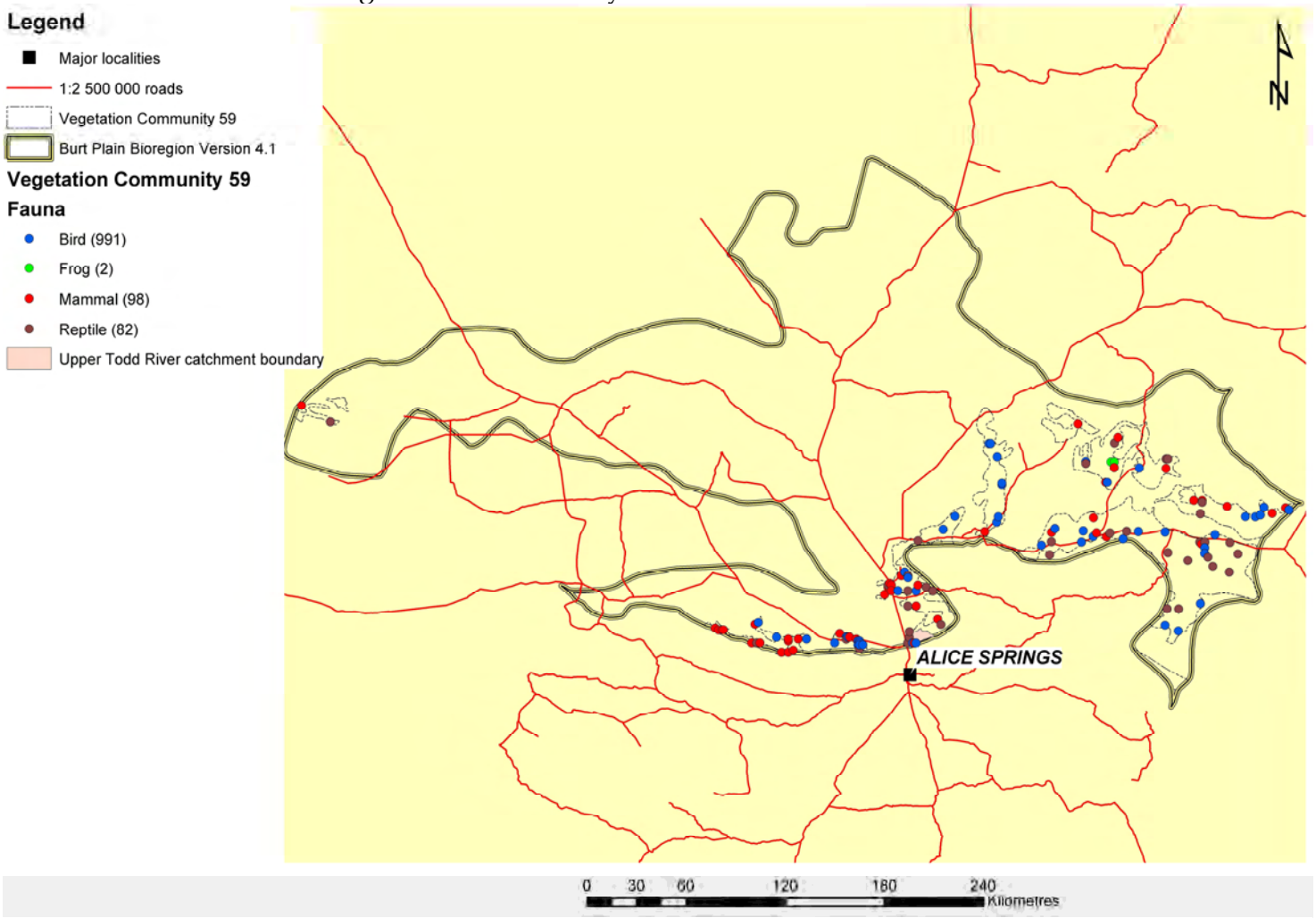


Figure 6.4 Distribution of fauna across Vegetation Community 65

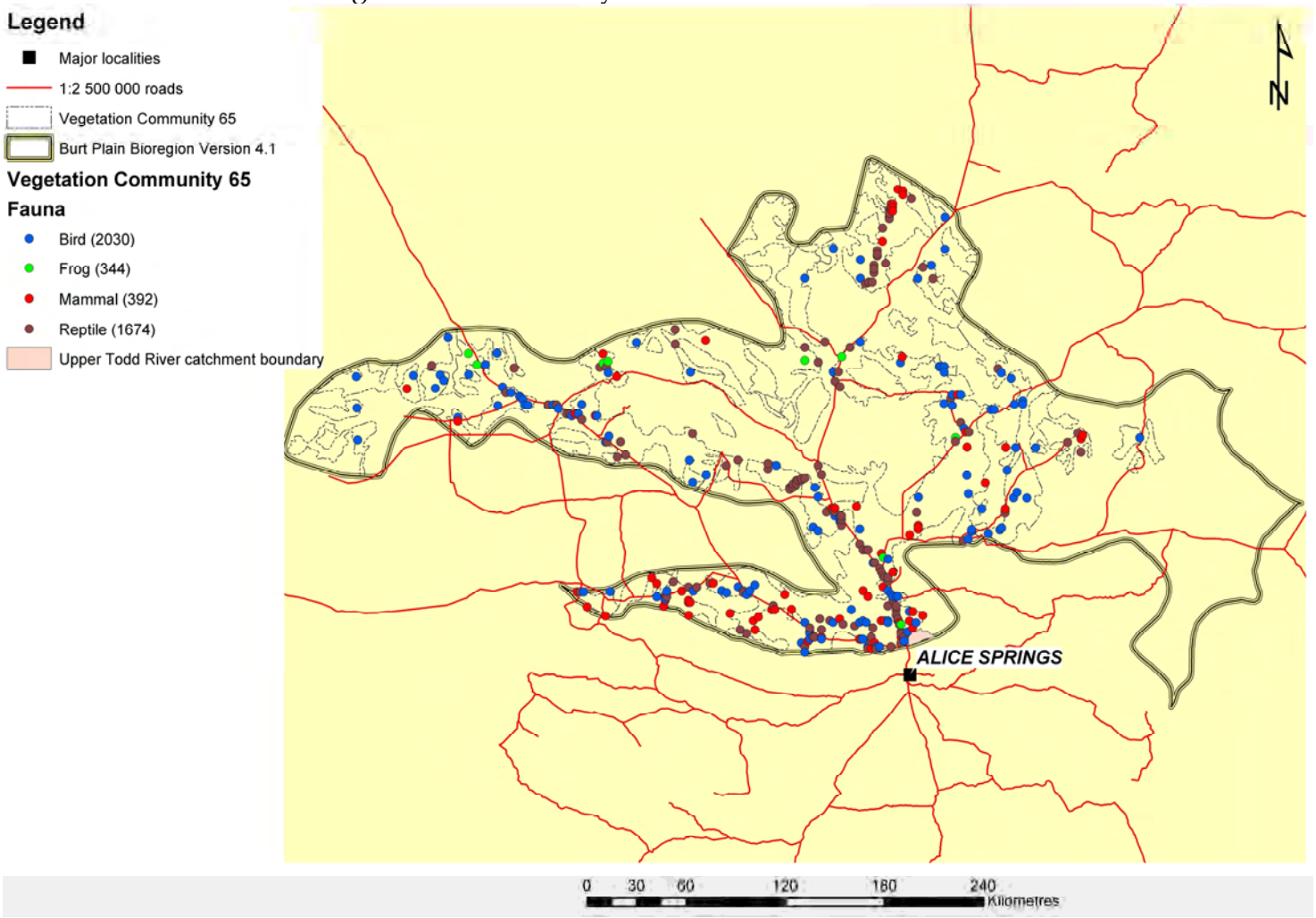
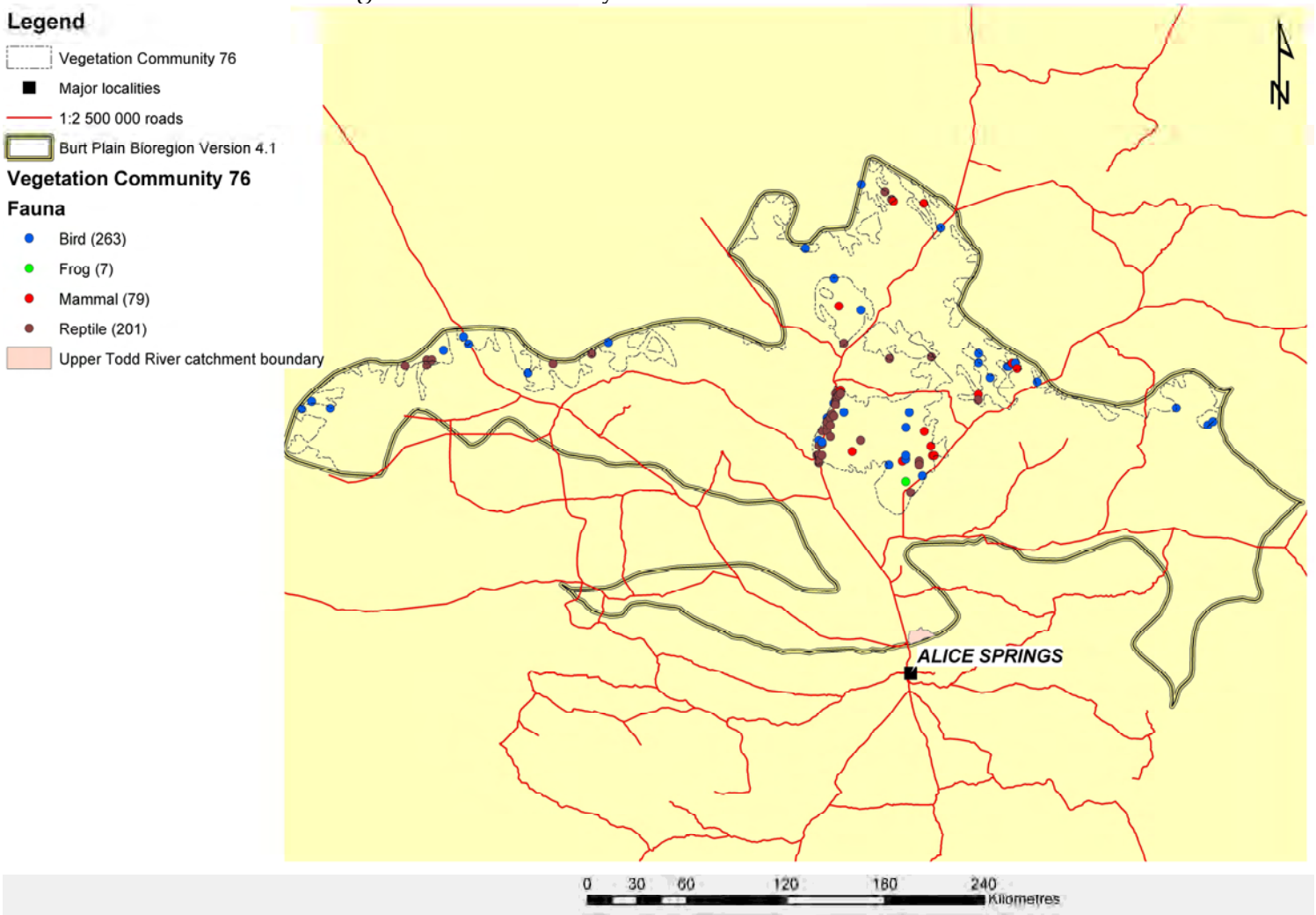


Figure 6.5 Distribution of fauna across Vegetation Community 76



The least commonly recorded frogs across the Burt Plain bioregion were the Desert Spadefoot Toad, Giant Frog and Water-holding Frog with less than ten records (Figure 6.6). There are 17 mammal species in the Burt Plain bioregion with fewer than 10 sightings, including the Central Rock-rat, Crescent Nailtail Wallaby, Dusky Horseshoe-bat, Ghost Bat, Golden Bandicoot, Hairy-footed Dunnart, Hill's Sheathtail-bat, Lesser Stick-nest Rat, Little Forest Eptesicus, Little Red Flying-fox, Long-haired Rat, Long-tailed Dunnart, Long-tailed Hopping-mouse, Long-tailed Planigale, Pale Field-rat, Pig-footed Bandicoot and Wongai Ningaui (Figure 6.7). The least commonly recorded reptiles were the Asian House Gecko, Bandy Bandy, Bearded Gecko, Black-headed Python, Common or Eastern Brown Snake, Dwarf Bearded Dragon, Eastern Spiny-tailed Gecko, Fourteen-lined Ctenotus, Green Tree Snake, Jewelled Gecko, Kintore's Egernia (Great Desert Skink), Northern Desert Banded Snake, Olive Python, Rich Ctenotus, Spencers Monitor, Stoke's Egernia, Tanami Ctenotus, Tesselated Gecko, Thick-tailed Gecko, Two-spined Rainbow Skink, White-striped Gecko (Figure 6.8). The least commonly recoded birds were the Australian Pratincole, Australian Spotted Crake, Australian White Ibis, Banded Whiteface, Black Swan, Black-chinned Honeyeater, Black-eared Cuckoo, Black-necked Stork, Black-shouldered Kite, Brolga, Chestnut Teal, Chestnut-breasted Quail-thrush, Clamorous Reed-warbler, Common Greenshank, Common Sandpiper, Darter, Flock Bronzewing, Golden-headed Cisticola, Great Cormorant, Inland Dotterel, Intermediate Egret, Jacky Winter, Letter-winged Kite, Marsh Sandpiper,

Nankeen Night Heron, Orange Chat, Peaceful Dove, Pied Cormorant, Plumed Whistling-duck, Red-necked Avocet, Redthroat, Rock Dove, Royal Spoonbill, Rufous-crowned Emu-wren, Sharp-tailed Sandpiper, Straw-necked Ibis, Sriated Grasswren, Stubble Quail, Swamp Harrier, Welcome Swallow, Whiskered Tern, White-breasted Woodswallow, White-browed Treecreeper, Wood Sandpiper (Figure 6.9).

Figure 6.6 Least commonly recorded frogs across the Burt Plain bioregion

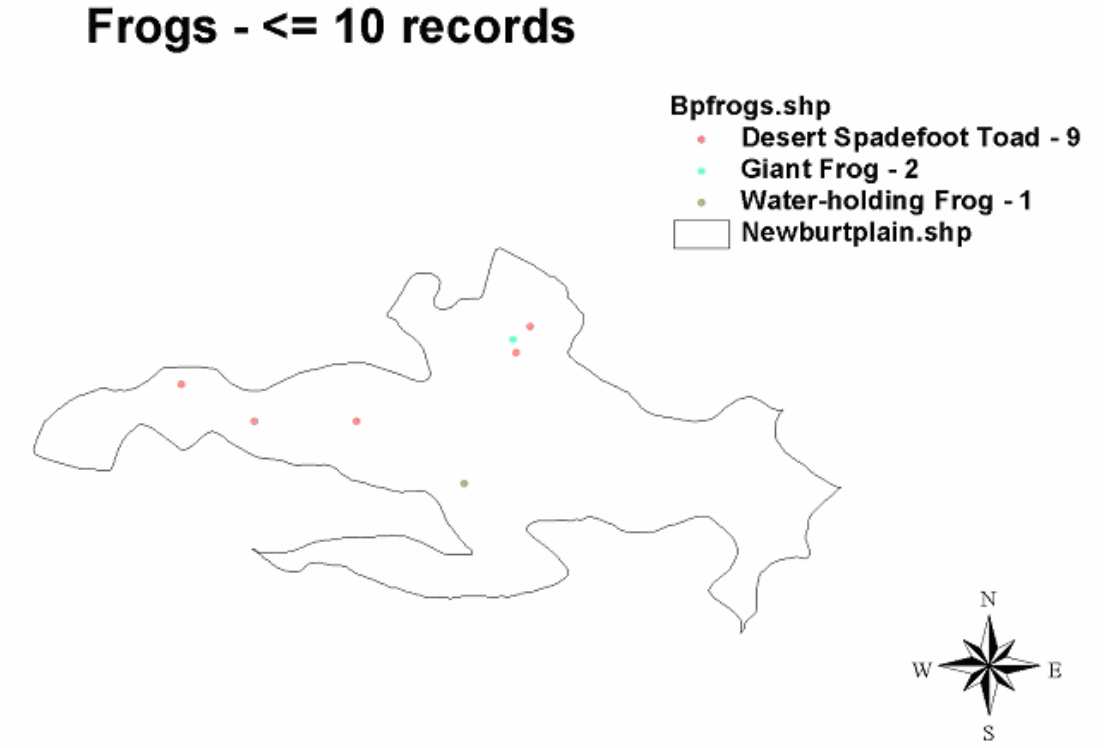


Figure 6.7 Least commonly recorded mammals across the Burt Plain bioregion

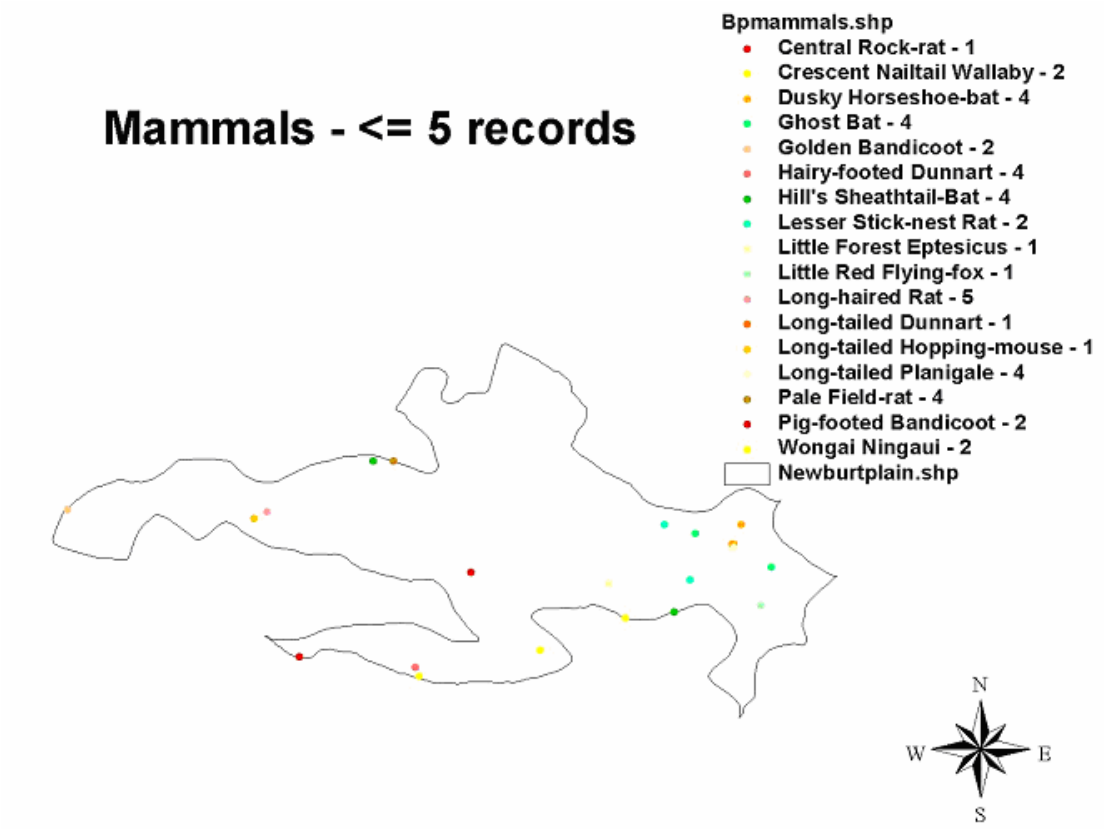


Figure 6.8 Least commonly recorded reptiles across the Burt Plain bioregion

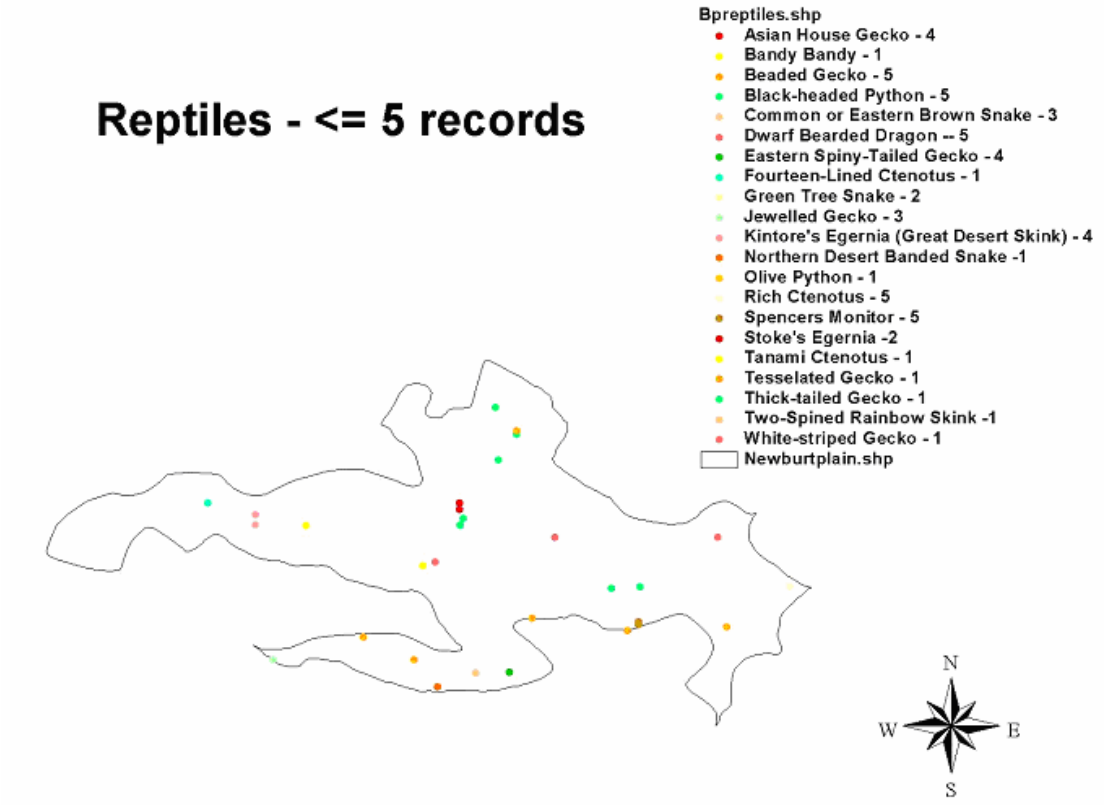
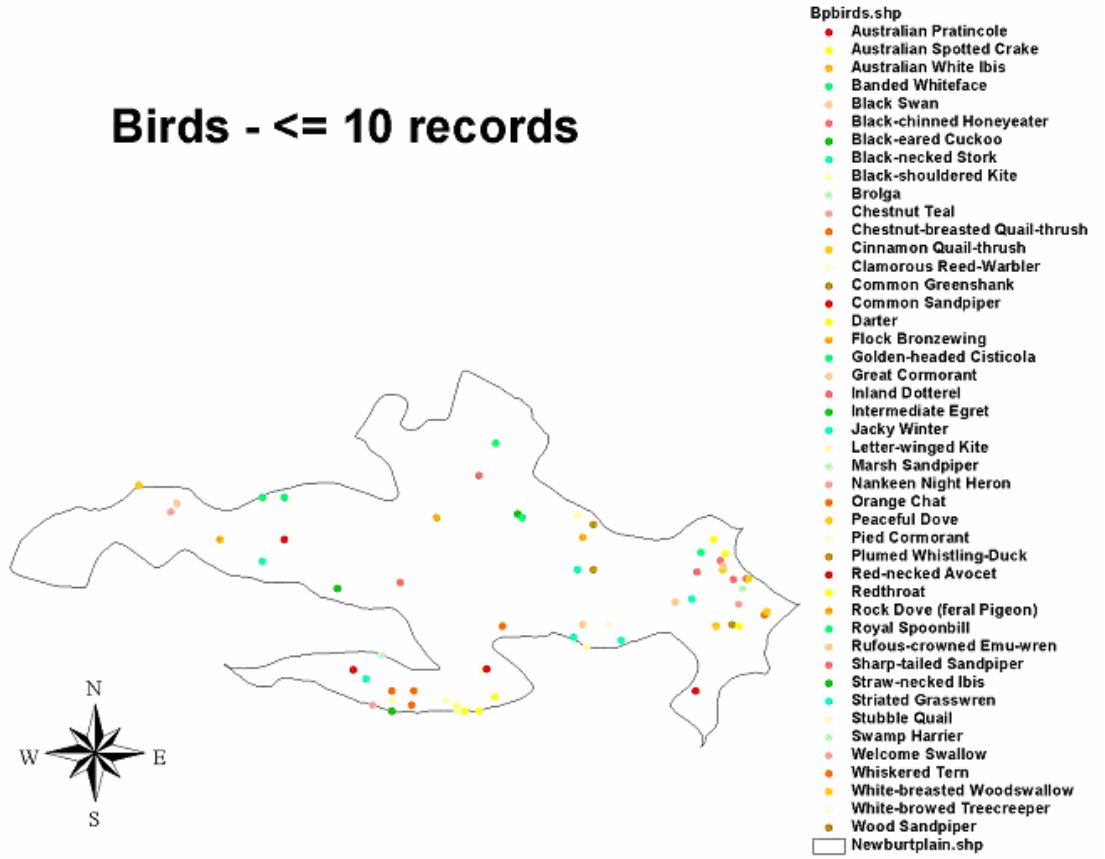


Figure 6.9 Least commonly recorded birds across the Burt Plain bioregion



6.5.2 Selected species analysis

Three target faunal species; Black-footed rock-wallaby *(Petrogale lateralis)*, Spinifex Hopping Mouse (*Notomys alexis)* and Spencers Frog (*Limnodynastes spenceri*) were selected for further detailed modelling to illustrate the potential capability and utility of the modelling approach to inform biological survey and monitoring in the arid zone. In addition to meeting the necessary biological data requirements for building statistically-robust models, target species were chosen to represent different taxonomic groups and forms of habitat use that need to be adequately assessed in the Burt Plain bioregion. *Petrogale lateralis* was chosen as it is listed as vulnerable nationally and had greater than 10 records enabling it to be able to run though SPMODEL. A small mammal *Notomys alexis* was also chosen which was more commonly found in arid areas and a frog *Limnodynastes spenceri*. The distribution of each of these species in relation to environmental layers is summarised in Table 6.8. Figure 6.10 summarises the distribution of these records in environmental space of mean annual temperature and rainfall. The mean for each variable was calculated based on all sites and presence records available for each species.

Petrogale lateralis

Petrogale lateralis is listed nationally as a vulnerable species and has only been recorded at 19 sites in the study area. The environmental variables used to characterise the distribution of these sites are described in Table 6.8. Only 35

presence records were available for analysis. The mean annual temperature was 21.8°C, higher in the wet season 26.9°C and lower as expected, in the dry season 16.7°C. The mean annual rainfall was 23.9 mm and evaporation 248.9 mm. Using the DEM, elevation diversity (the standard deviation of elevation on the surrounding 3 (300m) cells and 5 (500 m) cells was calculated as 12.4 and 13.8. Position in the landscape (i.e. position relative to the extremes of elevation in the surrounding cells 3 was also derived (-0.9, and -1.0) indicating the species is found on lower elevation (such as the foothills) when compared to the surrounding area. *Petrogale lateralis* occurred in 65 vegetation communities, 27 geology units and across 29 different land systems.

Notomys alexis

Notomys alexis has only been recorded at 16 sites in the study area. The environmental variables used to characterise the distribution of these sites are described in Table 6.8. 64 presence records were available for analysis. The mean annual temperature was 22.0°C, higher in the wet season 27.0°C and lower as expected, in the dry season 16.9°C. The mean annual rainfall was 24.5 mm and evaporation 248.6 mm. Using the DEM, elevation diversity (the standard deviation of elevation on the surrounding 3 (300m) cells and 5 (500 m) cells was calculated as 1.6 and 2.6. Position in the landscape (i.e. position relative to the extremes of elevation in the surrounding cells 3 was also derived (-0.5, and -0.9) indicating the species is found on lower elevation

when compared to the surrounding area. *Notomys alexis* occurred in 58 vegetation communities, 57 geology units and across one land system.

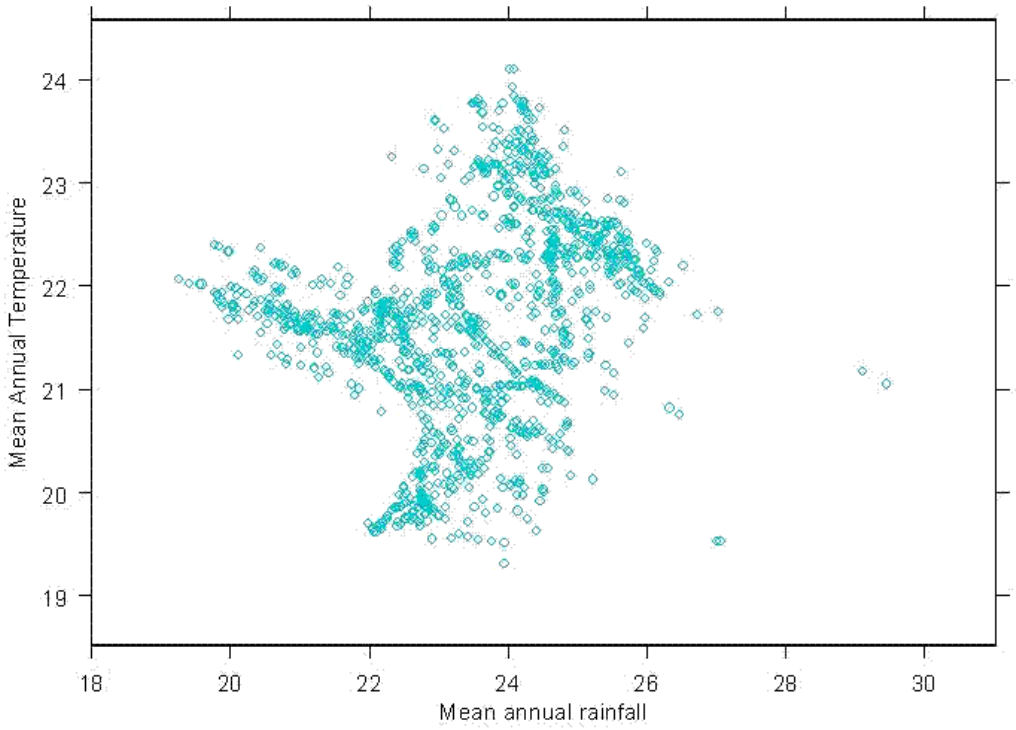
Limnodynastes spenceri

Limnodynastes spenceri has only been recorded at 18 sites in the study area. The environmental variables used to characterise the distribution of these sites are described in Table 6.8. 198 presence records were available for analysis. The mean annual temperature was 20.9^{o}C, higher in the wet season 26.1^{o}C and lower as expected, in the dry season 15.7^{o}C. The mean annual rainfall was 24.2 mm and evaporation 243.2 mm. Using the DEM, elevation diversity (the standard deviation of elevation on the surrounding 3 (300m) cells and 5 (500 m) cells was calculated as 3.0 and 4.4. Position in the landscape (i.e. position relative to the extremes of elevation in the surrounding cells 3 was also derived (-0.3, and -0.4) indicating the species is found on lower elevation when compared to the surrounding area. *Limnodynastes spenceri* occurred in 65 vegetation communities, 27 geology units and across 9 different land systems.

Table 6.8 Summary of environmental conditions for selected species

Species	***Petrogale lateralis***	***Notomys alexis***	***Limnodynastes spenceri***
2002 EPBCA Conservation status	Vulnerable	N/A	N/A
No. of sites	19	16	18
No. of presence records	35	64	198
Mean Annual Temperature ^{o}C	21.8	22.0	20.9
Mean Annual Raindays	3.9	4.0	4.1
Mean Dry Season Temperature ^{o}C	16.7	16.9	15.7
Mean Evaporation (mm)	248.9	248.6	243.2
Mean Annual Rainfall (mm)	23.9	24.5	24.2
Mean Wet Season Temperature ^{o}C	26.9	27.0	26.1
Potassium	3.1	3.2	2.7
Thorium	13.4	17.4	19.6
Uranium	3.8	3.9	3.8
Total Count	47.5	48.7	57.0
Hi-Pass Total Count	0.001	0.022	0.000
Elevation Diversity 300m	12.4	1.6	3.0
Elevation Diversity 500m	13.8	2.6	4.4
Position in landscape, 300m	-0.9	-0.5	-0.3
Position in landscape, 500m	-1.0	-0.9	-0.4
Mean Elevation (m)	593.2	636.3	668.0
No. of Vegetation units	65	58	65
No. of Geology units	27	57	27
No. of Land system units	29	1	9

Figure 6.10 Location of biological survey sites used in this study in relation to the quantified environmental space of the Burt Plain bioregion (shown in light blue) as defined by mean annual rainfall (mm) and mean annual temperature (degrees Celcius). The biological survey sites sample the observed variation in climate in the bioregion as determined by these variables.



GLM Models

Using the software SPMODEL the three selected species were analysed using the GLM option. A prediction map based on 17 available records using a GLM model is provided for the *Petrogale lateralis* (Figure 6.11). The map shows the predicted probability of *Petrogale lateralis* presence throughout the region. Probabilities have been classified into six categories (0–0.01, 0.01–0.05, 0.05–0.10, 0.10–0.30, 0.30-0.60, 0.60-1.00) for presentation. Darker areas indicate the probability of locating the species in this area is higher than those which are shaded light blue. This map displays the presence records for the species that were used in model fitting, allowing a visual assessment of predictive performance. Figure 6.12 shows the associated statistics for the predictor variables selected which help to best explain the distribution of the species: slope and rddist (euclidean distance to road).

There were 16 available records for *Notomys alexis* and these were used to derive a GLM model provided for *Notomys alexis* (Figure 6.13). The map shows the predicted probability presence of *Notomys alexis* throughout the region. Probabilities have been classified into six categories (0–0.01, 0.01–0.05, 0.05–0.10, 0.10–0.30, 0.30-0.60, 0.60-1.00) for presentation. Darker areas indicate the probability of locating the species in this area is higher than those which are shaded light blue. This map also displays the presence records for the species that were used in model fitting, allowing a visual assessment of predictive performance. Figure 6.14 shows the plots of predictor variables

selected which help to best explain the distribution of the species included wtmintm (Wet season annual temperature), rddist (euclidean distance to road), dist (euclidean distance to hydrological feature), dem3min (Minimum elevation values 300m) and latitude.

A prediction map based on 18 available records using a GLM model is provided for the *Limnodynastes spenceri* (Figure 6.15). The map shows the predicted probability of *Limnodynastes spenceri* presence throughout the region. Probabilities have been classified into six categories (0–0.01, 0.01–0.05, 0.05–0.10, 0.10–0.30, 0.30-0.60, 0.60-1.00) for presentation. Darker areas indicate the probability of locating the species in this area is higher than those which are shaded light blue. This map also displays the presence records for the species that were used in model fitting, allowing a visual assessment of predictive performance. Figure 6.16 shows the significant explanatory environmental variables selected which help to best explain the distribution of the *Limnodynastes spenceri* included totcnt (Total Count) and pos3 (Position in landscape, 300m).

Figure 6.11 Prediction for *Petrogale lateralis* using GLM modelling

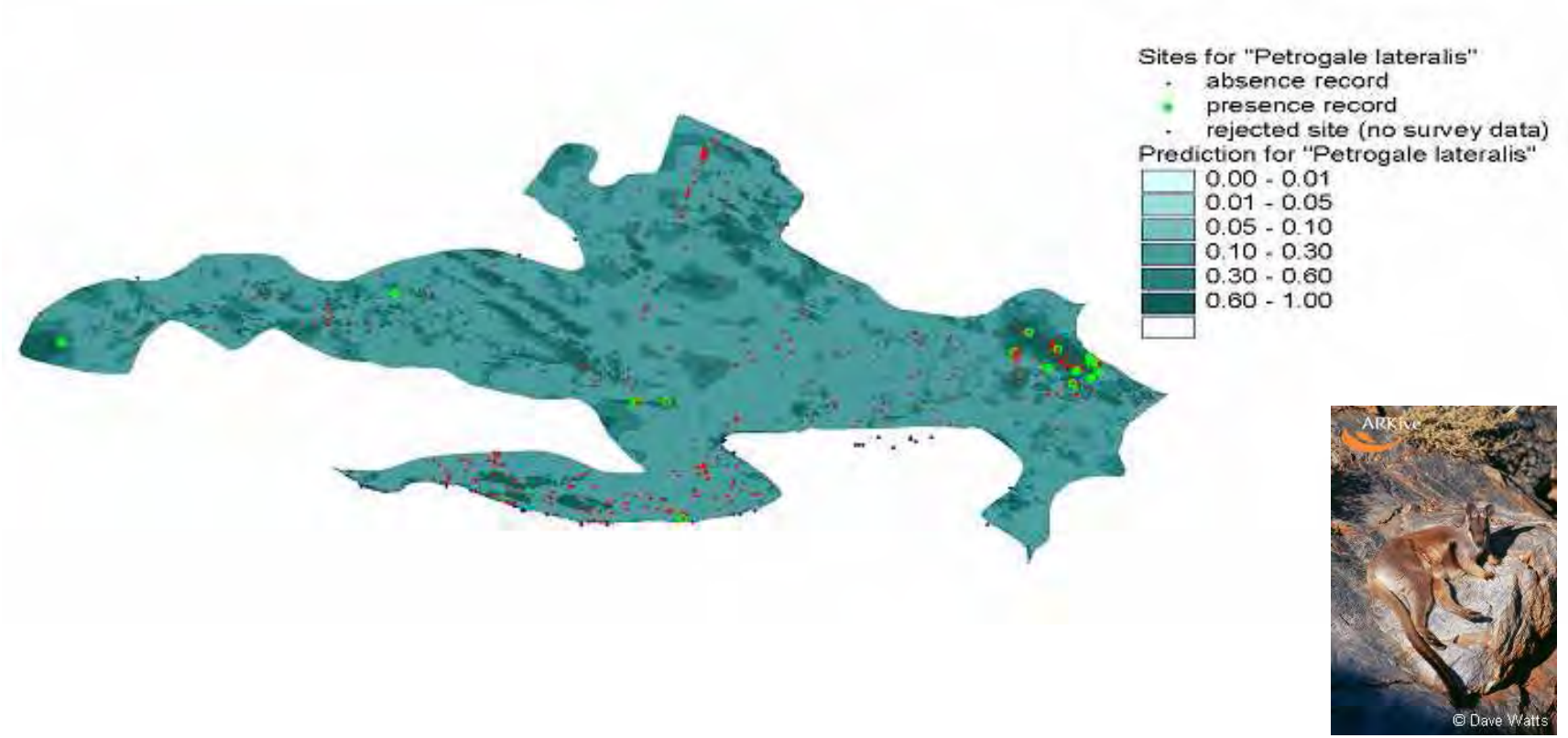


Figure 6.12 Plots describing the relationship of selected environmental predictors for *Petrogale lateralis* using GLM modelling.

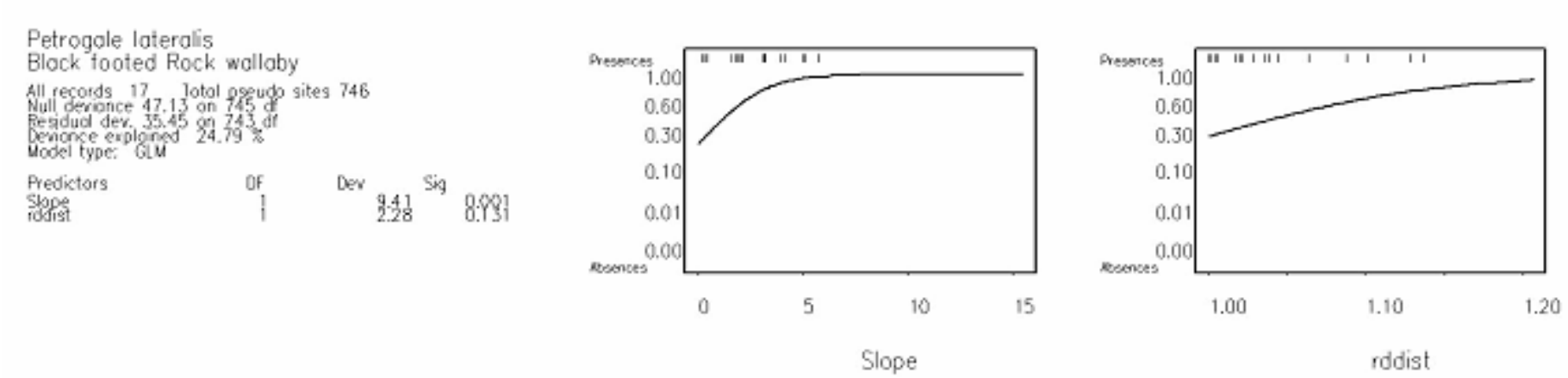


Figure 6.13 Prediction for *Notomys alexis* using GLM modelling

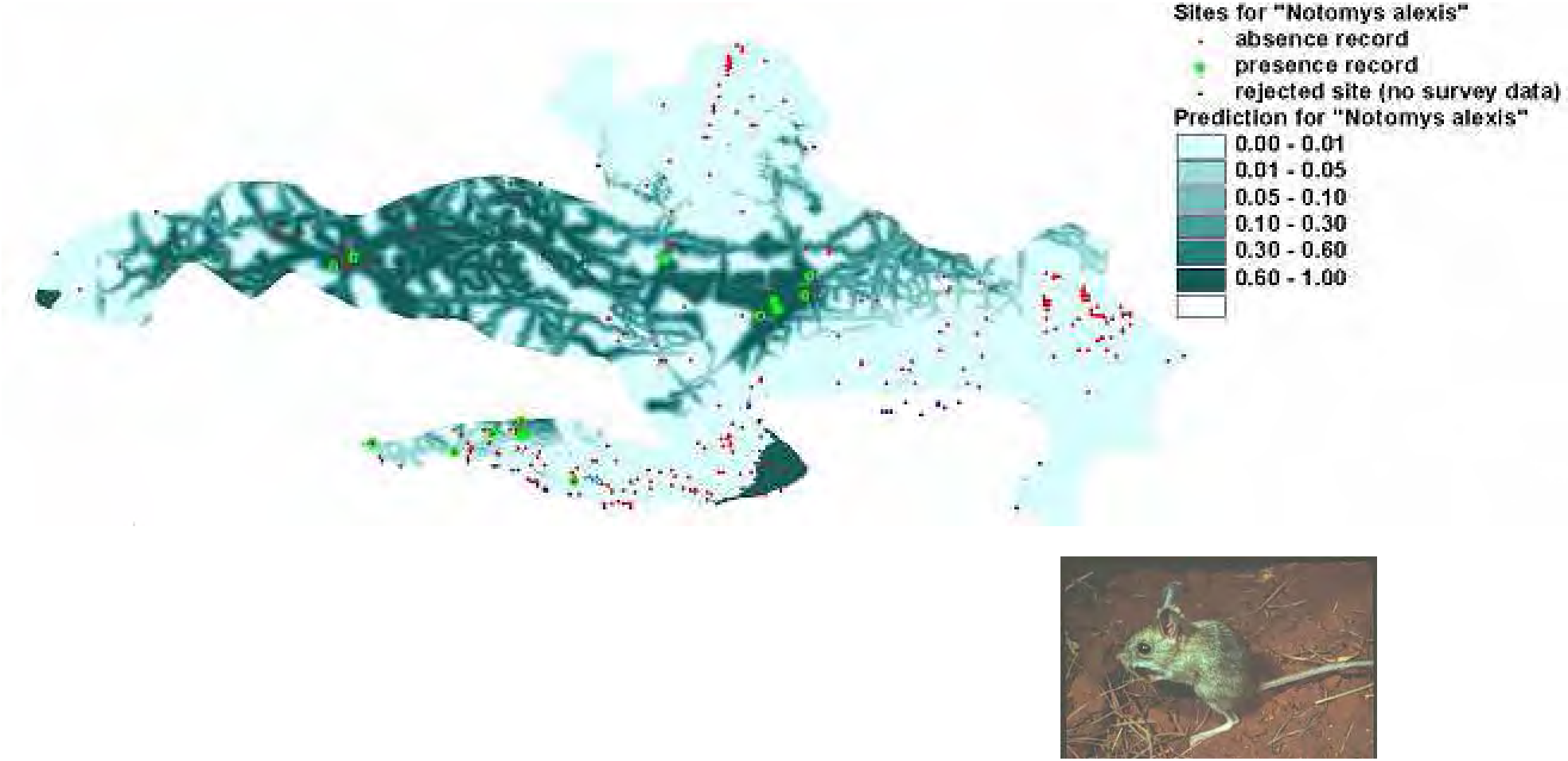


Figure 6.14 Plots describing the relationship of selected environmental predictors for *Notomys alexlis* using GLM modelling.

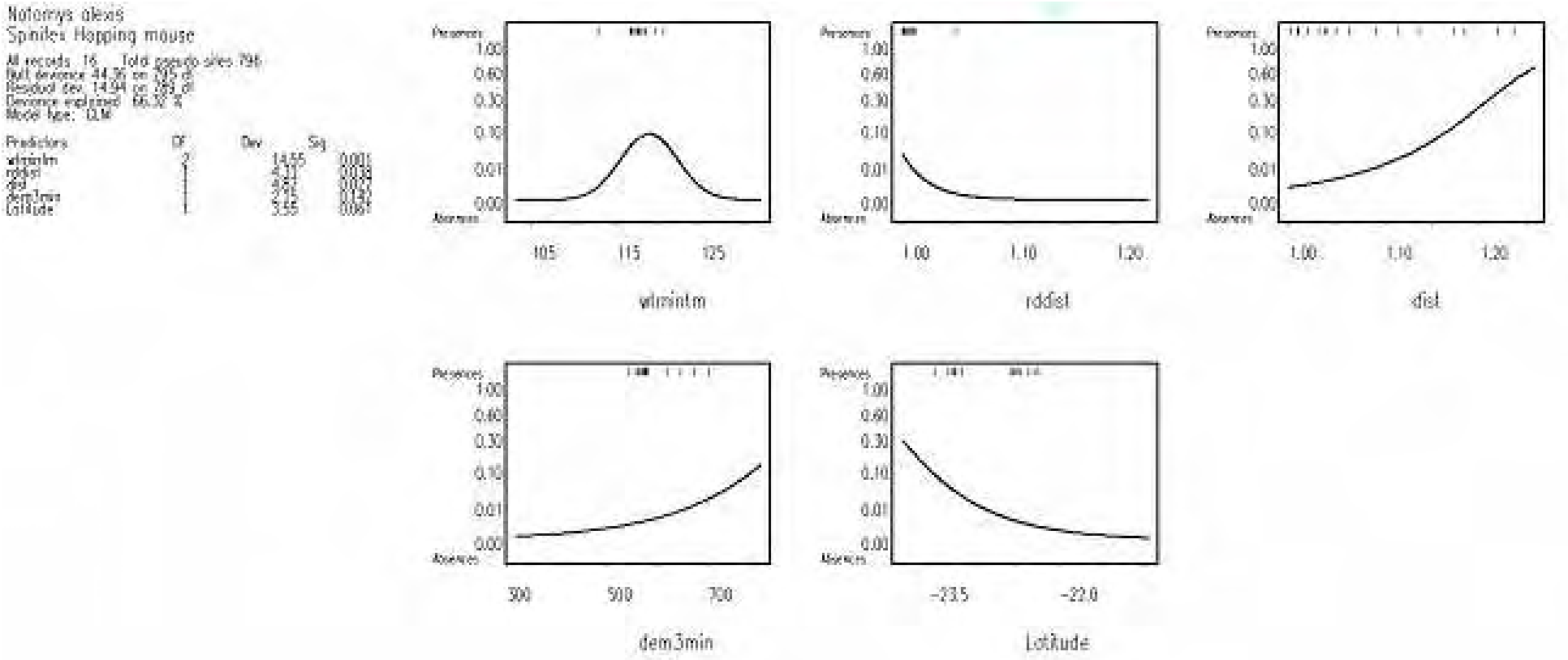


Figure 6.15 Prediction for *Limnodynastes spenceri* using GLM modelling

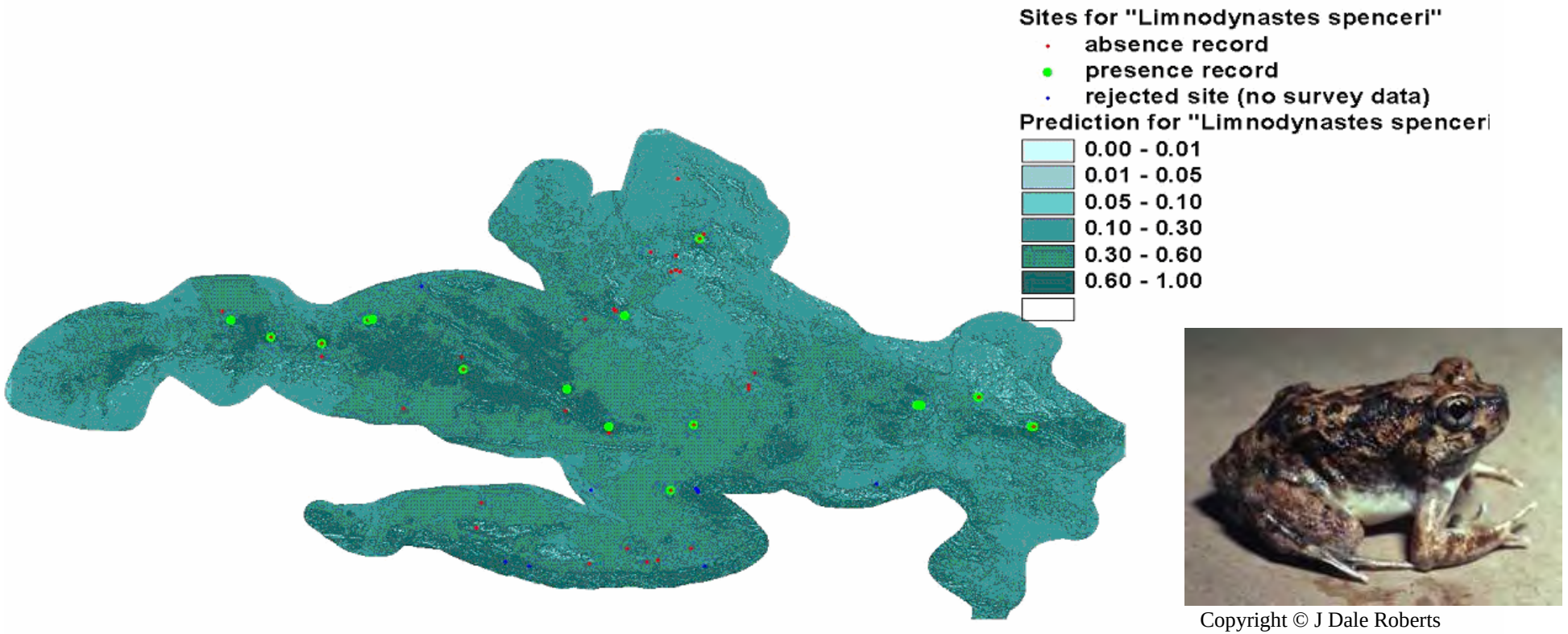


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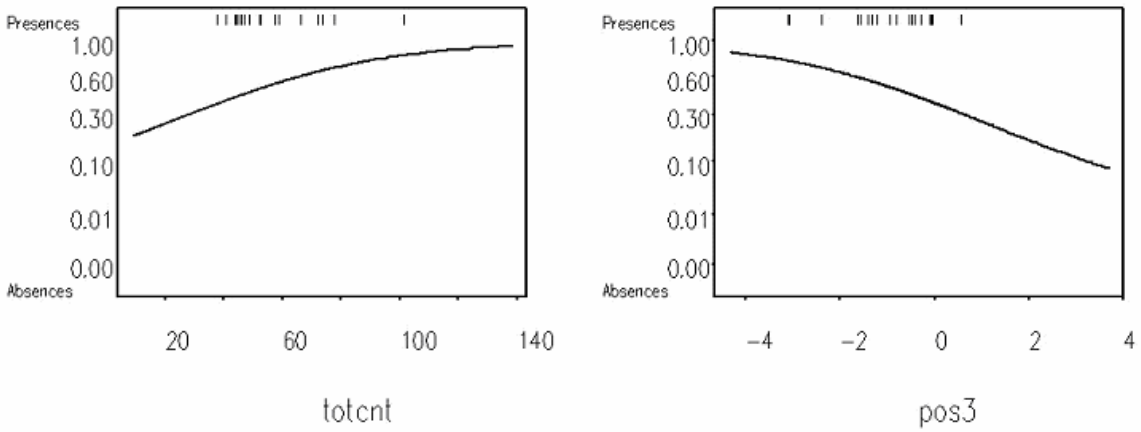
Figure 6.16 Plots describing the relationship of selected environmental predictors for *Limnodynastes spenceri* using GLM modelling.

Limnodynastes spenceri
Spencer s Frog

All records 18 Total pseudo sites 744
Null deviance 49.91 on 743 df
Residual dev. 44.34 on 741 df
Deviance explained 11.15 %
Model type: GLM

Predictors	DF	Dev	Sig
totcnt	1	3.27	0.033
pos3	1	2.29	0.131



GAM Models

Using the software SPMODEL the three selected species were analysed using the GAM option. Figure 6.17 displays the prediction for *Petrogale lateralis* based on 17 available records, with darker areas indicating the probability of locating the species in this area are higher than those which are shaded light blue. Figure 6.18 shows the associated statistics for the selected predictor variables: dem3range (Elevation range 300m), wtmintm (wet season annual temperature) and rddist (euclidean distance to road).

Figure 6.19 displays the prediction for *Notomys alexis* based on 16 available records with darker areas indicating the probability of locating the species in this area are higher than those which are shaded light blue. Figure 6.20 shows the selected predictor variables including wtmintm (Wet season annual temperature), rddist (euclidean distance to road), dist (euclidean distance to hydrological feature), dem3min (Minimum elevation values 300m) and latitude.

Figure 6.21 displays the prediction for *Limnodynastes spenceri* based on 18 available records, with darker areas indicating the probability of locating the species in this area are higher than those which are shaded light blue. Figure 6.22 shows the selected predictor variables including totcnt (Radiometric total count) and pos3 (Position in landscape, 300m).

Comparison between GLM and GAM Models

The principal difference between GAMs and GLMs in modelling species distributions is that GAMs allow the survey data to determine the shape of the response curves, instead of being constrained by specific parametric forms. In other words, fewer assumptions are made about how species respond to their environment. The number of grid cells assigned to prediction values for both GLM and GAM models can be used to compare the models (Table 6.9). When comparing the outputs of GLMs an GAMs produced by SPMODEL the same predictor variables were selected for *Limnodnastes spenceri* as well as for *Notomys alexis*, except for one variable 'dem3range' which was also selected in the GAM. For *Petrogale lateralis* three predictor variables were selected for GLM and two for GAM. The predictor variable 'rddist' was selected in both GLM and GAM outputs.

Table 6.9 A comparison of the number of grid cells for GAM and GLM prediction models for *Petrogale lateralis, Limnodynastes spenceri* and *Notomys alexis.*

	GAM			GLM	
SPECIES	**0-30%**	**30-70%**	**70-100%**	**0-30%**	**30-70%**	**70-100%**
Petrogale lateralis	734230	218913	82652	728506	220720	86497
Limnodynastes spenceri	393933	847380	123942	386883	870836	107586
Notomys alexis	645777	221204	168814	838878	108709	88208

Figure 6.17 Prediction for *Petrogale lateralis* using GAM modelling

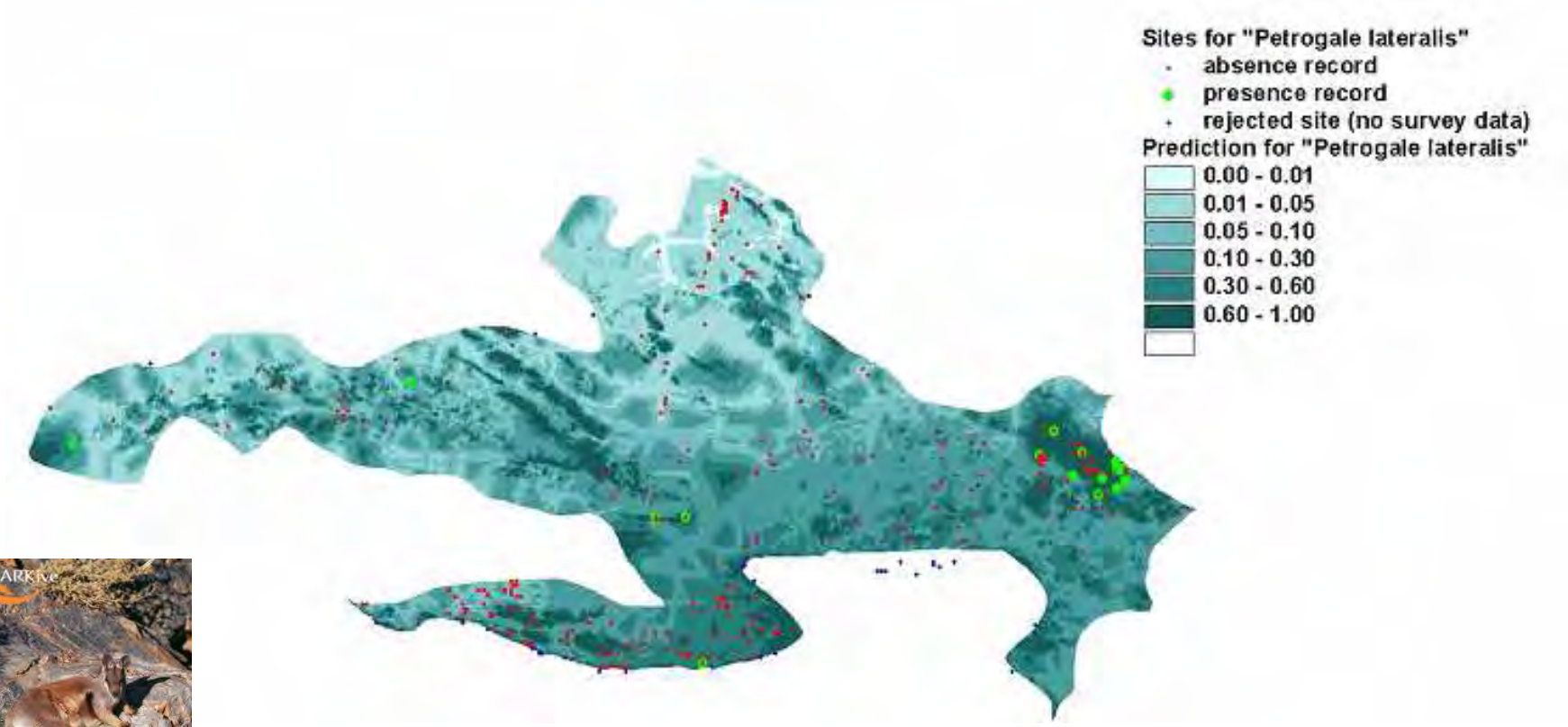


Figure 6.18 Plots describing the relationship of selected environmental predictors for *Petrogale lateralis* using GAM modelling.

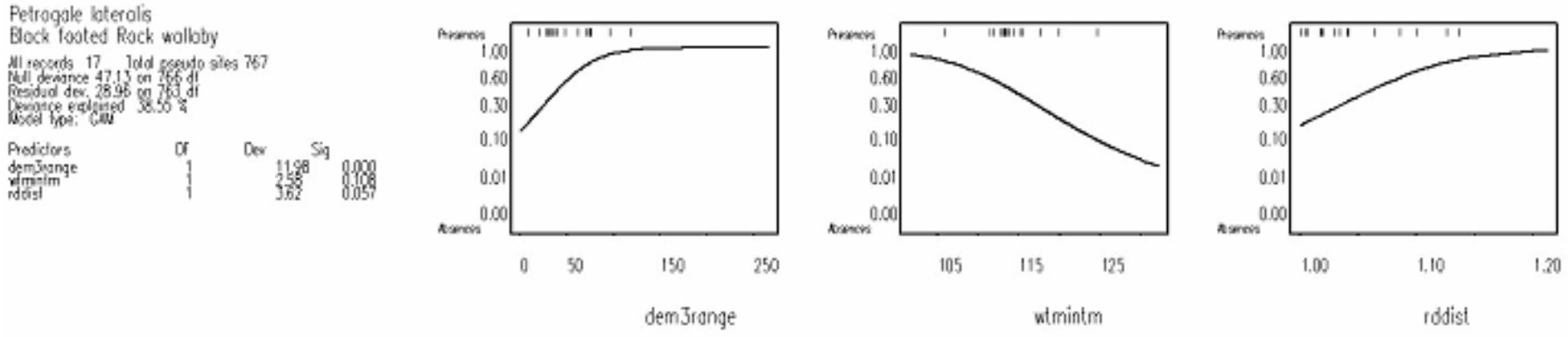


Figure 6.19 Prediction for *Notomys alexis* using GAM modelling.

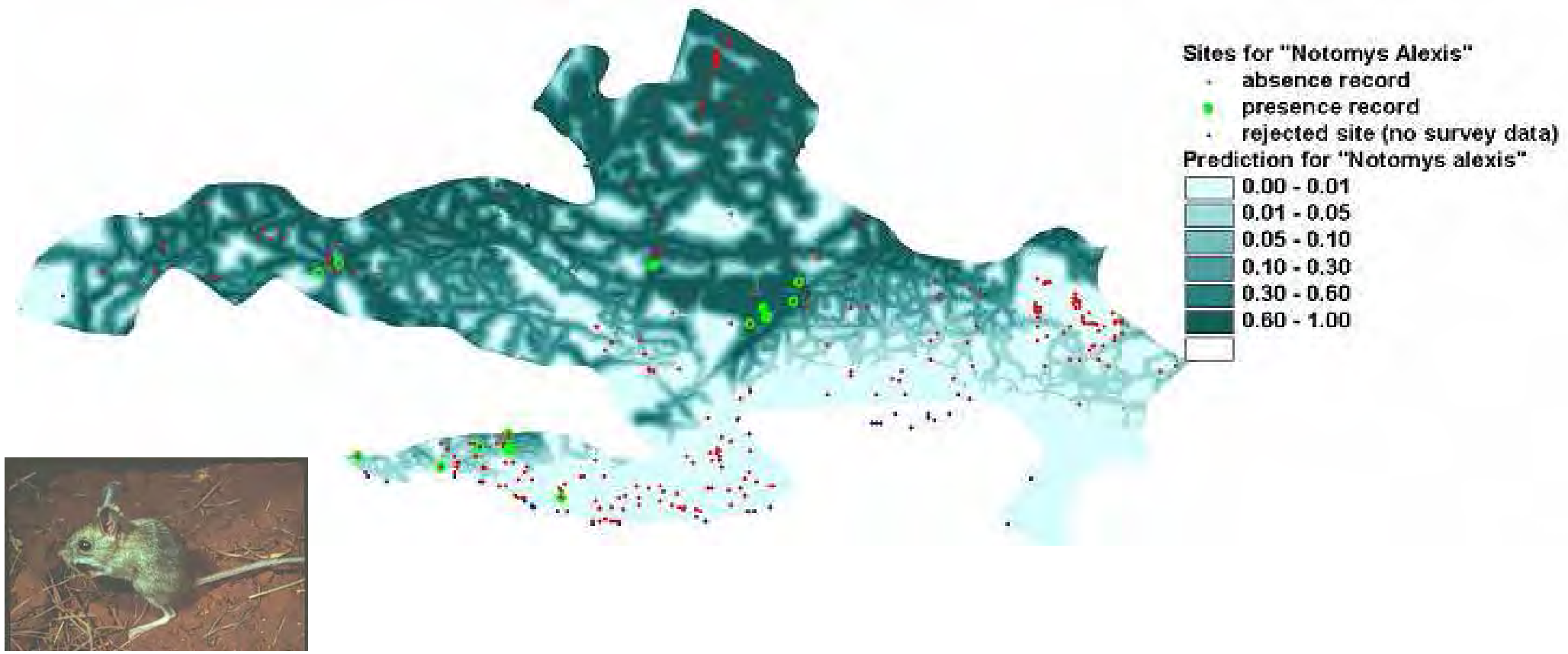


Figure 6.20 Plots describing the relationship of selected environmental predictors for *Notomys alexlis* using GAM modelling.

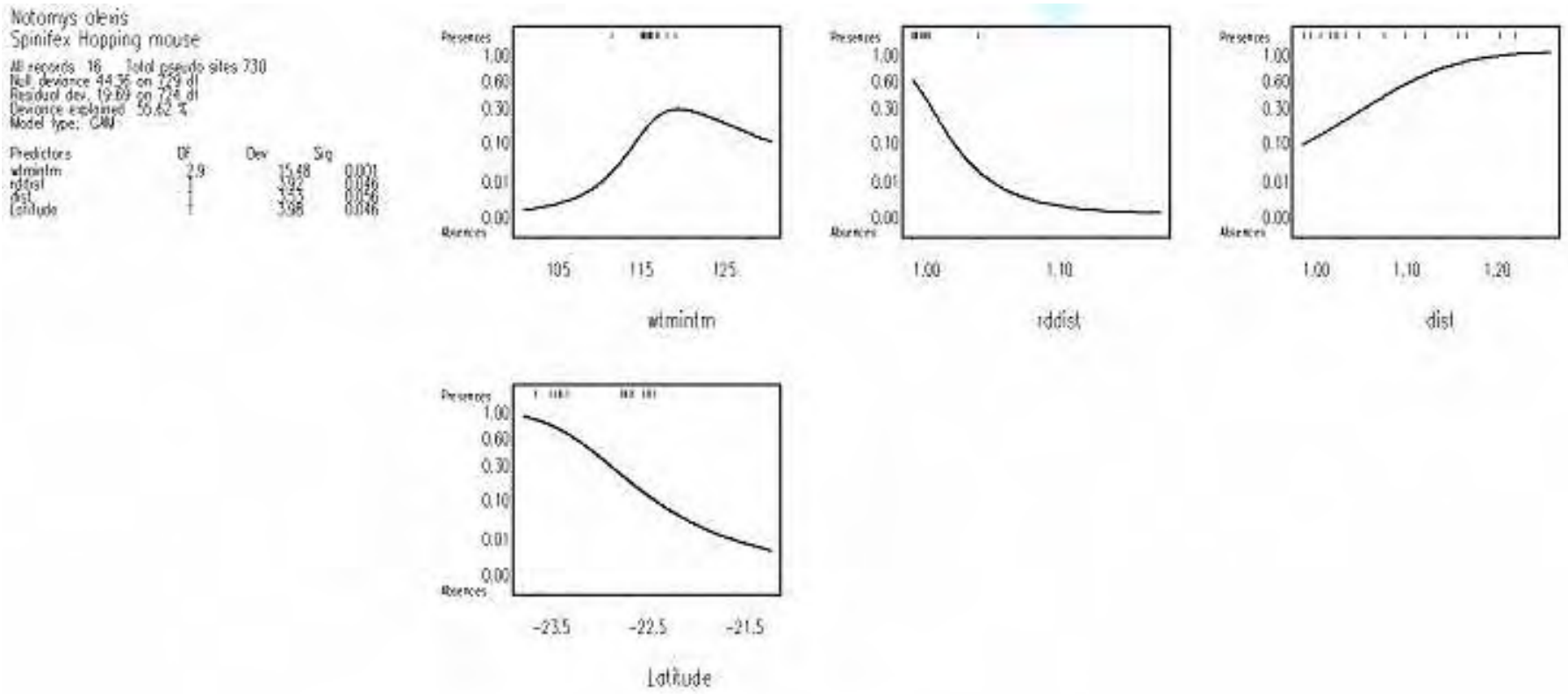


Figure 6.21 Prediction for *Limnodynastes spenceri* using GAM modelling.

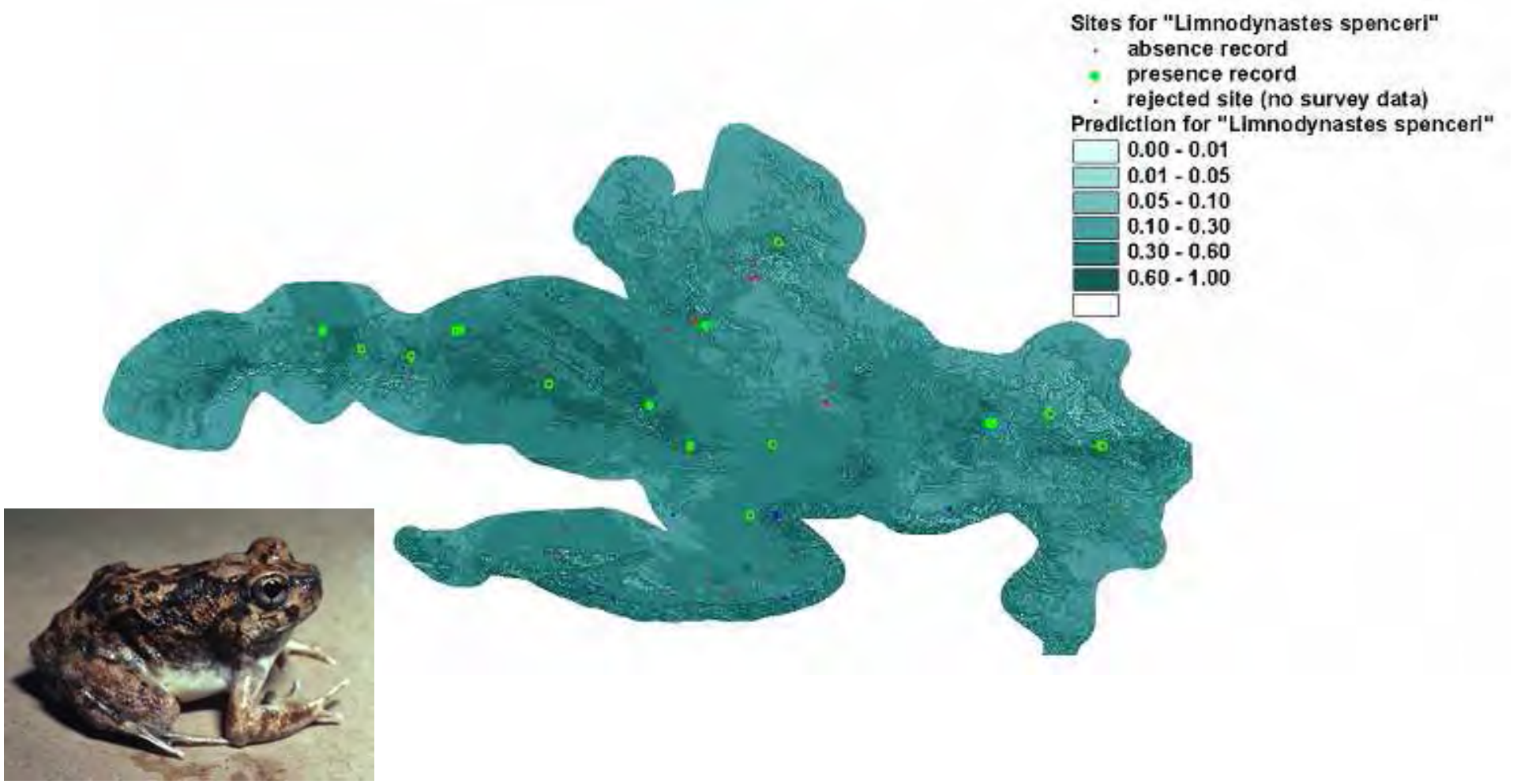
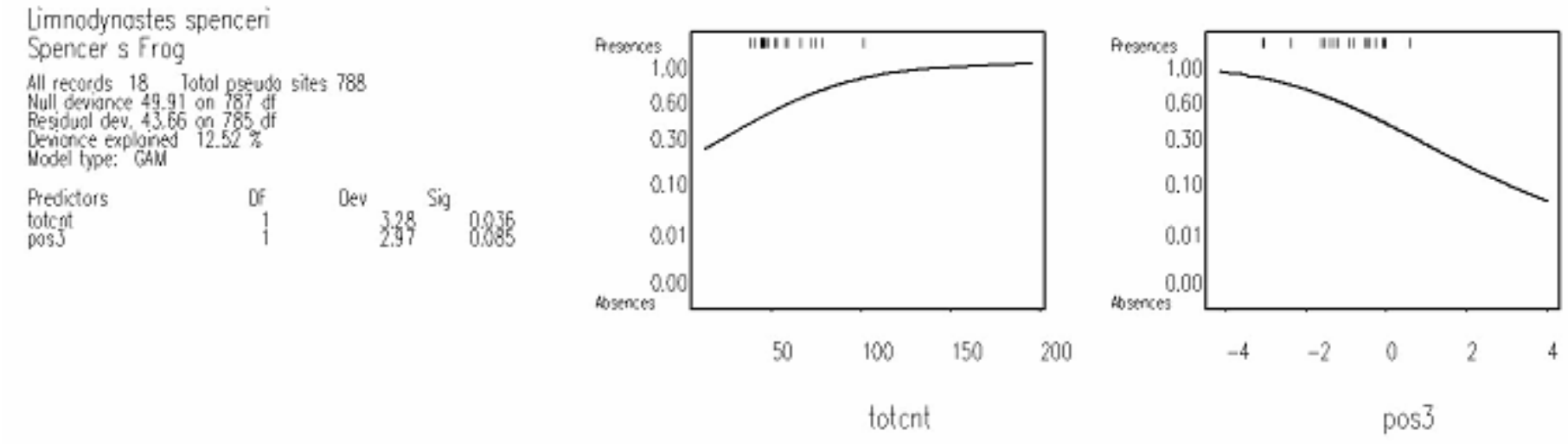


Figure 6.22 Plots describing the relationship of selected environmental predictors for *Limnodynastes spenceri* using GAM modelling.



6.6 DISCUSSION

6.6.1 Distribution of fauna across the Burt Plain Bioregion

The distribution of the animal species across the central Australian ranges are influenced by a variety of environmental terrain factors (Griffin 1997; Reid *et al.* 1997). Many of these factors can be quantified or approximated using data from digital elevation models (DEM) and associated geographic information system (GIS) technology. The vertebrate fauna of Central Australia is comparatively rich for an Australian desert region. This richness stems largely from the geological and topographic diversity characteristic of the study region. This statement can be supported by comparing counts of species richness by vertebrate class in the region with published data from other inland Australian regions. For example, Gentilli (1992) has demonstrated this for birds. There is, however, very little published information on the habitat relationships or on environmental controls of vertebrate distribution within the central ranges, or indeed in most Australian desert regions e.g. James *et al.* (1995).

Biological surveys are necessary to gather species distribution data for the identification of priority conservation areas. Wessels *et al.* (1998) suggests that the gradsect method should detect the maximum number of species in an area. Wessels *et al.* (1998) evaluated the efficiency of the method and found it

to be as efficient as the habitat-specific survey method and consistently more efficient than the systematic and random surveys for both taxa sampled.

Comprehensive biological surveys are expensive (Burbridge, 1991). Financial constraints and the increasing demand for living resource data both provide a strong incentive for optimising survey methods (Gillison, 1983; May, 1994). Historically, surveys were based on random, systematic or simple stratified sampling (Lambert, 1972; Smartt and Grainger, 1974; Green, 1979; Greig-Smith, 1983). These 'statistical' (probability) sampling procedures have proven to be logistically demanding and costly (Austin and Basinki, 1978; McKenzie and Austin, 1993). They also ignore the underlying non-random relationship between biota and their physical environment (Gillison and Brewer, 1985).

There have been no systematic, extensive wildlife surveys of the Burt Plain bioregion. The only surveys known was those conducted in the Dulcie Ranges National Park (Gibson *et al.* 1989; Latz & Langford 1983). The distribution of fauna and survey sites across the Burt Plain bioregion in respect to geographical space is heavily biased towards the main road network. Over 12 1985 vertebrate species occurrences have been recorded within the bioregion. However, there are a number of species (including threatened species) that had been recorded less than 10 times.

6.6.2 Modelling and spatial predictions

Given adequate, georeferenced biological data, regional environmental data coverages can be used to model spatial distributions of biota. Generalised additive modeling is a recent extension of generalized linear modeling (Neldner and Wedderburn 1972; McCullagh and Neldner 1989) that relaxes previous assumptions concerning the functional form of species' responses to environmental variables. Generalised linear modeling has been widely used to model species distributions, most commonly as a logistic regression with a binomial (presence versus absence) response (e.g. Austin *et al.* 1984; Buckland and Elston 1993; Lenihan 1993; Pearce *et al.* 1994).

Modelling may be used to make inferences about the habitat requirements of species and likely response to environmental change, or it may be used to predict a species abundance, density, carrying capacity or probability of occupying a location based on its environmental attributes (Wintle *et al.* 2005; Austin 2002; Elith and Burgman 2002). The primary use of habitat modelling in conservation planning is in predicting the spatial distribution of suitable habitat for species of interest in a given landscape. As with any statistical exercise, samples either of small size or having few cases where the response variable is non-zero cause problems. The main limitations for modelling fauna species across the Burt Plain were that only presence data were available (i.e. where occupied locations are recorded but no attempt has been

made to record locations that are unoccupied systematically) and the data were heavily biased either towards road networks and possibly certain environments. The use of presence-only data may be problematic since these data may have been collected as a result of unplanned and biased surveys with unspecified spatial accuracy. As a consequence, the inherent variation in survey effort between different environments and geographical areas cannot be controlled or adjusted in model fitting (Ferrier *et al.* 2002; Kadmon *et al.* 2003). This was evidenced by the predictor variable 'rddist' (Euclidean distance to roads) for the biological data available in this study. Notwithstanding these difficulties, spatial models of the distribution of selected wildlife species were generated using two techniques GLM and GAM. Apart from suggesting localities where future searches and surveys for a species may be conducted, the analysis helps in separating ecological and historical determinants of various species distributions. Significant extensions to home ranges of many species are still possible. SPMODEL may provide important cues about preferential conditions, and is a useful analysis tool to generate potential habitat maps. It may also be useful for predictions about the expected expansion of introduced species. Ground-truthing of models would be the next logical step to further evaluate the predicted occurrences of species across the bioregion.

The values of environmental features shown to be significant correlates of the presence or abundance of the species can be used to predict its distribution

across the region; generalised linear modelling is an effective tool for this process (Nicholls 1989, 1991). GLMs are reported to constitute a more flexible family of regression models, which allow other distributions for the response variable and non-constant variance functions to be modelled (Guisan *et al.* 2002). Whereas, GAMs are commonly used to implement non-parametric smoothers in regression models (Austin & Meyers 1996; Yee & Mitchell 1991). This technique applies smoothers independently to each predictor and additively calculates the component response (Guisan *et al.* 2002).

Petrogale lateralis

Three species of rock-wallabies are currently known from the Northern Territory (N.T.). The Black-footed Rock-wallaby *Petrogale lateralis* is listed by ANZECC as vulnerable and the Northern Territory populations are known to have declined over the past 40 years (Lundie-Jenkins & Findlay 1997). Although populations in the extreme south of the overall range of the species have declined or become extinct over the past 20-30 years, it has disappeared from only 21 of 400 sites surveyed (5%) in the Territory (Gibson 2000). The distribution of the MacDonnell Ranges race is centred on the MacDonnell Ranges bioregion but also extends north to the Burt Plain bioregion of central Northern Territory. The extent of occurrence within the Territory is estimated at 37 000 km^2 (Gibson 2000). Further, most of these sites were small, isolated hills that supported small populations. Whilst populations of all three rock-wallaby species are represented in the N.T. reserve system there are currently

no formal programs to monitor or manage these populations (Lundie-Jenkins & Findlay 1997). The factors of most concern in relation to conservation of rock-wallabies in the N.T. are changes in fire regimes, habitat degradation caused by grazing feral and domestic stock and introduced predators (Lundie-Jenkins & Findlay 1997), particularly foxes (McCallum 1997).

Notomys alexis

Dickman *et al.* (1999) described how populations of rodents were studied for periods of 7-9 years at three sites in arid Australia. All species fluctuated dramatically in abundance, being absent or in low numbers during droughts but erupting after significant rainfall, with *Notomys alexis* erupting 3-10 months after rain. Dickman *et al.* (1999) concluded that long-term studies should play an important role in describing temporal changes in rodent populations in arid Australia and, with field experiments, in evaluating how rainfall and other factors combine to effect the changes.

In another study, fire-driven succession and a period of high rainfall had a pronounced effect on the distribution and abundance of small mammals such as *Notomys alexis* inhabiting spinifex grassland (Masters 1993). Both Masters (1993) and Letnic (2003) have indicated that *Notomys alexis* were more abundant on sites burnt and respond positively to the fire treatment. The study by Masters (1993) highlighted the importance of fire as a management tool and that patch burning within spinifex grasslands maximises species

diversity of small mammals by ensuring that suitable successional states are present at all times. Letnic and Dickman (2005) in their study noted that *Notomys alexis* showed some preferences for regenerating habitats but concluded that patch-burning regimes do not benefit small mammals directly, but are likely to increase the resilience of 'fire-sensitive' species that are dependent on dense spinifex by reducing the extent of wildfires.

Limnodynastes spenceri

Habitat modification remains a key threat to Australian frogs (associated with the status of 50% of threatened species) (Hero & Morrison 2004). Legislative protection is an essential process to ensure the conservation of these species. While many threats associated with frog habitat loss and change have been identified there is little quantitative information on frog–habitat relationships in modified landscapes, habitat fragmentation or knowledge of the connectivity required between terrestrial and aquatic frog habitat (Hazell 2003). Without this information frogs have largely been ignored in efforts to revegetate and manage for the conservation of Australian biota outside reserves. Ecological frog research in modified landscapes is required to avoid land-management decisions and conservation strategies based on inappropriate assumptions of how biota respond to landscape change.

In this chapter I have focused on one frog species as an example of how species modelling can be used to provide more information on environmental correlates and its occurrence across the Burt Plain bioregion.

6.7 CONCLUSION

Predictions of species distributions may be useful for prioritising land acquisitions for reserve status as well as for the future design of surveys. Models of probability or likelihood of species presence and associated environmental variables to predict species distributions at non-surveyed sites can provide a 'stepping stone' for further biodiversity conservation. Ideally, modelling should be an iterative procedure based on sound theoretical assumptions as to the driving variables and processes influencing the response variable. Successive refinements could be made to models to improve the predictive success, reliability and robustness, and ideally the models would be tested on an independent data set. In the absence of detailed autecological and natural historical knowledge of vertebrates recorded in the Burt Plain bioregion and Central Australia, the driving ecological factors that account most functionally for their distribution are poorly known. There were a number of species which have been recorded less than ten times, therefore it is recommended that these species are given priority in future survey designs.

CHAPTER 7 - CASE STUDY OF THE BURT PLAIN BIOREGION – IV. USE OF RADIOMETRIC DATA FOR WILDLIFE HABITAT MODELLING

7.1 INTRODUCTION

Airborne geophysical methods have traditionally been used in geological mapping and the exploration for valuable minerals (Bodorkos *et al.* 2004; Dickon and Scott 1998; Worrall *et al.* 1999). Radiometric surveys measure the distribution of uranium, thorium and potassium in the Earth's crust, by recording the gamma-ray radiation emitted during the decay of these elements. Approximately 90% of measured gamma rays are received from the top 30 cm of the ground. These measurements enable the interpretation of rock and soil types. These data can be used to define soil types, and radiometrics may help differentiate key discharge and recharge zones at the catchment level. However, the application of airborne geophysical technologies to other areas of land and resource evaluation remains limited despite the rapid development of these technologies over the past decade.

In this chapter I introduce a study investigating the utility of radiometric data for predicting vegetation community patterns and wildlife habitat in the arid zone. Statistical relationships are tested between the concentrations of the elements

uranium, thorium and potassium and terrain characteristics such as position in landscape, slope and aspect and other environmental variables.

The following research objectives were set to further evaluate select fauna species within the Burt Plain study region:

- to examine the relationship between radiometric elements as predictors of wildlife distribution; and
- to compare the outputs of GLM presence-only models to GAM presence-only models produced by the software SPMODEL for selected taxa.

7.2 BACKGROUND

The arid zone represents around 70% of the Australian land mass and supports a significant component of the continent's biological diversity (Williams *et al.* 2001). Although the region has not been subject to the extensive clearance of native vegetation that has occurred in many other parts of Australia, European occupation has brought many changes to arid landscapes and its indigenous people. Pastoralism, introduced species such as the rabbit, fox, horse, donkey and camel, and altered patterns of fire have modified and degraded rangeland ecosystems and the biota (Williams 2002). One of the most striking impacts has been the extinction and significant reduction in geographic range experienced by the mammalian fauna (Morton 1994). Of the 72 species of terrestrial mammals known originally from the arid zone, 11 have become extinct and five are now

confined to small, fenced refugia (representing tiny parts of their former range) and off-shore islands (Williams *et al.* 2001). Another striking feature of the arid zone is the very low level of conservation protection afforded to most landscapes and ecosystems compared to southern Australia (Connors *et al.* 1996; Williams *et al*. 2001).

In recognition of the need to put land use on a sustainable basis in the rangelands and conserve the environment, governments have begun to implement field surveys to improve understanding of biodiversity and the potential threats posed to it by human land uses. The diverse ecosystems of the arid zone have been classified into over 30 bioregions based principally on similarities in climate, terrain and vegetation (Williams *et al.* 2001). The aim is to develop improved land management and biodiversity conservation strategies for each region based, in part, on new information gathered during the field surveys of each bioregion.

Since field surveys of bioregions are time consuming and expensive, various geospatial technologies and modelling techniques have been employed in an endeavor to make the surveys more cost-effective and information-rich. These techniques include the use of satellite imagery, derived spatial coverages such as terrain, and predictive models of biodiversity to direct survey work and/or to analyse the data collected during the surveys to enhance understanding of the

diversity of ecosystems and wildlife habitats. Spatial variability in geology, regolith, and surface and sub-surface hydrology can have a significant influence on vegetation and wildlife (Morton 1994), but collectively fine-scale spatial information on geology, soils and hydrology is problematic and the present availability of these data is typically limited. Since 1981, the Northern Territory Geological Survey has been flying semi-regional airborne magnetic and multi-channel radiometric surveys on a prospectivity priority basis over mineral fields and basement terrains. In many of parts of the arid zone these airborne geophysical data sets are the most complete representation of the geology presently available, and various researchers have investigated landscape, geomorphic and hydrological processes and mineralogical patterns using these data e.g. (Pickup & Marks 2000, 2001; Woodcock *et al.* 1997).

7.3 DOMINANT VEGETATION AND FAUNA

There are 25 vegetation communities in the Burt Plain bioregion (as delineated by the 1:1000000 Northern Territory Vegetation Types Map – refer to Chapter 4). Of those 25, four dominant vegetation communities occupy approximately 73.3% of the bioregion. The four communities comprise tall-open and low-open shrubland and woodland characterised by a few dominant species such as *Acacia aneura* and A, *estrophiolata*, and grassland characterised by spinifex. Throughout this thesis 'Mulga' is used as a common name for *Acacia aneura* while 'mulga' is used to describe plant communities dominated by Mulga. *Acacia* woodlands and

shrublands occupy large areas of Central Australia, with Mulga *Acacia aneura* having by far the largest representation. Williams (2002) reported that Mulga dominated communities, together with hummock grasslands wooded with Mulga, are estimated to occupy 150000 km^2 or about 20% of the continent. At regional and local scales, mulga may occur as continuous stands or as patches interspersed with a variety of other plant species such as Spinifex (Williams 2002). In central Australia, mulga is found on a range of landforms including rocky hillslopes, at the base of hills and rock outcrops (where it receives additional water by run-off from adjacent hills and low ranges), and in swales. Mulga generally occupies soils of intermediate fertility and, though found on a variety of soils, large stands are most commonly found on red earths, which are light textured with hard coherent subsoil. Dunkerley (2002) described the spatial patterns of soil moisture and infiltration rates in a groved mulga woodland in arid central Australia. Within the groves, infiltration rates were found to be highest close to stems and declined rapidly with increasing distance. Dunkerley (2002) also found that the position of the intergrove-grove boundary, which was shown to sit in the middle of the wettest belt of soils in the landscape, was not readily explicable in terms of available soil moisture. Dunkerley (2002) suggests that other factors such as nutrient availability or soil physical properties might be involved in setting the location of these boundaries.

Detailed studies on the indigenous fauna of mulga have largely only been undertaken in the last 10 years or so e.g. (Landsberg *et al.* 1997b; Recher & Davis Jr 1997; Reid *et al.* 1993). These studies demonstrate that mulga contains rich faunal assemblages, as might be expected for such a dominant element in the landscape. Williams (2002) noted that different animals have different degrees of reliance on mulga for food and shelter.

7.4 METHODS

7.4.1 Spatial datasets

Gamma ray, terrain elevation and magnetic data were acquired for the Alice Springs area of central Australia from the Northern Territory Department of Mines and Energy. Surveys were flown at 400m line spacing with a mean terrain clearance of 60 m in a north-south flight-line direction. Radiometric and elevation data were sampled at 70 m intervals along each line. A total count measurement records overall radioactive levels and represents the combined measurements of potassium, thorium and uranium in counts per second. Spatial resolution is determined by the survey altitude of the aircraft, flight line spacing, the sampling intervals along that line and the sensitivity of the spectrometer onboard the aircraft. Surveys undertaken with a flight line spacing of 500 m or less were flown at an altitude of 60 - 100 m above ground level. Surveys which employed a flight line spacing in excess of 500 m were flown at an altitude of 150 - 400 m. All surveys flown since 1997 have been captured in GDA94 datum.

Climate Surfaces

The five climate surfaces used in this chapter were derived from the software package ANUCLIM Version 5. A full description is given in section 4.3 of Chapter 4. The climate surfaces used with the most relevance to desert conditions were: mean annual evaporation; mean annual temperature during the

dry season months (April – September); mean annual temperature during the wet season months (October - March); mean annual rainfall; and mean annual temperature.

Information on vegetation types is once again based on (Wilson *et al.* 1990), who mapped NT vegetation types at 1:1000000 scale, defining 112 mapping units or vegetation communities. Mapping units were interpreted after recognition of vegetation patterns on Landsat (bands 4, 5 and 7), with reference to existing vegetation and land resource maps and some 1:500000 Landsat imagery (Wilson *et al.* 1990). Modification of the mapping units were carried out after three years of field work, data analysis and re-interpretation, with further reference to geological, topographic and existing vegetation maps.

Over 12185 vertebrate species occurrences have been recorded within the Burt Plain bioregion and recorded in the Northern Territory Parks and Wildlife Commission Biological Records Scheme database, including 168 bird species, 10 frogs, 53 mammals and 106 reptiles. Statistical modelling of species habitat was undertaken using the Species Distribution Modelling Toolkit (SPMODEL) software (Bennett *et al.* 1997). Species with greater than 10 presence records were analysed with SPMODEL software. Relationships between the presence of a species and mapped environment variables were generated using GLM regression modelling techniques. These models could then be used to predict the

probability of occurrence of a species at any given location, defined in terms of its environmental attributes. Interpolating model results using selected environmental variables produced bioregional maps of the predicted probability of occurrence of species.

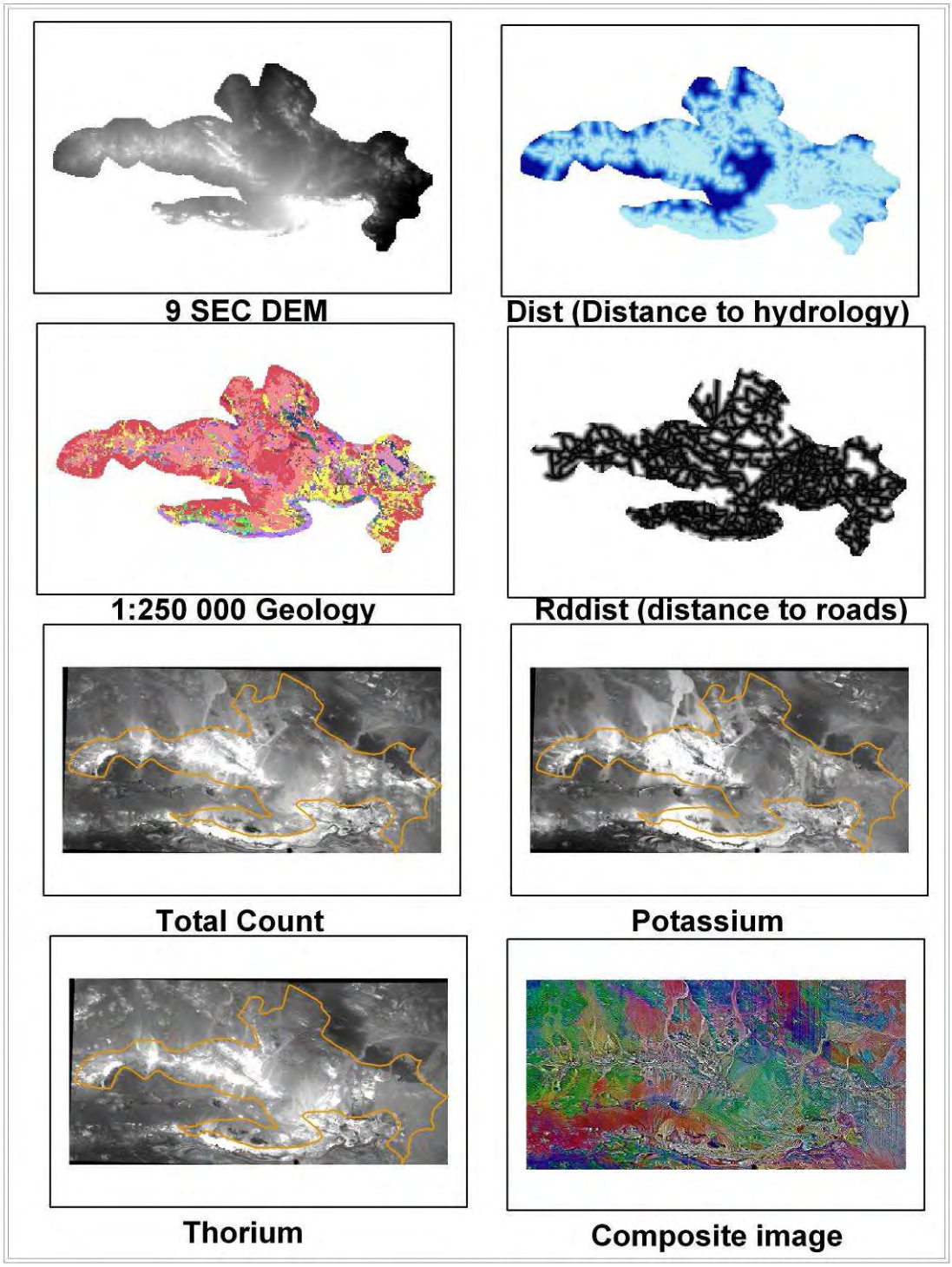
The grid coverage distance to water (dist) was calculated using the ARC/INFO command EUCDIST with the original cover containing drainage lines and waterbodies at 1:250000 provided by the Northern Territory Parks and Wildlife Commission.

Refer to table 6.3 in Chapter 6 for a full description of environmental grids used in the analysis. Table 7.1 lists the radiometric grids used for wildlife habitat modelling in this chapter and Figure 7.1 graphically displays environmental datasets used in the radiometrics analyses.

Table 7.1 Radiometric grids used in wildlife habitat modelling

Name	**Full Description**
ethfix	Concentration of radiometric element - thorium
eufix	Concentration of radiometric element - uranium
kfix	Concentration of radiometric element - potassium
tcfix	Total Count
Hiptc	Hi-Pass Total Count

Figure 7.1 Environmental datasets used in radiometric analyses



7.5 RESULTS

A summary of fauna species and their key radiometric explanatory variables are shown in Table 7.2.

Table 7.2 Summary of number of sample records used to build models for selected species and the key explanatory variable(s) and associated statistics (deviation, significance) identified during the modelling using radiometric data. See text for a discussion of the basis of the identified correlations between the radiometric data and distribution of taxa.

Taxa	**No. of records**	**Predictive GLM modelling significance Dev, Sig**	**Explanatory radiometric variables**
Red-tailed Black-Cockatoo	36	2.51, 0.114*	Potassium
Grey Crowned Babbler	147	2.08, 0.149*	Potassium
Grey Butcherbird	30	7.37, 0.001***	Potassium
Australian Bustard	39	0.23, 0.062*	Potassium
Black-faced Woodswallow	271	4.31, 0.038**	Potassium
Brown Honeyeater	70	2.36, 0.125*	Potassium
Chestnut Rumped Thornbill	55	13.36, 0.004***	Potassium
Cockatiel	115	5.54, 0.063*	Potassium
Variegated Fairy Wren	51	3.24, 0.72*	Potassium
Zebra Finch	351	2.39, 0.122*	Potassium
Desert Dunnart	22	3.53, 0.061*	Potassium
Inland Thornbill	55	14.35, 0.003***	Thorium

Crested Bellbird	237	7.67, 0.022**	Thorium
Emu	26	6.37, 0.012**	Thorium
Half Girdled Snake	10	3.47, 0.062*	Thorium
Cat	22	4.21, 0.041**	Thorium
Red Kangaroo	80	4.4, 0.036**	Thorium
Southern Boobook	33	2.55, 0.111*	Uranium
Rabbit	39	2.41, 0.121*	Uranium
Rufous Whistler	174	6.36, 0.095*	Total Count
Red Capped Robin	123	5.14, 0.076*	Total Count
Mulga Parrot	72	4.87, 0.088*	Total Count
Banded Whiteface	10	0.68, 0.026**	Total Count
Crimson Chat	111	6.77, 0.009***	Total Count
Grey Headed Honeyeater	67	9.54, 0.002***	Total Count
Spencers Frog	18	2.79, 0.095*	Total Count
Little Spotted Snake	60	2.49, 0.114*	Total Count
Australian Hobby	22	2.66, 0.103*	Hi-Pass Total Count
Black Breasted Buzzard	52	2.28, 0.131*	Hi-Pass Total Count
Black Honeyeater	32	5.31, 0.021**	Hi-Pass Total Count
Masked Woodswallow	60	2.98, 0.084*	Hi-Pass Total Count
Rabbit	39	6.62, 0.011**	Hi-Pass Total Count

Level of significance are given as *P $\leq$ 0.05; **P < 0.01, ***P < 0.001

7.5.1 Radiometrics and terrain

Statistical relationships between concentrations of uranium, thorium, potassium and their total count are given in Table 7.3. The concentration of these elements in the study area was strongly auto-correlated. Concentrations of these elements were found together and the spatial distribution of these elements was positively correlated with aspect. No statistical correlation was found between the concentration of these elements and position in landscape or slope.

7.5.2 Radiometrics and vegetation

Relationships between uranium, thorium, potassium, the total count and the four mapped dominant vegetation communities in the Burt Plain bioregion were investigated (Table 7.3). No apparent relationships were found between these radiometric coverages and the mapped vegetation at this scale of analysis. However, while detailed analyses are yet to be undertaken, I suspect there are likely to be correlations between some of the less dominant vegetation communities occurring at higher elevation and the coverages for thorium and the total count. An example of the spatial variation in the total count for the radiometrics coverage and the mapped vegetation is shown in Figure 7.2.

7.5.3 Radiometrics and fauna

Radiometric data were found to be useful for developing statistical predictive models of three fauna species in the Burt Plain bioregion: Red Kangaroo, *Macropus rufus*; Desert Dunnart, *Sminthopsis youngsoni*; and the Rabbit, *Oryctolagus cuniculus* (Figures 7.3-7.5). The predicted probability of the occurrence of the Red Kangaroo was negatively correlated with the concentration of thorium, while the predicted occurrence of the Desert Dunnart was positively correlated with the concentration of potassium. Three independent variables (distance to nearest artificial watering point, total count, and uranium) were identified as statistically significant in the probabilistic model for the rabbit. The predicted probability of occurrence of this introduced species was negatively

correlated with the concentration of uranium and total count radiometrics (Figure 7.5).

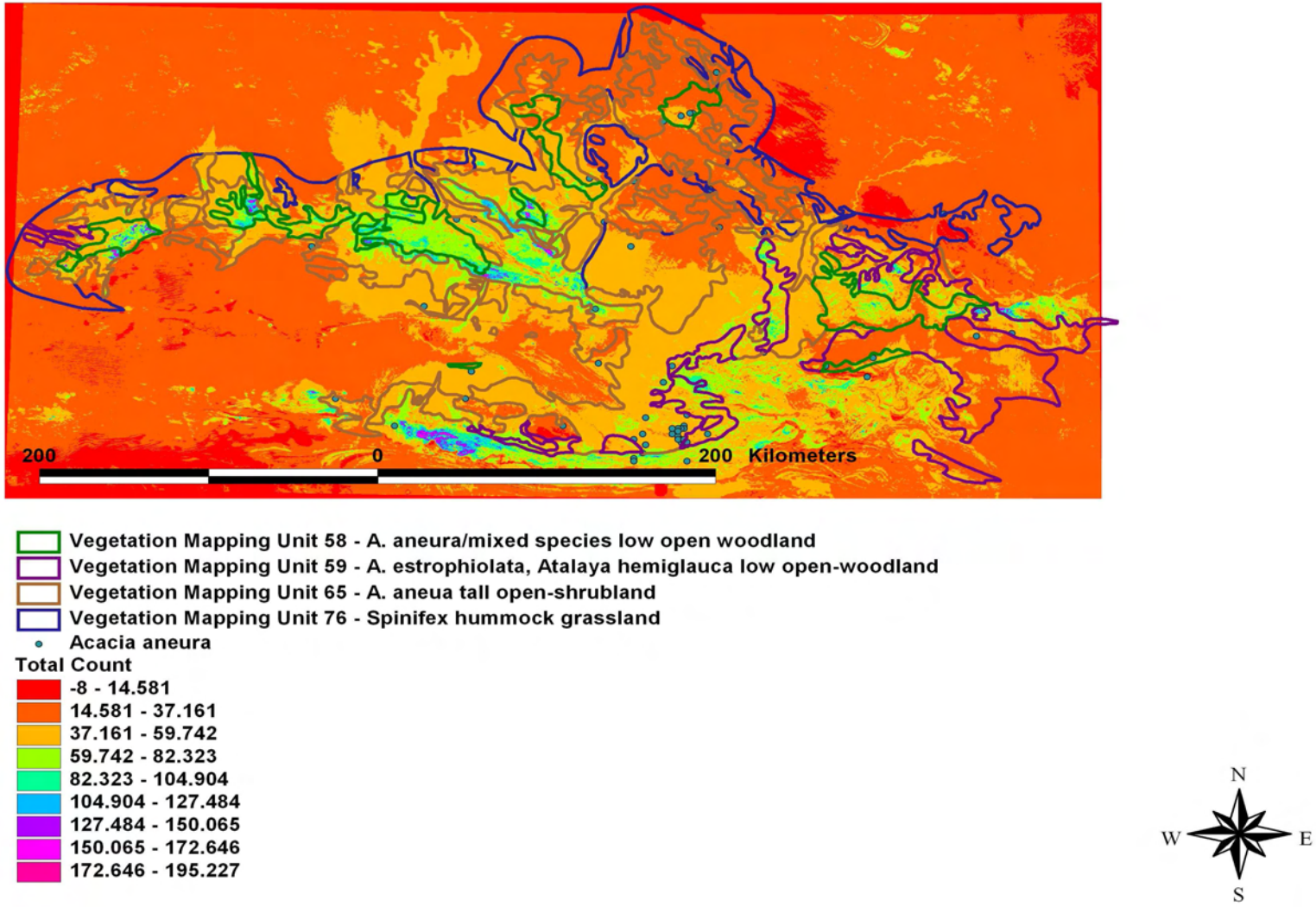


Figure 7.2 Total count versus vegetation communities

Figure 7.3 Predicted distribution of *Macropus rufus* (Red Kangaroo) and results of relationship with distance to road and thorium (see text for explanation).

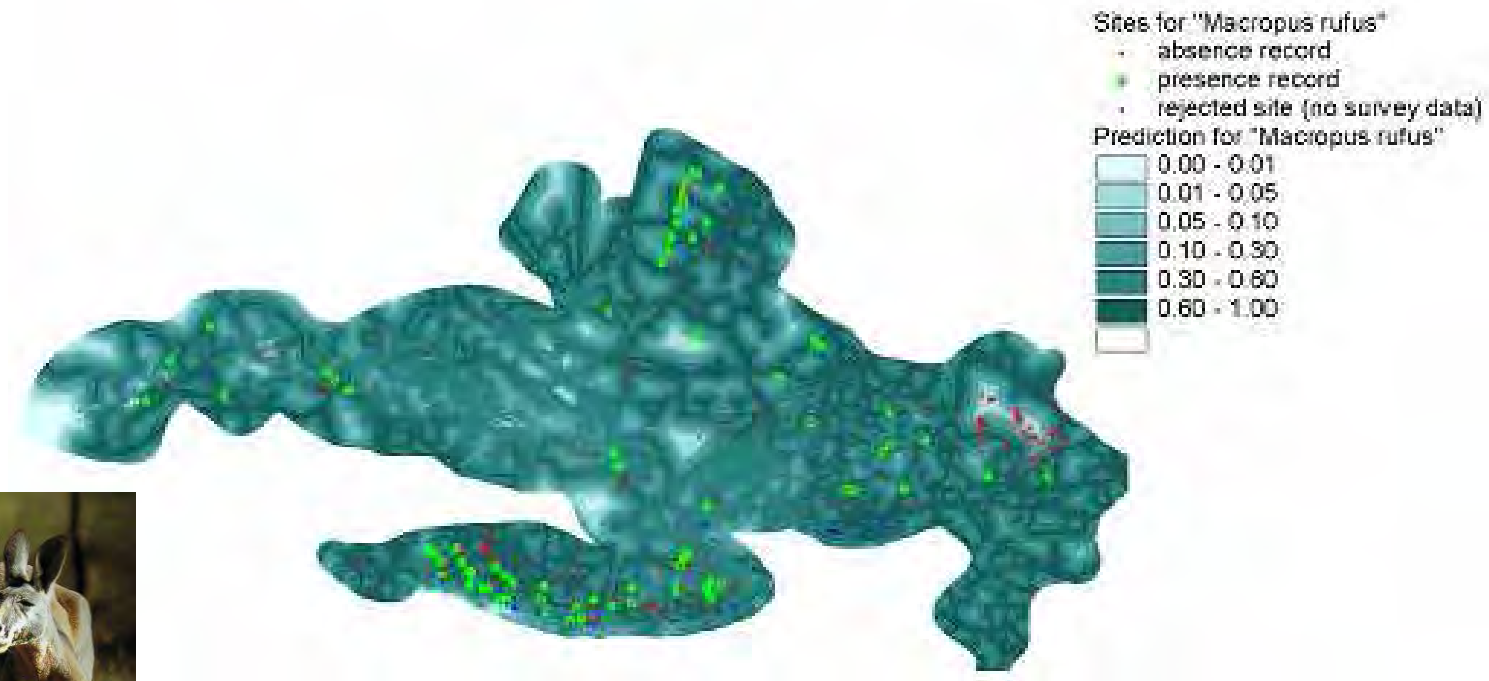


Figure 7.4 Plots describing the relationship of selected environmental predictors for *Macropus rufus* (Red Kangaroo) using GLM modeling.

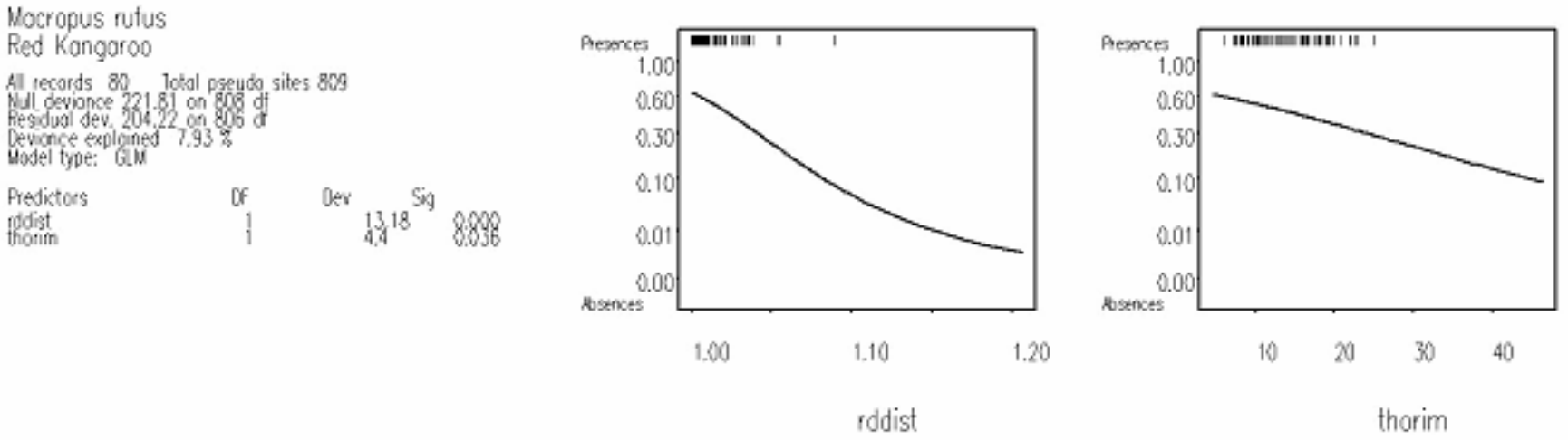


Figure 7.5 Predicted distribution of *Sminthopsis younsoni* (Desert Dunnart) and relationship with distance to water, elevation and potassium (see text for explanation).

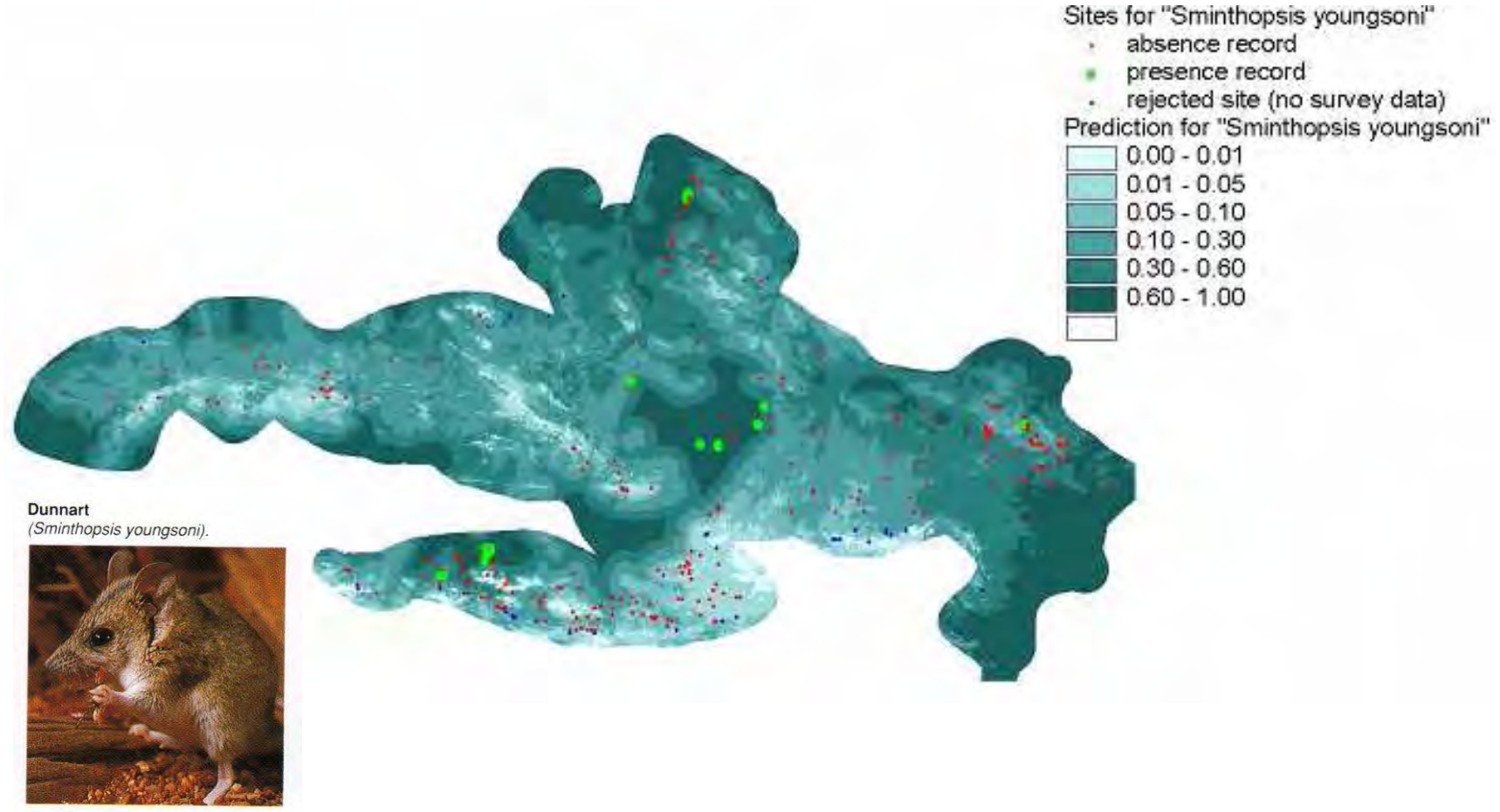


Figure 7.6 Plots describing the relationship of selected environmental predictors for *Sminthopsis youngsonii* (Desert Dunnart) using GLM modeling

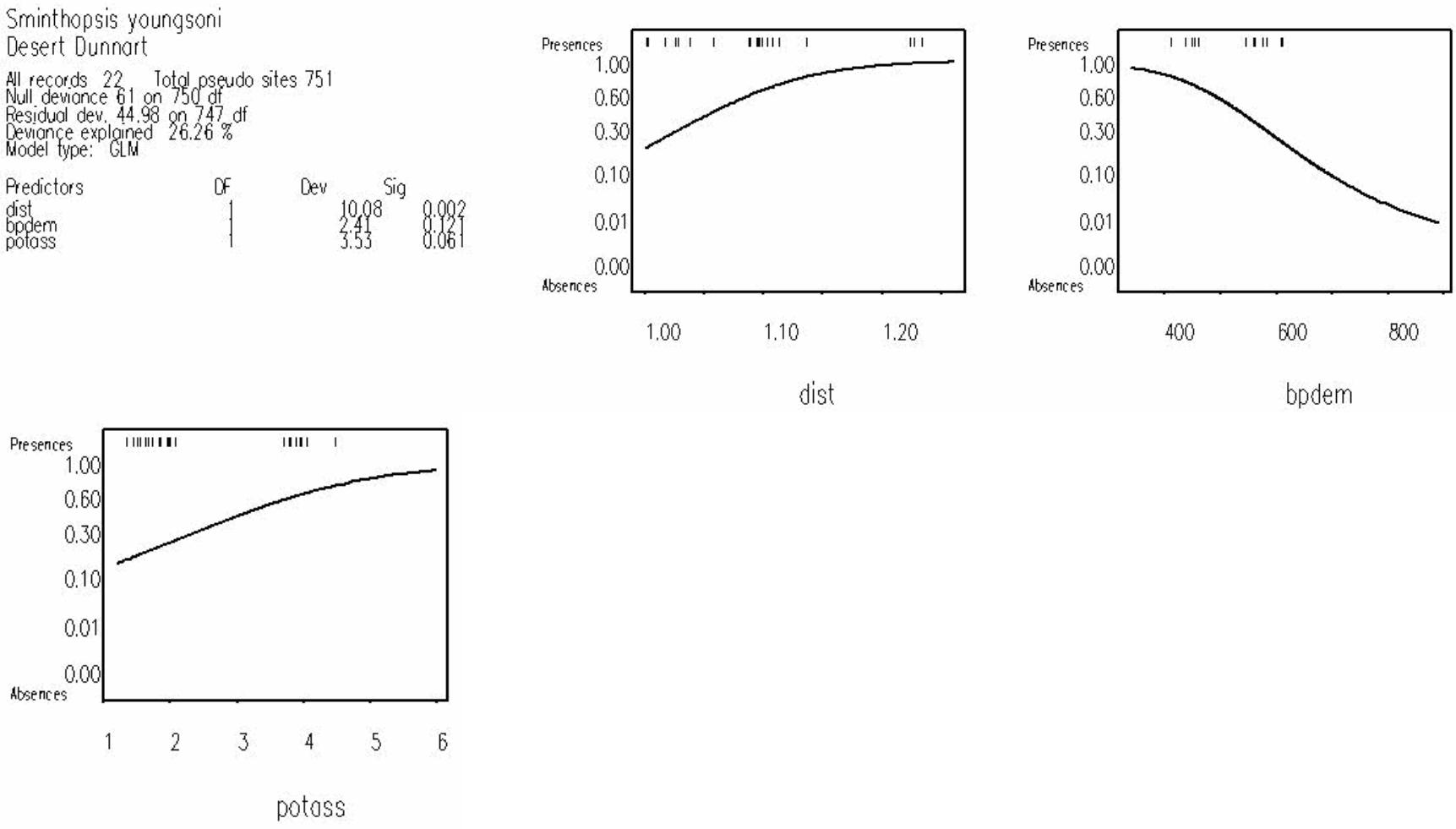


Figure 7.7 Predicted distribution of *Oryctolagus cuniculus* (Rabbit) and relationship with distance to water, high pass total count and uranium (see text for explanation).

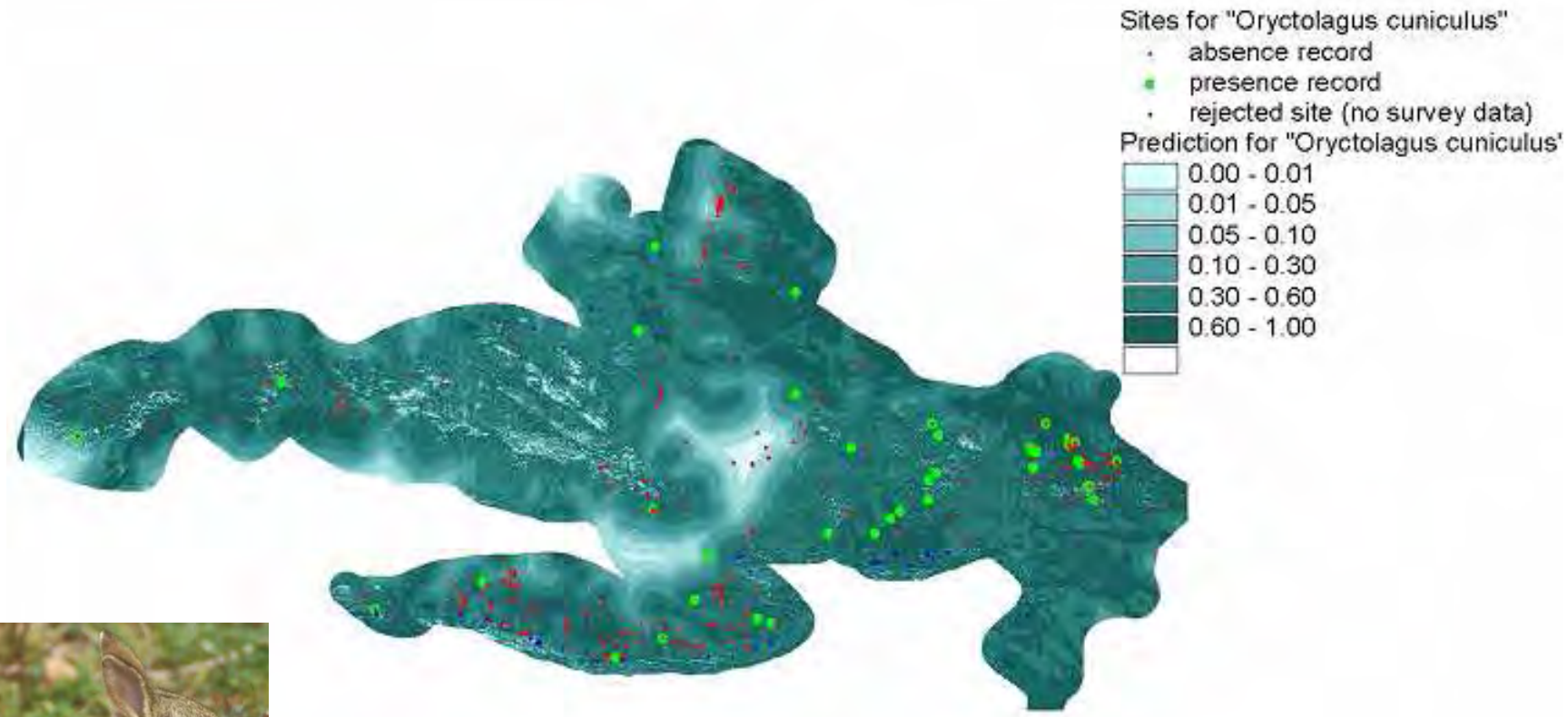


Figure 7.8 Plots describing the relationship of selected environmental predictors for *Oryctolagus cuniculus* **(Rabbit)** using GLM modeling

Oryctolagus cuniculus
Rabbit (feral)

All records 39 Total pseudo sites 768
Null deviance 108.13 on 767 df
Residual dev. 91.97 on 764 df
Deviance explained 14.95 %
Model type: GLM

Predictors	DF	Dev	Sig
dist	1	7.13	0.008
hightc	1	6.62	0.011
uranm	1	2.41	0.121

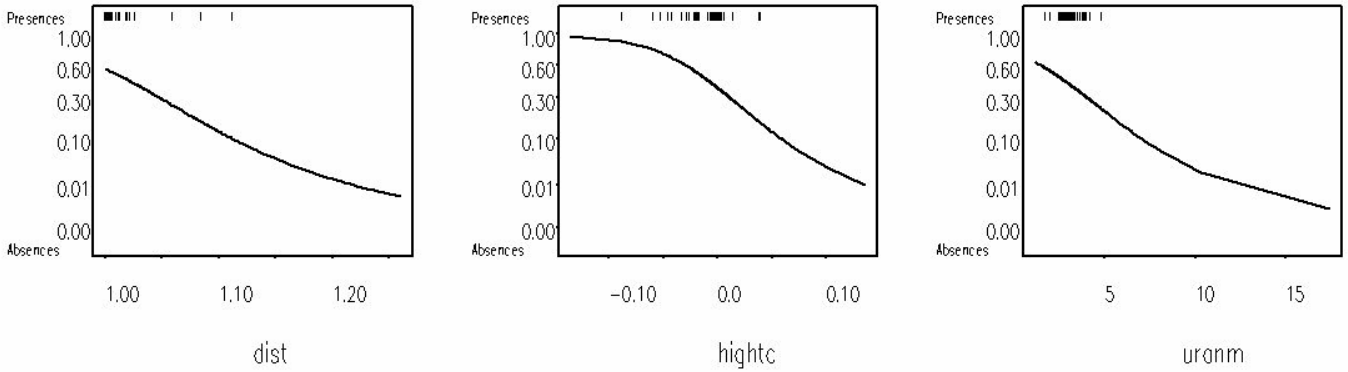


Figure 7.9 Predicted distribution of *Lichmera indistincta* (Brown Honeyeater) and relationship with mean evaporation, distance to water, elevation diversity 300m and potassium (see text for explanation).

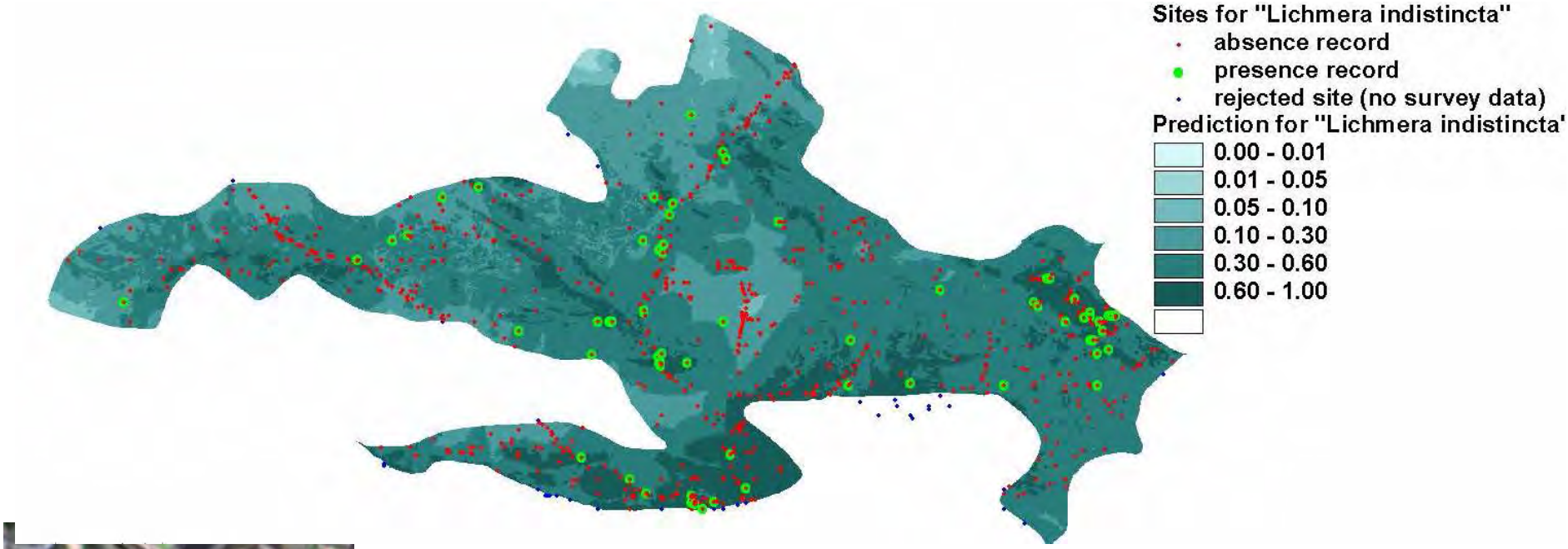


Figure 7.10 Plots describing the relationship of selected environmental predictors for *Lichmera indistincta* (Brown Honeyeater) using GLM modeling

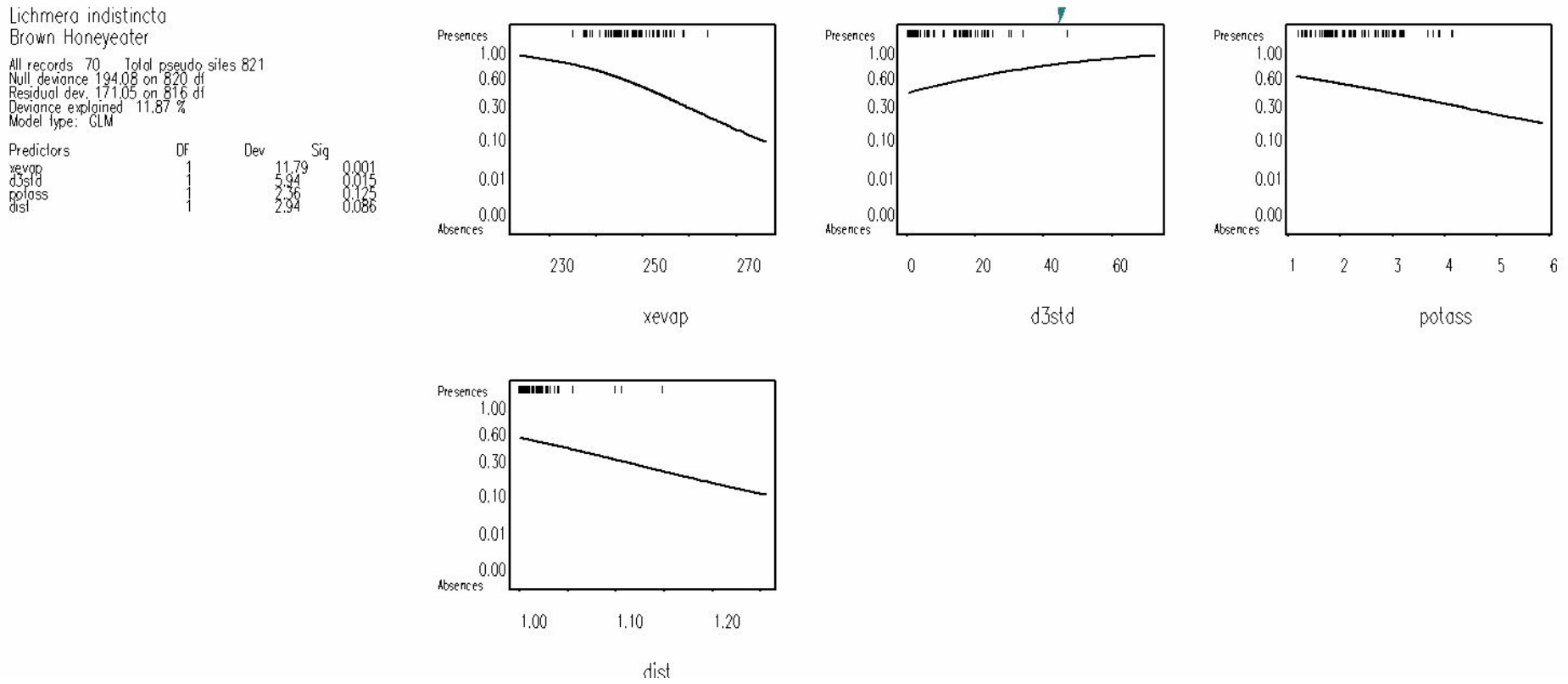


Figure 7.11 Predicted distribution of *Suda punctata* (Little Spotted Snake) and relationship with distance to road, distance to water, total count and longitude (see text for explanation).

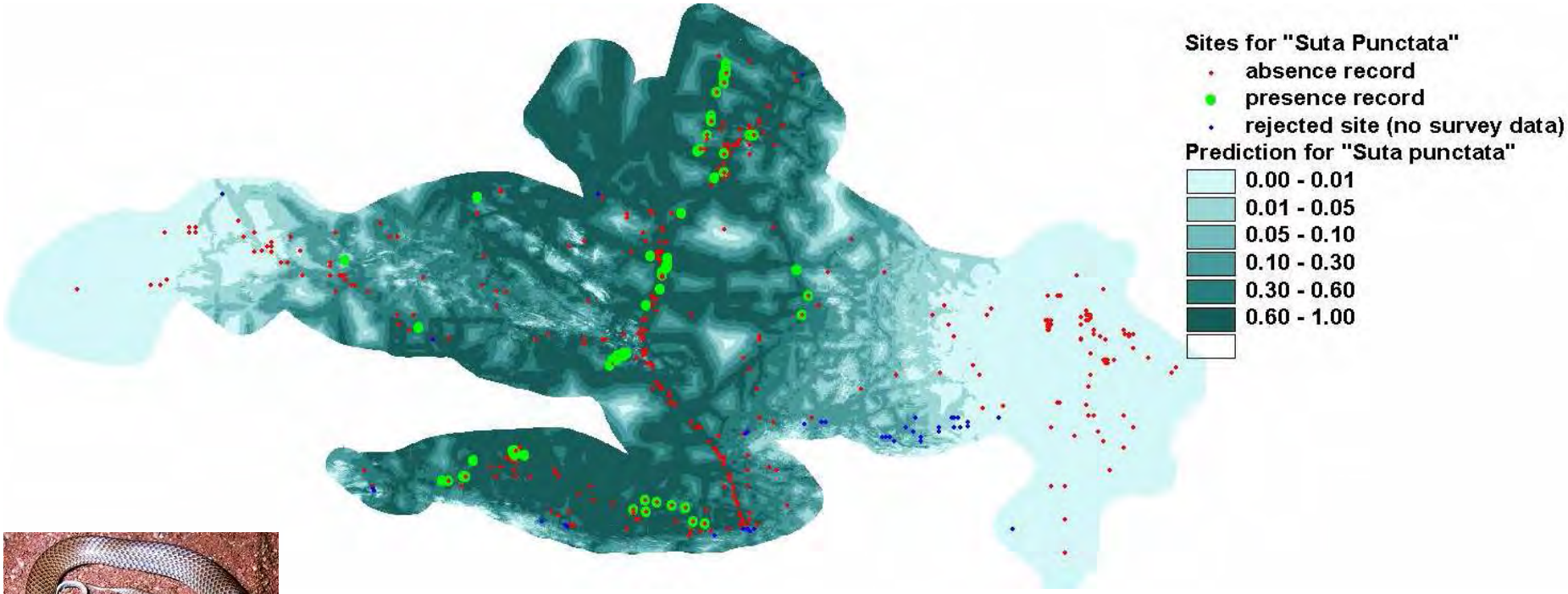


Figure 7.12 Plots describing the relationship of selected environmental predictors for *Suda punctata* (Little Spotted Snake) using GLM modeling

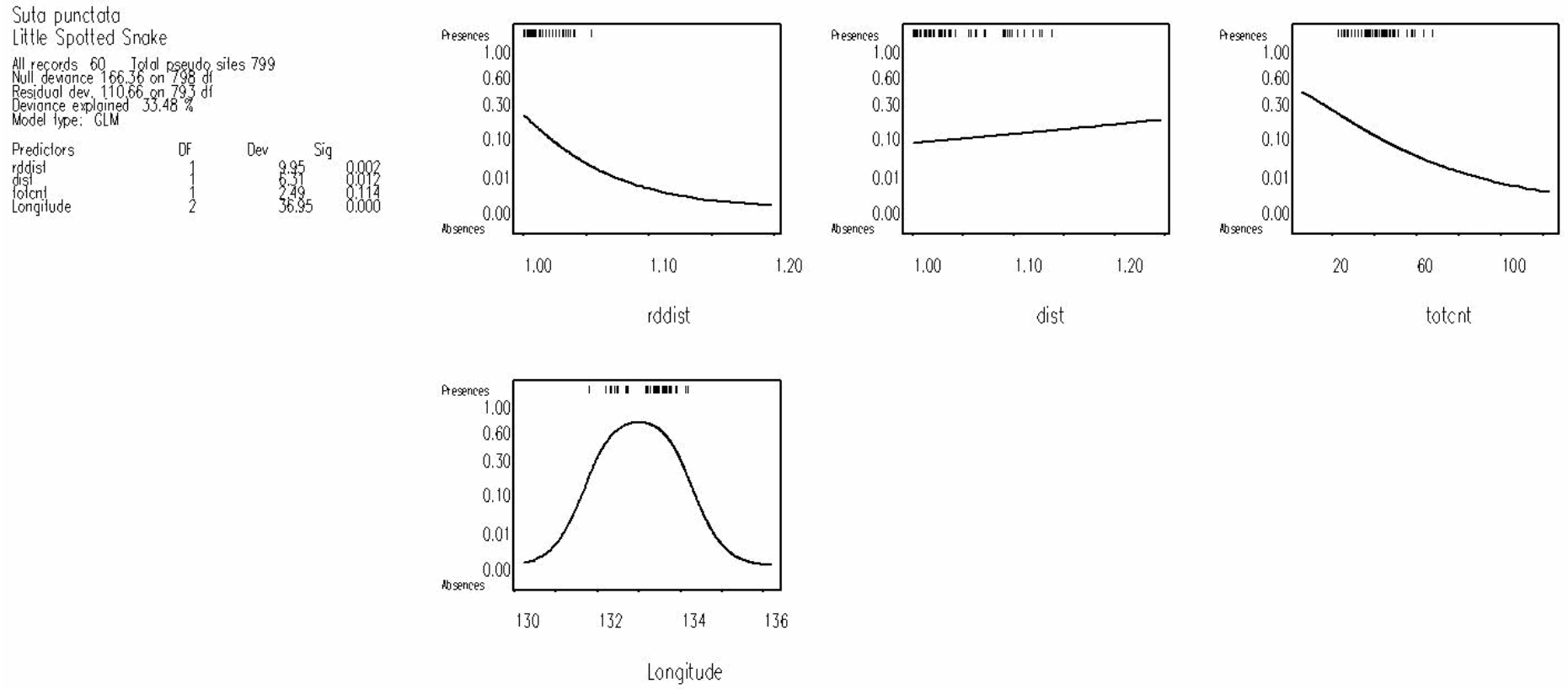


Figure 7.13 Predicted distribution of *Ninox novaeseelandiae* (Southern Boobook) and relationship with minimum temperature – dry season, and uranium (see text for explanation).

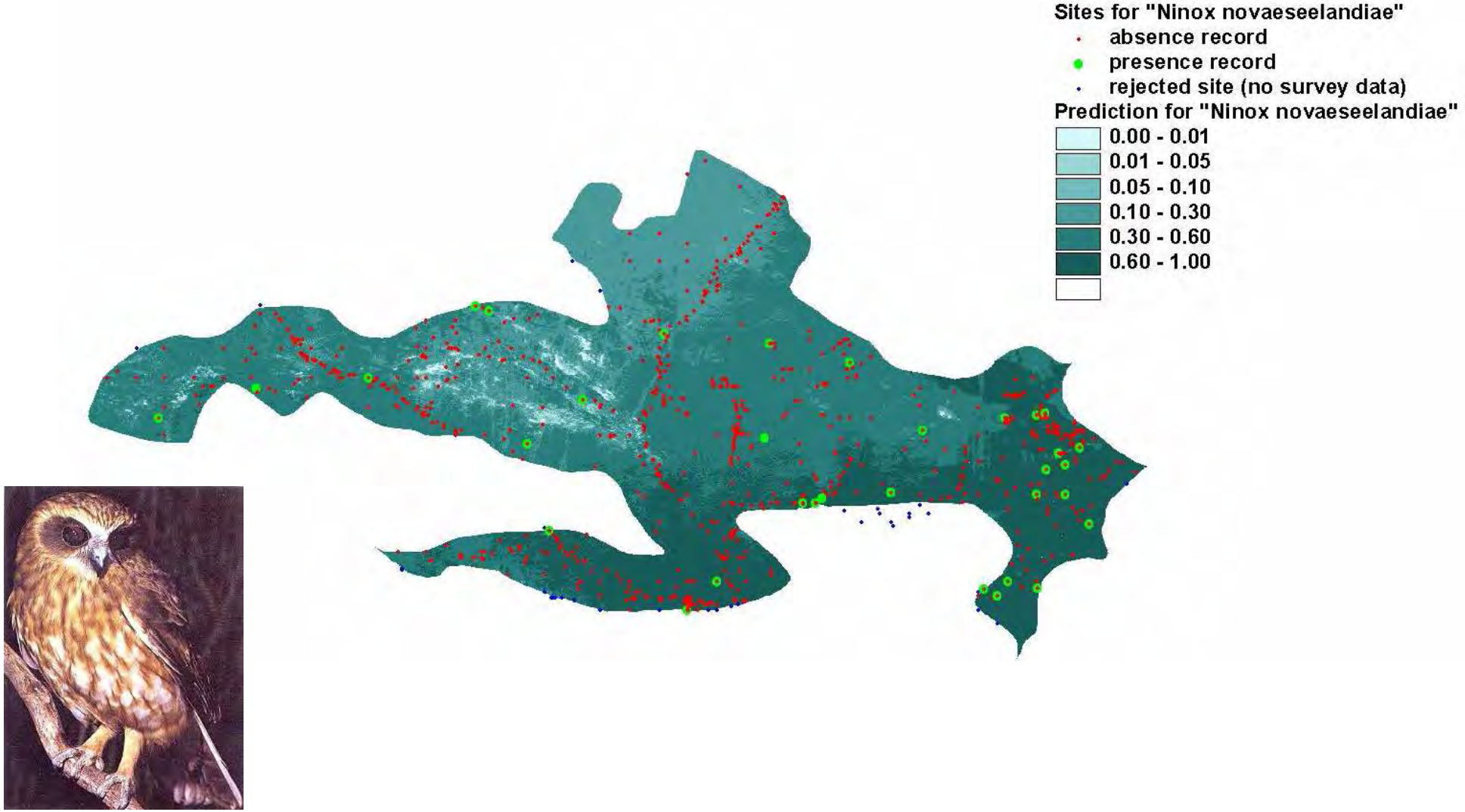


Figure 7.14 Plots describing the relationship of selected environmental predictors for *Ninox novaeseelandiae* (Southern Boobook) using GLM modeling.

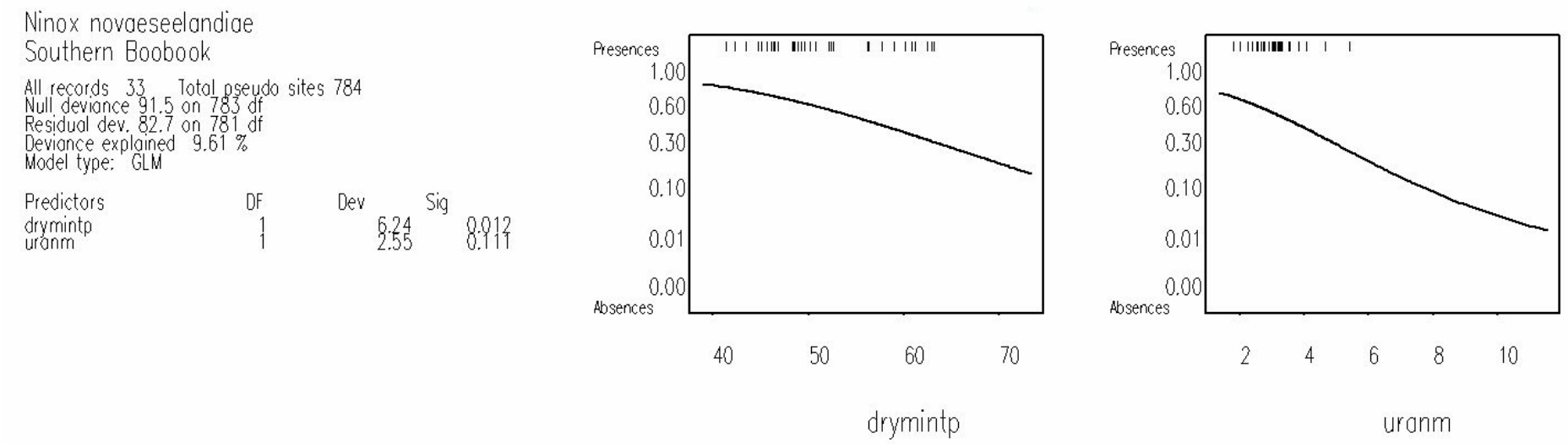


Table 7.3 Summary of statistical analyses of radiometric and DEM data: top - univariate statistics; middle - covariance matrix; bottom - correlation matrix. (See text for a discussion of the basis of the identified correlations between the radiometric data and distribution of taxa).

	Min	Max	Mean	Stdv
Uranium	-1.041	32.1668	2.75555	1.33047
Thorium	-3.711	93.4595	10.9352	6.5264
Total Count	-8.000	195.227	33.4035	18.0632
Potassium	0	8.04574	2.1191	0.882442
Aspect	-1	360	174.868	115.586
Slope	0	26.243	0.744667	1.36353

	Uranium	Thorium	Total Count	Potassium
Uranium	1.77016	7.00099	20.3466	0.878102
Thorium	7.00099	42.5939	110.532	4.41091
Total Count	20.3466	110.532	326.278	14.1641
Potassium	0.878102	4.41091	14.1641	0.778703
Aspect	117.819	691.24	1924.47	69.7694
Slope	0.798428	3.35896	10.0891	0.384196

	Uranium	Thorium	Total Count	Potassium
Uranium	1	0.806269***	0.846625***	0.747916***
Thorium	0.806269***	1	0.937603****	0.765894***
Total Count	0.846625***	0.937603****	1	0.888604***
Potassium	0.747916***	0.765894***	0.888604***	1
Aspect	0.766132***	0.916323***	0.921746****	0.684026**
Slope	0.440114**	0.377456*	0.409632**	0.319302*

**** Very Strong correlation > 0.9; *** Strong correlation 0.7 to 0.9; ** Moderate correlation 0.4 to 0.7; * Weak, low correlation (not very significant) 0.2 to 0.4; Very weak to negligible correlation 0.0 to 0.2.

7.6 DISCUSSION

Ecologists and resource managers have used remote sensing techniques to monitor vegetation condition, patterns, and trends in arid regions where rugged terrain, poor access, and extreme climate make field research difficult. Unfortunately, because of low canopy density the synoptic data provided by the relatively broad-band moderate resolution Multispectral Scanner (MSS) and Thematic Mapper (TM) satellite sensors have been used with only limited success for extracting detailed vegetation information (Myers 1983; Tueller 1980; Colby and Keating 1998; Song *et al.* 2001).

In regolith-dominated terrains, the nature of contemporary processes and the surface distribution of regolith materials may be a poor guide to the character and history of regolith materials at depth (Worrall *et al.* 1999). The nature of regolith materials at depth is often critical to unravelling the development of a landscape. Conventional mapping aids such as air photos, multispectral remote sensing and airborne radiometrics are not wholly adequate in this context, as they penetrate limited depths (<0.4 m). Airborne electromagnetics (AEM) on the other hand, has the potential to map regolith materials to considerable depths (>100 m). The application of AEM to regolith mapping and its potential as a tool in geomorphology are illustrated by reference to an AEM survey flown at Lawlers in the Yilgarn Craton of Western Australia (Worrall *et al.* 1999).

Using radiometrics to map soils potentially allows mapping without reference to information on terrain or vegetation. It also allows mapping of soil properties as opposed to soil types, which facilitates application to land use and management, and the testing of map reliability (Tunstall *et al.* 1998). A detailed soils map can be efficiently produced where all mapped classes are significantly different at the 95% confidence level (Tunstall & Gourlay 1994). Fine patterns of vegetation are usually associated with position in the landscape. Soil patterns associated with landscape position have been successfully mapped by relating soil properties to vegetation classes (Tunstall *et al.* 1998). Moreover, the soil patterns derived from the radiometrics aligned with vegetation patterns, such as tree regeneration and weed and grass species (Tunstall & Gourlay 1994).

The aim of this chapter was to introduce a study investigating the utility of radiometric data for predicting vegetation community patterns and wildlife habitat in the arid zone based on the Burt Plain bioregion. My preliminary analyses suggest that radiometric data sets involving the radioactive elements uranium, thorium and potassium and vegetation may have use as surrogates or predictors of biodiversity patterns at the bioregional and landscape level. Statistical relationships were tested between the concentrations of the elements uranium, thorium and potassium and terrain characteristics such as position in landscape, slope and aspect. A statistical correlation between these elements and aspect was found using a nine second DEM. The basis of

this correlation needs further investigation and warrants analysis using a higher resolution DEM. Pickup and Marks (2001) used airborne gamma ray survey data to provide information on potassium, thorium and uranium concentrations in surface soil and rock in a similar area of central Australia. They reported that coverages of these radioelements, when combined with a 100m grid cell DEM, allowed tracing of paths of sediments at the catchment scale. The tracing of these paths permitted an improved understanding of erosional and depositional events including episodic patterns of flooding in the area. The gamma ray data showed consistent variation with slope. Meleik (1998) identified both uranium and thorium anomalies in their interpretation of airborne radiometric and magnetic data in the Wadi Millaha area, North Eastern Desert, Egypt. The fault systems in the area under study played an important role in the distribution of most of the identified radioactive anomalies. Two sets oriented ENE to NE and NNW proved to have a significant effect on of the majority of these radiometric anomalies.

As part of a general soil and regolith mapping exercise across cleared and remnant bush land by Verboom and Pate (2003), radiometric data for distribution of potassium (K), uranium (U) and thorium (Th) were examined alongside relief models and floristic and soil surveys in test catchments at Elashgin and Toolibin in the Western Australian wheat-belt. The Elashgin survey showed that highly weathered low K soils co-concentrated U and Th and were vegetated mainly by cluster root-bearing Proteaceae and

Casuarinaceae (Verboom & Pate 2003). Draping of radiometric imagery over a digital elevation model showed spiral waveforms of high and low U and Th signal which were largely independent of topography but demarcated different oligotrophic communities (Verboom & Pate 2003).

Further work is required to clarify any potential quantitative relationships between the three radioelements and mapped vegetation communities, especially those rare and geographically restricted communities found at higher elevation in the ranges of the bioregion. Only three probabilistic models were developed for fauna occurring in the bioregion where one or more of the radioelements were statistically significant independent variables. At present, explanation of the biophysical functions that these variables play in influencing habitat is unclear.

Although airborne geophysical techniques have been used extensively and are now used almost routinely by mineral explorers, it is only in the last ten years that governments have been involved as major players in the acquisition of data (Denham 1997). In the future, as land management issues become more important, radiometric and digital elevation information will become more significant. These data sets provide crucial information of such things as soil types and drainage models (Dickson and Scott 1996). The 1995 Liverpool Plains survey by AGSO is a good example of this application, where 200 m spaced data sets have been acquired to map soil types in the

context of dry-land salinity problem. The use of high-quality airborne geophysical data sets have proved extremely valuable, not only for penetrating the regolith to map the bedrock geology but also to map the regolith itself (Denham 1997).

It is speculated that radioelements will influence vegetation and that there may be distinct local controls that can be gleaned from existing geological maps – namely mafic volcanics and metamorphic equivalents which provide relatively rich soils (clays/phosphates/trace elements) and limestone/carbonatite distribution will control soil pH. The utility of radiometrics data for wildlife habitat modelling should be explored further using alternative quantitative modelling techniques and presence/absence records for target faunal species. I discuss opportunities to expand this research component further in Chapter 8.

CHAPTER 8 - BIODIVERSITY CONSERVATION AT THE BIOREGIONAL LEVEL - A SYNTHESIS

8.1 INTRODUCTION

Contemporary quantitative biological modelling and conservation evaluation techniques use ecological knowledge of the distribution and habitat requirements of species in relation to gradients in major environmental factors to establish quantitative relationships or correlations that can be used to build predictive models. These models are intended to provide predictions of the likelihood of the selected species occurring across the region of interest including those sites that have not been subject to biological survey. To undertake the modelling it is necessary to identify and quantify the major environmental gradients of a study region using a combination of point-based empirical data and statistically-robust derivation techniques. In my study of the Burt Plain bioregion, a range of spatial coverages for environmental variables such as terrain, climate and vegetation were systematically created that could then be used to combine with the available point-based biological data to determine relationships between the observed presence and absence of species and their environment. Quantitative relationships were then used to build predictive models and create maps of the probabilistic distribution of species across the Burt Plain bioregion. Ideally, strong statistical relationships found between the distribution of a species and one or more environmental gradients can be explained

(process understanding) using an ecological understanding of the habitat requirements of the species. This increases the confidence in the spatial models to generate reliable predictions across regions where ground survey may be limited or absent. This modelling approach is significant as it can be used to help optimise the number and location of biological survey sites used to survey large regions such as the bioregions of central Australia, to systematically and efficiently test predictive models, and to create reliable maps of the distribution of target species such as threatened species that are of significant interest to land managers. My study clearly demonstrated the utility of the modelling approach to improve the efficiency of the current biological survey programs undertaken in central Australia, and could be used as a framework for the design and implementation of biological surveys and conservation evaluation in bioregions that are yet to be assessed.

The term 'biodiversity' historically was coined by Walter G. Rosen at some point during the organisation of the 21-26 September 1986 National Forum on BioDiversity held in Washington, D.C., under the auspices of the US National Academy of Sciences and Smithsonian Institution (Takacs 1996). The new term was intended as nothing more than a shorthand for biological diversity for use in internal paperwork during the organisation of that forum. The term biodiversity found wide use following its 'invention'. Primack (1993) published the first textbook of conservation biology in 1993 and Meffe and Carroll (1994) followed with their comprehensive survey in 1994.

Biodiversity conservation has become the stated objective of national governments, state agencies, local communities, and scientific organizations (Redford & Richter 1999). Yet despite this attention the term biodiversity remains poorly defined and often fails to encompass all the complex aspects such as genetic and various life forms. In past decades, biodiversity has been viewed largely in terms of species richness, and the ecosystems supporting these species were often seen as static and predictable (Fiedler et al, 1997). Conservation efforts were often aimed at hotspots rich in total species or in rare species (Noss 1987). Consequently, relatively small nature reserves proliferated through the 1970s and 1980s, as did endangered species management and recovery plans on more extensive public lands (Noss 1987). More recently, the complexity and dynamic nature of biodiversity has become more widely recognized and acknowledged, and the new findings of the Millennium Ecosystem Assessment are strengthening this recognition. Today, recommendations for biodiversity conservation typically focus on the need to conserve dynamic, multi-scale ecological patterns and processes that sustain the full complement of biota and their supporting natural systems e.g. (Angermeier & Karr 1994; Harris *et al.* 1996; Poff *et al.* 1997; Turner *et al.*1995).

8.1.1 Biodiversity in arid Australia

The arid region of Australia is known to support a rich and diverse flora and fauna (Landsberg *et al.* 1997). It is also environmentally significant as it is one of the least human-populated arid regions in the world, and appears to have had far less land use throughout human history than other such regions (Morton *et al.* 1995). At present,

knowledge of the biological and ecological interactions between a number of arid zone species and their environments is limited (Landsberg *et al.* 1997). Biodiversity is under threat in the arid regions with pressures on both flora and fauna. The arid zone has experienced the extinction of many species of mammals, and has many rare and threatened species (Briggs & Leigh 1996). Although the general pressures and threats to biodiversity in the arid zone are recognized, many ecological key interactions and drivers of change from the population and community to landscape level remain poorly understood, and provide the motivation for my review of biodiversity conservation approaches at the bioregional level, and the case study in the Burt Plain of central Australia.

8.2 APPROACH AND MAJOR FINDINGS

Many approaches and techniques have been used to describe and map biological diversity and divide countries into various types of biological regions. The conception and definition of a bioregion were discussed in chapter one, as were recent and contemporary approaches to developing a bioregionalisation framework for Australia. In chapter two I reviewed published literature on approaches to bioregional planning and management techniques utilised for biodiversity conservation in Australia and overseas. I considered the concept of comprehensive, adequate and representative protected area systems and techniques for identify and select areas to add to protected areas systems. Even where protected areas are established and suitably managed it is argued that the conservation of biodiversity will often also rely on the management of landscapes outside of formal reserves. This

is clear in areas such as the Northern Territory where only 3 % of the arid zone is dedicated as conservation reserves, and the level of reservation appears unlikely to increase significantly in the foreseeable future.

The idea of regional-scale planning or ecosystem management (Noss & Cooperrider 1994) concerns an overall conservation strategy that integrates the management of all natural and semi-natural areas, whether or not they are formally listed and categorised as protected areas. It is suggested in fact that in inland Australia it may be practicable to develop a system where there are many small areas across the vast landscapes that are managed for conservation by people who use the land (e.g. pastoralists, tourism operators, aboriginal traditional owners, or mining companies). In all case studies, a mix of conservation reserve consolidation, threatened species and ecosystem recovery and integrated natural resource management measures were identified as essential to achieve effective biodiversity conservation.

National conservation initiatives such as the bioregional approach and international initiatives such as the biosphere reserves program to support the planning and management of biodiversity conservation were discussed in chapter two. The scientific and related processes underpinning the development of bioregions and strategies across the states and territories were then considered. An important finding arising from the review was the need to improve the biological information, especially through systematic surveys and on-going monitoring of ecosystems and populations of species, at the bioregional level to inform land allocation and land

management. This finding was consistent with one of the general aims of the thesis to improve the spatial modeling techniques available for bioregional assessment and biodiversity conservation.

In chapter three I reviewed the role and limitations of geospatial technologies currently employed for biodiversity conservation management. Current developments and applications of GIS and remote sensing to wildlife research, conservation gap analysis and conservation reserve design were considered. Geographic information systems (GIS) are now routinely used by ecologists to analyse spatial data. Although various forms of GIS have been available for 15 to 25 years, the biological applications of GIS have figured most prominently in the ecological literature only in the past 15 years. The use of computer-generated models to simulate environmental events can provide a greater understanding of ecosystems, and offers improved predictive powers to conservation and land managers. The decision support offered by computer-based modelling techniques appears likely to underpin conservation and management decisions much more into the future providing that adequate biological and other datasets are available for this purpose.

The Interim Biogeographic Regionalisation for Australia (IBRA) is a bioregional framework developed in the 1990s that has become well established in conservation planning. IBRA regions represent a landscape-based approach to classifying the land surface from a range of continental data on environmental attributes. In the most recent classification (Version 6.1), 85 bioregions have been identified across Australia,

each reflecting a unifying set of major environmental influences, which shape the occurrence of flora and fauna and their interaction with the physical environment In 1997, a map of 'priority' bioregions in Australia was developed to assist organisations concerned with conservation planning and management issues. This was revised in 2001 and the revised interim biogeographic regions that were identified for Australia (IBRA 5.1) were allocated a priority ranking of 'Very High', 'High', 'Medium' or 'Low'. These priority rankings referred to the potential value that additional land reservation in each bioregion would contribute to the development of a comprehensive, adequate and representative Reserve System for Australia. The Burt Plain bioregion was one of 19 bioregions given a 'very high' priority status, and was chosen as a case study area to explore approaches and techniques for biodiversity conservation at the bioregional level in more detail.

Dominant vegetation communities and various environmental gradients were analysed to characterise environmental niches at the bioregional scale for the Burt Plain bioregion (Chapter 4) and more locally at the catchment scale for the Upper Todd River Catchment (Chapter 5). In Chapters four and five I described in detail the land tenure and use, land systems, climate soil, geology, topography, hydrology, vegetation and biodiversity of the Burt Plain bioregion and Upper Todd River Catchment. The bioregion contains some ephemeral watercourses, which are generally in fair to good condition, but are afforded little protection from a range of threatening processes, including grazing and trampling by feral animals and livestock and weed infestation. The major river systems occurring in the bioregion

include parts of the Plenty, Hanson, Sandover and Lander Rivers. In the Upper Todd River Catchment the major watercourses are the Todd River and Station Creek, which exit the area via two narrow gaps in the low rocky hills on the southern boundary of the bioregion.

The dominant geology can be summarised as plains and low rocky ranges of Pre-Cambrian granites on red earths. The bioregion has approximately 200 - 250 mm of summer rainfall, with rainfall occurring on 20 - 30 days per year. The average annual potential evaporation is approximately 3 600 - 4 000 mm per year. There is a high variability and range of temperatures, *with* an annual temperature of approximately 22-23°C.

In Chapter six I considered a range of species found within the Burt Plain bioregion using existing survey data and techniques enabling prediction of the spatial distribution of taxa. Using GLM and GAM models, three species were chosen *(Petrogale lateralis, Notomys alexis and Limnodynastes spenceri)* for a more in-depth analysis. These three target faunal species were selected for further detailed modelling to illustrate the potential capability and utility of the modelling approach to inform biological survey and monitoring in the arid zone. In addition to meeting the necessary biological data requirements for building statistically-robust models, target species were chosen to represent different taxonomic groups and forms of habitat use that need to be adequately assessed in the Burt Plain bioregion. Environmental variables correlated with the presence of each species were described

and prediction maps showing the probability or likelihood of the presence of the species within the bioregion were developed. In Chapter seven I examined the utility of radiometric data for modeling the distribution of different fauna as well as vegetation. Statistical relationships were tested between the concentrations of the elements uranium, thorium and potassium and terrain characteristics such as position in the landscape, slope and aspect as well as climatic variables. Radiometric data were found to be useful for developing statistical predictive models of six fauna species in the Burt Plain bioregion: Red Kangaroo (*Macropus rufus),* Desert Dunnart *(Sminthopsis youngsoni),* Rabbit *(Oryctolagus cuniculus),* Brown Honeyeater *(Lichmera indistincta),* Little Spotted Snake *(Suda punctata)* and Southern Boobook *(Ninox novaeseelandiae).* I suggested that the utility of radiometrics data for modelling fauna distribution would appear significant and should be explored further using alternative quantitative modelling techniques and presence/ absence records for target species. Predictions of species distributions may be useful for prioritising land acquisitions for reservation as well as in the future design of biological surveys and other conservation planning software.

8.2.1 Limitations

The environmental and biological modelling undertaken in the study was not without limitations. The types of data available for the study area were limited, and few datasets were suitable for landscape analysis across the entire bioregion. The irregularities in the data were generally due to the nature of the original capture of data and/or survey design and were shown to be heavily biased toward road

networks, and relatively accessible places/sites. The spread of the data over environmental space and model evaluations indicate that more data needs to be collected in a purposeful and systematic manner to reduce these biases and to facilitate more reliable predictive environmental and habitat modelling. Through the utilisation of other conservation planning tools such as Marxan, C-Plan or ResNet properties may be more readily identified for establishing a reserve network.

The scale of the available data was also a major limitation of the study. Most of the datasets were accurate to a scale of 1:1 000 000. This scale poses problems of showing less detail in the data and gives the appearance of homogeneity when, in fact, landscapes will have considerable environmental heterogeneity. At this scale, only well-defined boundaries between large areas of particular categories are evident, whereas the subtleties of the changes in natural features are generally omitted. There is clearly a requirement for higher resolution data in order to undertake more insightful analysis into biodiversity conservation and explaining pattern in species distributions in the arid zone. These high resolution data may come from a variety of sources including more detailed biological surveys after gap analyses have been performed, high resolution satellite imagery and a higher resolution DEM.

8.3 MANAGEMENT ISSUES IN THE ARID ZONE AND BURT PLAIN BIOREGION

8.3.1 Introduced animals

Introduced animals alter the consumption (i.e. predation and herbivory) regime of a landscape, leading to extinctions of species unable to cope with novel forms of predation and loss of their functional roles (e.g. pollination, seed dispersal, litter decomposition, nutrient and energy cycling). This may in turn lead to further biodiversity loss. There is overwhelming evidence that predation from the fox and feral cat is a major contributing factor in the decline of medium-sized mammals in arid Australia (eg. Morton 1990). There are data clearly demonstrating that grazing by rabbits and introduced livestock reduces the abundance of important annual grasses, sedges and the regeneration of shrubs. Prolonged grazing pressure can eradicate these plants at a regional level resulting in habitat degradation (Stafford Smith & Morton 1990).

Introduced plants alter the competitive pressures for space and resources, leading to displacement, community restructuring and more extinctions. As the agricultural economy grows, land use becomes both extensive and intensive, modifying resource availability through alteration of soils, hydrology, nutrients and toxic substances, and causing habitat loss and landform damage with associated consequences for natural heritage. Extensive land use alters spatial relationships between ecosystems, fragmenting large ecosystems and isolating fragments. Transport networks create

ecological connections between naturally isolated ecosystems. Both may lead to biodiversity loss. Weeds such as Couch Grass *Cynodon dactylon* have become major problems along some drainage lines in central Australia and have severely affected the distribution of *Cyperus bulbosus* (see Chapters 4 and 5).

8.3.2 Wetlands and Climate Change

Wetland ecosystems dependent on a few infrequent heavy rainfalls are vulnerable to any change in frequency or magnitude of these events. Climate change that results in a drying or reduced frequency of large flood events, exacerbated by extraction of water for agriculture, could be catastrophic for some biota, particularly waterbirds, which use a mosaic of wetland habitat at broad spatial scales.

8.3.3 Artificial Watering Points

Direct effects of supplying artificial waters include: (1) the development of wetland habitats where artesian bores are allowed to flow freely; (2) the expansion of the geographic range of many bird species that drink at water points; (3) the expansion of range and increase in relative abundance of native mammals that require drinking water (e.g., kangaroos); and (4) the possible expansion of breeding ranges of many invertebrates that require water for some stage of their life cycle.

Published effects of grazing on native fauna include: (1) speculative discussions that attribute the recent extinction of medium-sized native mammals to grazing; (2) the displacement of some ground-dwelling bird species from heavily grazed areas and a

reduction in the range in many other species; and (3) changes in the distribution and relative abundance of invertebrates such as grasshoppers, ants and collembolans (Landsberg *et al.* 1997).

Other changes that affect flora and fauna are the use of artificial waters by introduced feral animals. The fox and feral cat use water points as a focus for hunting and drinking activities (Landsberg *et al.* 1997). Horses, donkeys and goats require drinking water and have grazing impacts on vegetation that can be substantial where the population density of these species is high (Landsberg *et al.* 1997). Feral pigs inhabit some arid and semi-arid regions where artificial water is available and they disturb floodplain vegetation with their feeding activities.

8.3.4 Fire

As fire is a management tool, as well as a natural agent of ecosystem dynamics, fires can be used to manipulate biodiversity (Gill 1975). Understanding fire and its effects is important if biodiversity is to be conserved and suitably managed. An understanding of fire in Australian savanna landscapes remains inadequate, so there is a continuing need for close partnerships between scientists and land managers, with fire management treated as a series of landscape experiments in an adaptive management framework (Stafford Smith & Morton 1990). A major need for fire management today is the implementation of practical monitoring systems (Gill 1975).

8.3.5 Grazing

Grazing has been associated with compaction of soil, and altered water regimes compounding the direct effects of grazing, and altering patterns of predation and competition. There is a lack of understanding of the effects of different grazing strategies and pasture management on biodiversity and this is a major impediment to the development of appropriate and compatible best management practice that might be adopted within the Burt Plain bioregion. Although there is an increasing desire to find management strategies that protect and enhance biodiversity without hindering long-term agricultural production, in many cases this may not be possible. There is a need for improved communication and coloration between agronomic and ecological researchers and research agencies to ensure that future programs consider sustainability in terms of biodiversity as well as pasture and livestock productivity and soil and water health (Landsberg *et al.* 1997; Dorrough *et al.* 2003).

8.4 ADVANCES IN BIOREGIONAL BIODIVERSITY ASSESSMENT

In responding to the conservation imperative, it is important to supplement the essential work of systematics with spatially-explicit information on species and assemblages of species. This is possible because of recent conceptual, technical, and organizational progress in generating synoptic views of the Earth's surface at multiple scales of thematic as well as geographic resolution. The development of spatial data on the distribution of species and vegetation types provides a framework for: (a) assessing landscape pattern and process at the meso-scale, and (b) stratifying

landscape using biophysical variables so that higher-resolution surveys can be more efficiently implemented (eg, to consider: geographic adequacy of specimen collections, population size and relative abundance of species, reproductive success, and genetic dynamics).

When mapping elements of biodiversity over large areas, the relationships among and between the pattern of dominant land cover types, diversity, and spatial scale are critical. Measures of species diversity must be expressed relative to biogeographic units of a determined spatial scale if they are to be meaningful (Levin 1992). However, confusion about the differences between types of diversity ("thematic resolution") and cartographic scale is persistent (e.g. Edwards 1995, Scott et al. 1995, Short & Hestbeck 1995). Conservation efforts implemented at the population and species level alone may no longer be effective when system-wide changes are being forced at landscape and global levels of ecosystem functioning. Much more comprehensive and detailed descriptions of the habitat requirements of species, based on unbiased data sampled from the known or potential entire geographic range of species, are required.

8.5 FUTURE RESEARCH

Biological surveys of the arid zone of Australia should attempt to include the species composition of all types of land cover because both indigenous and exotic biodiversity are present in all types. Land cover data may provide a useful first-order

stratification of biodiversity within an environmental framework once these landscape level associations are more formally established. Land use information could be used to assess physical and chemical disturbance and consequent change to the resource base such as in the Upper Todd Catchment.

A fragmentation index could be derived from land cover data using a combination of ecologically relevant spatial measures such as size, number of fragments, distance to nearest neighbour and edge to core area ratio. These indices could each be calibrated against biodiversity loss to maximize their value as surrogate measures of biodiversity and employed within bioregions such as the Burt Plain to assist planning and management. These approaches also provide a basis to systematically address other management issues discussed earlier including fire.

Southworth *et al.* (2004) examined the patterns of landscape fragmentation, a discrete analysis of a forest/non-forest classification using the software FRAGSTATS as compared to a continuous NDVI-based analysis using the local indicator of spatial association (LISA) statistic. They found that the use of both FRAGSTATS and LISA together was more beneficial than either analysis by itself. While there is increasing awareness of the need for using continuous data for land cover modelling and fragmentation, this area remains little explored. The research presented by Southworth *et al* (2004) provides insights for additional future applications utilizing continuous data analyses.

Aurambout *et al*. (2005) also developed a general model, adaptable for specific species, capable of identifying suitable habitat patches within fragmented landscapes and investigating the capacity of populations to move between these patches. This approach combined a GIS analysis of a landscape, with spatial dynamic modelling. Suitable habitat was identified using a threshold area to perimeter ratio. Potential movement pathways of species between habitat patches were modeled using a cellular automaton. Habitat connectivity was estimated by overlaying habitat patches with movement pathways. The maximum potential population was calculated within and between connected habitat patches and potential risk of inbreeding within meta-populations was considered.

More detailed spatial analyses are required to identify minimum patch sizes of suitable habitat for a range of vertebrates. This will involve intensive GIS manipulation and further field research (Reid 1997). Greater complexity still is inherent in unraveling patch mosaic and neighbourhood/connectivity relationships that might influence animal distribution patterns, across various spatial scales, as predicted by Wiens (1989b) and Holling (1992). Combined with additional on-ground surveys, the predictive models developed for selected fauna in the Burt Plain bioregion during this study provide a useful basis to examine population – patch size relationships.

Australian deserts are characterised by highly patterned plant productivity and an extremely unpredictable climate. This study suggested that rainfall (at least in arid

environments) is a more biologically-meaningful predictor variable of a species' *distribution* than purely directional variables. Paltridge and Southgate (2001) conducted fauna surveys in two areas of the Tanami Desert to investigate the relative importance of palaeodrainage habitat for fauna under different seasonal conditions. The two areas were at latitudes separated by approximately 400 km, and during the study period the northern study area (Tennant) received considerably more rainfall than the southern study area (Kintore). The species richness and abundance of a range of taxonomic groups were compared between the two study areas and between palaeodrainage habitat and adjacent sandplain habitat. Overall, bilbies, bustards and macropods were significantly more abundant at Tennant than Kintore, but significantly more small mammals were captured at Kintore. In both habitats and areas, capture rates, track counts and species richness of reptiles varied significantly with season. Burrowing frogs were active only after rain, and birds showed significant fluctuations in abundance and species richness associated with rainfall. Local seasonal conditions were generally more important determinants of the abundance of fauna in the spinifex grasslands of central Australia than was habitat type (Paltridge and Southgate 2001).

Kadmon and Heller (1998) in their study describe a multivariate approach based on geographical information system (GIS) technology for the analysis of faunal responses to climatic gradients, in particular land snails. Patterns of faunal variation were significantly correlated with underlying variation in rainfall. However, the per-unit effect of rainfall on the composition of the studied fauna was much greater in

dry regions than in more rainy areas. Above 450 mm, no relationships could be detected between the observed patterns of faunal variation and rainfall. The overall results indicated that the integration of GIS tools with standard multivariate techniques may serve as a valuable methodology for the identification and interpretation of regional patterns of faunal variation.

Future modelling of the distribution of fauna in central Australia could consider the influence of rainfall distribution on species' distributions in greater detail than has been possible in this study. None of the generated vertebrate models presented in this dissertation have been tested against an independent data set. A primary recommendation, therefore, is for model evaluation, validation and refinement to be carried out using independent, appropriately geo-referenced vertebrate data sets.

Low sample sizes for the rarer wildlife species precluded the effective modelling of their distribution and habitat requirements in this study. A recommendation is that rare species become a much greater focus for future biological survey, with an aim to increasing sample size to a robust number for the purposes of statistical spatial modelling as well as an improved description of habitat requirements and population management. Although some may argue that an equally valid case would exist to study those species that are more common and/or robust enough to persist in a system where changes may occur.

8.6 CLOSING COMMENTS

Australia's conservation reserve system is incomplete. There are major gaps in the nation's system of nature conservation reserves that are placing biodiversity at risk. Forty-two major regions in Australia have only a poor conservation reserve system, and seventy-one sub-regions have no protected areas at all. Significant on-going threats (including land clearing and degradation) mean that the opportunity to include many species and ecosystems in new conservation reserves is closing.

There is a crucial need to upgrade Australia's conservation reserve system. Currently only limited biodiversity monitoring is undertaken at large scales and so governments have little foundation on which to base forward planning and budgeting of scarce dollars for biodiversity conservation programs (Smyth 2003). This inadequacy is well illustrated in the Burt Plain bioregion and associated areas of central Australia. Many agencies and groups are engaged in biodiversity inventory, but few are tackling the problem of how to monitor cost-effectively over large areas and how to detect trends recognizing substantial natural "background" variations that may occur in these landscapes (Smyth 2003).

The Northern Territory has recently enacted legislation for classifying the conservation status of wildlife species (*Northern Territory Parks and Wildlife Conservation* Act 2000, see Parks and Wildlife Commission, 2003). However, there is no legislation in the Northern Territory for listing threatened ecological communities.

There appears to be only a limited focus on ecological communities, although the recent subregional biodiversity summaries provided by Woinarski & Fisher (2003) addressed threats in terms of communities, and ecosystems and are a positive contribution to this topic. The draft Northern Territory Parks and Conservation Masterplan recommends that the CAR criteria should not be applied at the bioregional and regional ecosystem level without additional criteria being included that assesses the natural and cultural values of the bioregion as a whole (Department of Natural Resources, Environment and the Arts, 2005).

Various applications present themselves as outcomes of the study. The distribution, relative abundance and habitat preferences of some fauna species as well as vegetation communities are now documented in much more detail in the Burt Plain bioregion than was the case prior to the study. Along, with the predicted occurrences of species, such information could be used to assist activities such as:

- helping mitigate the potential impacts of new developments;
- helping to identify significant habitats for rare and important species and diverse communities;
- helping select new sampling locations in targeted surveys; and
- generating species lists for designated areas.

Roland & Taylor (1997) demonstrated the varied effects on different organisms of multiple-scaled habitat patterns across large landscapes and entire regions, lending the necessary empirical support to previous theory. Similarly, in the arid portions of

the Northern Territory it has been suggested that the distribution of various threatened species may converge in certain landscapes, as in the Tanami Desert and at Uluru-Kata Tjuta National Park (Foulkes et al. 1995; Gibson 1986; Reid & Hobbs 1996). It is important that further research be undertaken to determine the occurrence and biological significance of such landscape patterns. This knowledge would contribute to the emergent concepts and theory of ecosystem dynamics and associated biodiversity patterns in arid zone Australia (Morton 1990; Stafford Smith & Morton 1990).

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LIST OF APPENDICES

APPENDIX 1 – Full description of Perry Land Systems found in the Burt Plain bioregion

Map Unit	Full description
Aa	Amadeus (1800 sq. miles). Saline pans with waterlogged clays; unvegetated or fringed with samphire. Fringing dunes of red sand with spinifex
Ab	Ambalindum (200 sq. miles). Weathered high terrace remnants, dissected low calcareous terraces, and derived alluvial plains, relief up to 150 ft; stony texture-contrast soils, some red clay soils; open Bassia spp., or Mitchell grass
Ac	Alcoota (1100 sq. miles). Undulating plains; red earths; mulga over short grasses. Erosional and alluvial slopes; texture-contrast soils, some stony; sparse low trees over short grass or woollybutt
Ad	Adnera (100 sq. miles). Fans in north-east of area; red earths with mulga over short grass, yellow earths with scattered trees over short grass
Ag	Alinga (800 sq. miles). Plains; red earths with mulga over short grass, some red clayey sands with soft spinifex. Ridges and broad rises, up to 70 ft high with various stony soils and spinifex
Ai	Aileron (100 sq. miles). Granite hills up to 350 ft high; some shallow gritty and stony soils; sparse grass. Erosional lowlands and alluvial plains; red earths and red clayey sands; sparse low trees over short grass. Plains of red clayey sand with spinifex
Al	Allua (600 sq. miles). Ridges and foothills, relief up to 500 ft; little soil; spinifex or sparse grass. Strike vales with alluvial plains; shallow stony soils and calcareous earths; gidgee and/or short grass
Am	Ammaroo (500 sq. miles). Lower flood-plains and flood-out basins in north-east of area; red earths, with sparse low trees or no trees over short grass, some brown alluvial clay soils with Mitchell grass
An	Angas (400 sq. miles). Plains; red clayey sands; spinifex. Stony rises up to 50 ft high; mainly stony soils; open or sparse shrubs over short grass or southern bluebush
Ar	Anderinda (200 sq. miles). Stony plains on granite, schist, and gneiss, with shallow valleys, relief up to 30 ft; texture-contrast soils and red earths; open, sparse shrubs, or mulga over short grass
Au	Amulda (100 sq. miles). Fans with extensive sandy plains within the central ranges; red clayey sands, some alluvial clayey sands; mainly spinifex, some sparse low trees over short grass
Ba	Barrow (100 sq. miles). Granite plains, up to 10 ft relief; red earths and red clayey sands; open or very sparse low trees over short grass
Be	Berrys Pass (100 sq. miles). Piedmont fans and terraces of coarse gravels, relief up to 150 ft; little soil; sparse shrubs and low trees over spinifex
Bo	Boen (2700 sq. miles). Plains with convex interfluves and broad shallow valleys, relief up to 20 ft; red earths; lateritic in part; mulga in groves over short grass or woollybutt
Bs	Bond Springs (1300 sq. miles). Ridges up to 500 ft. high and rugged terrain with up to 100 ft. relief; some shallow gritty and stony soils; sparse shrubs and grasses. Narrow plains; various soils; sparse low trees over short grasses
Bu	Bushy Park (6400 sq. miles). Plains; red earths; mulga in groves over short grass or woollybutt
Cc	Cherry Creek. (700 sq. miles). Subdued plateaux on shale and limestone, relief up to 75 ft; little shallow soil; sparse shrubs and low trees over spinifex. Fringing plains; red clayey sands; spinifex
Ch	Chisolm (200 sq. miles). Peneplain; red earths; mulga and short grass. Limestone cappings; calcareous earths; spinifex. Valleys entrenched up to 75 ft; texture-contrast soils; open with short grass
Cn	Chandlers (1000 sq. miles). Strongly deformed sedimentary rocks. Erosional and alluvial plains; stone-mantled texture-contrast soils; sparse shrubs, Bassia spp. Mesas and ridges, relief up to 250 ft; sparse shrubs and sparse grass
Co	Coghlan (<50 sq. miles). Low uplands, stony fringing slopes and alluvial plains, relief up to 50 ft; shallow stony or sandy soils; sparse shrubs and low trees over sparse grass
Cv	Cavenagh (400 sq. miles). Granite hills up to 350 ft high; some shallow soils; sparse grass. Erosional plains locally masked by sand; mainly red clayey sands, texture-contrast soils, and red earths; witchetty bush over short grass

Da	Davenport (2700 sq. miles). Bevelled quartzite and sandstone ridges and uplands, relief up to 750 ft; some clayey vey stony soils; spinifex. Minor narrow valleys; red clayey sands and coarse soils; spinifex
De	Delny (500 sq. miles). Peneplain, dissected margins, and lower erosional plains, relief up to 100 ft; red earths, calcareous earths, and stony texture-contrast soils; mulga, gidgee, or sparse low trees over short grass
Di	Dinkum (600 sq. miles). Hummocky sandy plains and some stony plains of schist and gneiss, relief mainly up to 20 ft; red clayey sands and sandy red earths; mainly open or with sparse low trees over short grass
Dr	Deering (100 sq. miles). Plains below dissected terraces in the western MacDonnell Ranges; scalded texture-contrast soils; open or sparse shrubs over Bassia spp.
Eb	Ebenezer (900 sq. miles). Plains with slightly eroded margins, kunkar in lower part, unchannelled valleys, up to 50 ft relief; calcareous earths and stone-mantled texture-contrast soils; open or sparse shrubs with Bassia spp. or southern bluebush
Ed	Endinda (800 sq. miles). Broadly undulating stony plains, relief up to 30 ft; stone-mantled texture-contrast soils; open or sparse shrubs with saltbush or southern bluebush. Locally, dunes of red sand with spinifex
En	Ennugan (200 sq. miles). Plains with gently sloping interfluves and flat valley floors, relief up to 20 ft; red earths and probably texture-contrast soils; mainly sparse low trees or mulga over short grass
Ew	Ewaninga (600 sq. miles). Undulating dune-covered terrain with stony conglomerate hills, relief up to 30 ft; red dune sands; spinifex mainly under mulga
Fi	Finke (700 sq. miles). Upper and middle flood-plains south of the MacDonnell Ranges; coarse alluvial, calcareous, and texture-contrast soils; open or sparse low trees over short grass or Bassia spp.
Gi	Gillen (3700 sq. miles). Quartzite and sandstone ridges up to 1000 ft high; little soil; spinifex. Vales with alluvial plains and gravel terraces; stony soils (texture-contrast, red earth), red clayey sands, and coarse soils; sparse shrubs and low trees, mulga, or witchetty bush over short grass
Ha	Harts (4500 sq. miles). Uplands, steep-sided mountains, and hills, relief about 1000 ft; pockets of shallow gritty and stony soils; sparse shrubs and grasses.
Hm	Hamilton (400 sq. miles). Plains flanking crystalline moutains, north of the MacDonnell Ranges; texture-contrast soils with short grasses or Bassia spp. or northern bluebush, some red earths and red clay soils with mulga and short grass
Hn	Hann (1500 sq. miles). Sandstone and quartzite ridges and uplands up to 300 ft high; little shallow soil; spinifex. Alluvial fans and erosional tributary slopes; red clayey sands and coarse alluvial soils; spinifex or sparse low trees over short grass
Ho	Hogarth (400 sq. miles). Sandstone uplands and ridges above dissected limestone plateaux, relief up to 100 ft; little sandy soil; sparse mulga or gidgee over short grass
Hu	Huckitta (600 sq. miles). Mountain ranges with rounded foothills and spurs, relief up to 750 ft; little soil; spinifex or sparse grass
Ib	Ilbumric (1200 sq. miles). Ridges, uplands and bevelled stony rises, relief p to 200 ft; little soil; soft spinifex. Lowlands; mainly red earths, some alluvial soils; mulga over short grass
Il	Ilgulla (400 sq. miles). Closely dissected plateaux, relief up to 100 ft; little soil; open, witchetty bush, or gidgee over short grass
In	Indiana (600 sq. miles). Stony schist and gneiss plains closely dissected up to 30 ft by flat, unchannelled valleys; shallow, stony, texture-contrast soils with open or sparse shrubs and low trees or no trees over short grass, some coarse soils with spinifex
Ji	Jinka (200 sq. miles). Granite plains with up to 30 ft relief, traversed by quartz reefs; shallow, stony, texture-contrast soils and red clayey sands; sparse shrubs and low trees over short grass
K	Kurundi (300 sq. miles). Rounded uplands, ridges with lateritic crusts, relief up to 500 ft; little soil; soft spinifex. Undulating lowlands with alluvial plains; shallow red earths and alluvial soils; open or gidgee over short grass
Ka	Karee (900 sq. miles). Plains; red clayey sands and sandy red earths; mulga in groves over woollybutt
Ke	Kernot (300 sq. miles) Bevelled strike ridges and stony rises, relief up to 200 ft; little soil; sparse grass. Unchannelled lowlands; coarse soils; mainly mulga over short grass
Kl	Kalamerta (200 sq. miles). Plains; red clayey sands; spinifex. Minor low hills and stony rises up to 50 ft high; coarse soils - red clayey sands, sandy red earths, calcareous earths, and

texture-contrast soils; mainly mulga over saltbush

Kn Kanandra (1300 sq. miles). Sandy plains on the north side of the MacDonnell and Harts Ranges; sandy alluvial soils, red clayey sands, and sandy red earths; sparse low trees over kerosene grass

Kr Krichauff (3100 sq. miles). Bold plateaux, with rocky summits and steep, dissected margins, relief up to 500 ft; some very stony and sandy soils; sparse shrubs and low trees over spinifex or sparse grass

Ku Kulgera (< 50 sq. miles). Schist plains with dissected weathered tracts and limestone cappings, relief up to 100 ft; shallow red clayey sands and calcareous earths, texture-contrast soils, and red earths; open with short grass or saltbush

Le Leahy (100 sq. miles). Plains; mainly red clayey sands and sandy red earths; mainly mulga over short grass, some spinifex

Li Lindavale (1100 sq. miles). Sand-covered or lightly dissected plains with up to 30 ft relief; red clayey sands and sandy calcareous earths; mainly mulga over short grass, some spinifex

Ll Lilla (300 sq. miles). Dissected erosional plains and terraces, relief up to 90 ft; stony soils, some shallow, some texture-contrast; mainly open with southern bluebush, saltbush, or Bassia spp.

Lu Lucy (1000 sq. miles). Plateaux and uplands, relief up to 75 ft; various coarse, shallow soils; mainly gidgee over short grass. Minor entrenched flat-floored valleys; red eaths; mulga or sparse low trees over short grass

Md McDills (200 sq. miles). Lower flood-plains and flood-out basins of the Finke; layered silty and sandy alluvial soils; mainly open, with Bassia spp., some coolibah over old man saltbush or northern bluebush

Mg McGrath (300 sq. miles). Flood-plains with restricted channel drainage; red earths, some layered alluvial soils, and red clay soils; open or sparse low trees over short grass

Mi Middleton (800 sq. miles). Sandstone ridges and plateaux up to 300 ft high and sandy lowlands; shallow soils and red clayey sands; spinifex

Mu Muller (400 sq. miles). Low hilly or undulating, relief up to 75 ft calcareous earths; open or witchetty bush over short grass

Na Napperby (1000 sq. miles). Granite hills, relief 500 ft; and gneiss ridges, relief 50 ft; some shallow soils; sparse grass. Lowlands; red earths and other soils; sparse low trees over short grasses

Oo Ooratipra (200 sq. miles). Dolomite and limestone plains with broad, unchannelled drainage floors, relief 5 ft.; red earths; gidgee over short grass on plains, mulga over short grass on drainage floors

Ou Outounya (600 sq. miles). Plains, partially dissected to 20 ft by flat-floored valleys; mainly red clayey sands; mainly witchetty bush over short grass

Pe Peebles. (500 sq. miles). Steep-sided hills, dissected spurs, and erosional terraces, relief up to 150 ft; stone-mantled texture-contrast soils; mainly open with saltbush

Pn Pertnjara (300 sq. miles). Hills and ridges of conglomerate, rounded stony crests, and steep hill slopes, relief up to 300 ft; shallow, very stony, calcreted soils; spinifex

Pu Pularoo (100 sq. miles). Closely dissected, stony granite and gneiss plains with flat-floored valleys entrenched up to 30 ft; shallow red clayey sands and red earths; sparse low trees over short grass

Py Pulya (300 sq. miles). Piedmont fans of calcareous alluvium and calcreted gravels; shallow red clayey sands over stone, some sandy calcareous earths; and sandy red earths; mainly open or gidgee over short grass

Re Reynolds (100 sq. miles). Dissected piedmont gravel terraces and rocky terrain, relief up to 50 ft; stony soils - fine red earths, some texture-contrast soils; spinifex

Ri Ringwood (500 sq. miles). Intermont plains of calcareous alluvium; calcareous earths and red earths over marl; open or gidgee over short grass

Rn Renners (300 sq. miles). Broadly undulating shale and limestone terrain with strike rises and broad valleys, relief up to 50 ft; shallow stony calcareous earths and texture-contrast soils; mainly southern bluebush

Ru Rumbalara (900 sq. miles). Stony plateaux, relief up to 300 ft; little soils; sparse shrubs and sparse grass. Spurs and lowlands; stone-mantled texture-contrast soils; open, Bassia spp., or saltbush

Ry Ryan (300 sq. miles). Stony granite and gneiss plains locally dissected up to 20 ft by flat-floored valleys; mainly texture-contrast soils; open or with sparse low trees over short grass

Sa Sandover (1700 sq. miles). Upper and middle flood-plains north of the MacDonnell Ranges;

	sandy alluvial clayey sands, alluvial sandy red earths, and some red earths; sparse low trees over short grass
Si	Simpson (37,800 sq. miles). Parallel, reticulate,and irregular sand dunes with stable flanks, minor areas of mobile sands, red dune sands and red clayey sands; spinifex
Sk	Stokes (700 sq. miles). Piedmont gravel terraces of two cycles, dissection valleys, relief up to 80 ft; stony fine red earths, some sandy texture-contrast soils; mainly sparse shrubs and low trees or mulga over spinifex
Sn	Singleton (38,100 sq. miles). Flat or gently undulating plain; red clayey sands and sands, in north-west some sandy red earths, in part lateritic; spinifex
So	Sonder (2300 sq. miles). Bold quartzite and sandstone ridges with rocky cliffs and steep slopes, relief up to 2500 ft; very little soil; spinifex
St	Santa Teresa (100 sq. miles). Plateaux with dissected escarpments, benches of weathered rocks, relief up to 300 ft; little shallow soil; spinifex
Ta	Table Hill (300 sq. miles). Low plateaux, relief up to 150 ft; shallow stony soils, calcareous earths, red clayey sands, and red earths; mainly sparse shrubs over short grass
Td	Todd (300 sq. miles). Coalescent flood-plains of the Todd River and tributaries; sandy alluvial soils, some red clayey sands and silty, fine and layered alluvial soils; sparse low trees over short grass
Te	Tennant Creek (300 sq. miles). Closely dissected, bevelled hills and spurs; little soil; soft spinifex. Plains with extensive sand cover, mainly coarse soils, some stony texture-contrast soils; soft spinifex
Ti	Titra (600 sq. miles). Plains with moderate sand cover and with very lightly dissected margins, 10 ft relief; shallow sandy calcareous earths, some saline, with open or sparse shrubs over short grass, and some sandy soils with soft spinifex
To	Tomahawk (<50 sq. miles). Dissected plateaux with regionally sloping summits, relief up to 150 ft; some very stony and coarse soils; sparse shrubs or gidgee over sparse grass
Tt	Tietkins (100 sq. miles). Granite plains extensively masked by sand sheets, dunes, and calcrete; red earths (mainly sandy, locally lateritic) and red clayey sands; mainly mulga over over woollybutt
Uc	Unca (200 sq. miles). Stony plains on granite, schist, and gneiss, dissected up to 15 ft by broad sandy valleys; sandy red earths with open or sparse low trees or no trees over short grass, some red clayey sands with spinifex
Un	Undippa (100 sq. miles). Lobate plains flanking crystalline ranges and chalcedony plateaux; red clay soils; open with Mitchell grass and some northern bluebush
Ut	Utopia (<50 sq. miles). Fans and alluvial basins, in north-east of area; grey clay soils; open with northern bluebush
Wa	Warburton (600 sq. miles). Plains with up to 15 ft relief; red earths and texture-contrast soils; mainly medium dense low trees over short grass or woollybutt
We	Weldon (100 sq. miles). Piedmont gravel terraces and undulating plains, dissected up to 40 ft; red earths, mainly fine and stony; mainly sparse shrubs and low trees over spinifex
Wi	Wilyunpa (300 sq. miles). Stony tablelands, relief up to 150 ft; stone-mantled texture-contrast soils; open with Bassia spp., or saltbush
Wl	Woolla (600 sq. miles). Low platforms with shallow sandy calcareous earths; drainage floors with red earths; sparse low trees over short grass. Some plains of red clayey sands with spinifex
Wn	Wonorah (4600 sq. miles). Gently undulating plains with stonier higher parts and broad lowlands, relief mainly up to 30 ft; red clayey sands and red earths, partly lateritic; soft spinifex with sparse shrubs and low trees
Wo	Woodduck (600 sq. miles). Fans with sandy plains in the north of the area; red clayey sands; spinifex or sparse low trees over short grass

APPENDIX 2 – Upper Todd Catchment Land Unit Mapping – Description of geomorphic units

1. TERRAIN DEVELOPED ON WEATHERED BASEMENT ROCK

1.1 Low hilly terrain; rudosols/lithosols; a low sparse shrubland of witchetty bush and mulga over annual grasses.

2. TERRAIN ON DEEPLY-WEATHERED SUBSTRATES

2.1 Low hills and rises with basement rock outcrop; calcarosols/lithosols over mottled saprolite; a low open woodland of red mallee over buck spinifex.

2.2 Slopes and breakaways; calcarosols/red calcareous soils over saprolite; a low open woodland of red mallee over buck spinifex.

2.3 Gravelly plains and low rises; sodosols/red-brown earths over mottled saprolite; a low sparse groundcover of copperburr.

2.4 Gravelly, weakly dissected margins to Unit 2.3; sodosols/red brown earths over mottled saprolite; a low sparse groundcover of copperburr.

2.5 Flat-crested gravelly rises; sodosols/red brown earths over mottled saprolite; a low open woodland of mulga and witchetty bush with rock fuschia and silver cassia over sparse copperburrs.

3. DURICRUSTED SURFACES

3.1 Low plateaus with gently-dipping planar surfaces; tenosols/lithosols overlying rubbly silcrete or soils absent; a low open woodland of mulga over copperburrs.

3.2 Plains, rises and low plateaus mantled with lateritic gravel; kandosols/red earths; a low open woodland of mulga over scattered rock fuschia-bush and a sparse groundcover of copperburr.

4. TERRAIN DEVELOPED ON WEATHERED SEDIMENTS

4.1 Plains with banded sheet flow drainage features; dermosols/red earths; a groved low woodland of mulga over annual grasses.

4.2 Low crests with rounded profiles on catchment margins; dermosols/red clays; a sparse ground cover of annual forbs with scattered juvenile mulga.

4.3 Plains, usually as linear ridge crests; kandosols/red earths; bare or with isolated mulga over sparse annual forbs.

4.4 Gentle slopes and plains; kandosols/red earths or calcarosols/solonized brown soils; a low open woodland of mulga and witchetty bush over annual grasses and copperburrs.

4.5 Gentle slopes and plains with banded sheet flow drainage patterns; kandosols/calcareous red earths; a groved woodland of mulga and witchetty bush over annual grasses and grey copperburr.

4.6 Low rises and gentle slopes; sodosols/red brown earths with shallow A-horizons; a sparse groundcover of copperburr.

4.7 Low rises and gentle slopes; sodosols/red brown earths; a tall sparse shrubland of harlequin emu-bush over copperburrs with annual and perennial grasses.

5. CLAY PLAINS DEVELOPED ON WEATHERED SEDIMENTS

5.1 Gently sloping gilgaied plains; deep vertosols/red clays; a low open tussock grassland of barley mitchell and neverfail grasses.

5.2 Slightly dissected plains where Unit 5.1 abuts floodplain; vertosols/red clays; a mid-high sparse tussock grassland of barley mitchell grass.

5.3 Gently sloping gilgaied plains; vertosols/brown clays; sparse copperburrs and annual grasses with perennial grasses in gilgais.

6. DRAINAGE FLOORS

6.1 Broad drainage floors; sodosols/red-brown earths; a low, sparse groundcover of copperburrs.

6.2 Linear drainage floors and depressions; dermosols/red earths; a mid-high woodland of mulga over a sparse green

grassland of annual grasses and seasonal forbs.

6.3 Broad drainage floors; kandosols/red earths; a mid-high open woodland of mulga over desert fuschia and a sparse groundcover of annual grasses and forbs.

6.4 Linear drainage floors with sandy braided channels; tenosols/alluvial soils; a sparse shrubland of needlebush with broombush, turpentine and harlequin emu-bush over copperburrs and annual grasses.

6.5 Linear drainage floors associated with Unit 5.1; sodosols/red-brown earths; a sparse grassland of 8-day and 5-minute grasses and copperburrs.

7. ALLUVIAL FANS AND SLOPE MANTLES

7.1 Gently sloping footslope plains associated with fans; sodosols/red-brown earths; a low sparse groundcover of copperburr annual grasses and seasonal herbage.

7.2 Footslope fans flanking breakaways; chromosols/red-brown earths; a low sparse chenopod shrubland of cottonbush with annual grasses.

7.3 Gently sloping plains; vertosols/red and brown clays overlying saprolite; a low sparse groundcover of copperburrs with annual and perennial grasses.

7.4 Gently sloping plains dissected by closely spaced tributary drainage channels; kandosols/calcareous red earths; a low open woodland of mulga over a sparse groundcover of woolly copperburr.

7.5 Alluvial fans; tenosols/alluvial soils; a mid-high open woodland of ironwood and mulga over sparse copperburrs and annual grasses.

7.6 Gently sloping plains; kandosols/red earths; a low open woodland of mulga with silver cassia over copperburrs and annual grasses.

8. FLOODPLAINS

8.1 Terraces elevated above presently active floodplains; sodosols/red-brown earths; a low sparse groundcover of copperburrs with annual grasses and forbs.

8.2 Floodplain; sodosols/red-brown earths; a low sparse groundcover of copperburrs with annual grasses and forbs.

8.2(a) Scours in the floodplain with bare scalded surfaces.

8.3 Active floodplain levees and sediment splays with well developed incised bedload channels; rudosols/alluvial soils; a tall open woodland of ironwood and river red gum with low shrubs over a sparse tussock grassland of creek windmill grass.

APPENDIX 3 – List of fauna species available for modelling

FAMILY NAME	GENUS NAME	SPECIES NAME	COMMON NAME
Casuariidae	*Dromaius*	*novaehollandiae*	Emu
Podicipedidae	*Podiceps*	*cristatus*	Great crested Grebe
Podicipedidae	*Poliocephalus*	*poliocephalus*	Hoary-headed Grebe
Podicipedidae	*Tachybaptus*	*novaehollandiae*	Australasian Grebe
Pelecanidae	*Pelecanus*	*conspicillatus*	Australian Pelican
Anhingidae	*Anhinga*	*melanogaster*	Darter
Phalacrocoracidae	*Phalacrocorax*	*carbo*	Great Cormorant
Phalacrocoracidae	*Phalacrocorax*	*varius*	Pied Cormorant
Phalacrocoracidae	*Phalacrocorax*	*sulcirostris*	Little Black Cormorant
Phalacrocoracidae	*Phalacrocorax*	*melanoleucos*	Little Pied Cormorant
Ardeidae	*Ardea*	*intermedia*	Intermediate Egret
Ardeidae	*Nycticorax*	*caledonicus*	Nankeen Night Heron
Ciconiidae	*Ephippiorhynchus*	*asiaticus*	Black-necked Stork
Threskiornithidae	*Plegadis*	*falcinellus*	Glossy Ibis
Threskiornithidae	*Threskiornis*	*molucca*	Australian White Ibis
Threskiornithidae	*Threskiornis*	*spinicollis*	Straw-necked Ibis
Threskiornithidae	*Platalea*	*regia*	Royal Spoonbill
Threskiornithidae	*Platalea*	*flavipes*	Yellow-billed Spoonbill
Anatidae	*Dendrocygna*	*eytoni*	Plumed Whistling-Duck
Anatidae	*Cygnus*	*atratus*	Black Swan
Anatidae	*Anas*	*superciliosa*	Pacific Black Duck
Anatidae	*Anas*	*gracilis*	Grey Teal
Anatidae	*Anas*	*castanea*	Chestnut Teal
Anatidae	*Malacorhynchus*	*membranaceus*	Pink-eared Duck
Anatidae	*Aythya*	*australis*	Hardhead
Anatidae	*Chenonetta*	*jubata*	Australian Wood Duck
Accipitridae	*Elanus*	*axillaris*	Black-shouldered Kite
Accipitridae	*Elanus*	*scriptus*	Letter-winged Kite
Accipitridae	*Milvus*	*migrans*	Black Kite
Accipitridae	*Hamirostra*	*melanosternon*	Black-breasted Buzzard
Accipitridae	*Haliastur*	*sphenurus*	Whistling Kite
Accipitridae	*Accipiter*	*fasciatus*	Brown Goshawk
Accipitridae	*Accipiter*	*cirrhocephalus*	Collared Sparrowhawk
Accipitridae	*Aquila*	*audax*	Wedge-tailed Eagle
Accipitridae	*Hieraaetus*	*morphnoides*	Little Eagle
Accipitridae	*Circus*	*assimilis*	Spotted Harrier
Accipitridae	*Circus*	*approximans*	Swamp Harrier
Falconidae	*Falco*	*subniger*	Black Falcon
Falconidae	*Falco*	*peregrinus*	Peregrine Falcon
Falconidae	*Falco*	*longipennis*	Australian Hobby
Falconidae	*Falco*	*hypoleucos*	Grey Falcon
Falconidae	*Falco*	*berigora*	Brown Falcon
Falconidae	*Falco*	*cenchroides*	Nankeen Kestrel
Phasianidae	*Coturnix*	*pectoralis*	Stubble Quail
Turnicidae	*Turnix*	*velox*	Little Button-quail
Rallidae	*Porzana*	*fluminea*	Australian Spotted Crake
Rallidae	*Gallinula*	*ventralis*	Black-tailed Native-hen

Rallidae	*Fulica*	*atra*	Eurasian Coot
Gruidae	*Grus*	*rubicunda*	Brolga
Otididae	*Ardeotis*	*australis*	Australian Bustard
Burhinidae	*Burhinus*	*grallarius*	Bush Stone-curlew
Charadriidae	*Vanellus*	*miles*	Masked Lapwing
Charadriidae	*Vanellus*	*tricolor*	Banded Lapwing
Charadriidae	*Erythrogonys*	*cinctus*	Red-kneed Dotterel
Charadriidae	*Elseyornis*	*melanops*	Black-fronted Dotterel
Charadriidae	*Charadrius*	*australis*	Inland Dotterel
Recurvirostridae	*Himantopus*	*himantopus*	Black-winged Stilt
Scolopacidae	*Tringa*	*glareola*	Wood Sandpiper
Scolopacidae	*Actitis*	*hypoleucos*	Common Sandpiper
Scolopacidae	*Tringa*	*nebularia*	Common Greenshank
Scolopacidae	*Tringa*	*stagnatilis*	Marsh Sandpiper
Scolopacidae	*Calidris*	*acuminata*	Sharp-tailed Sandpiper
Glareolidae	*Stiltia*	*isabella*	Australian Pratincole
Laridae	*Larus*	*novaehollandiae*	Silver Gull
Laridae	*Chlidonias*	*hybridus*	Whiskered Tern
Columbidae	*Columba*	*livia*	Rock Dove (feral Pigeon)
Columbidae	*Geopelia*	*striata*	Peaceful Dove
Columbidae	*Geopelia*	*cuneata*	Diamond Dove
Columbidae	*Phaps*	*chalcoptera*	Common Bronzewing
Columbidae	*Phaps*	*histrionica*	Flock Bronzewing
Columbidae	*Ocyphaps*	*lophotes*	Crested Pigeon
Columbidae	*Geophaps*	*plumifera*	Spinifex Pigeon
Cacatuidae	*Calyptorhynchus*	*banksii*	Red-tailed Black-cockatoo
Cacatuidae	*Cacatua*	*roseicapilla*	Galah
Cacatuidae	*Cacatua*	*sanguinea*	Little Corella
Cacatuidae	*Cacatua*	*leadbeateri*	Major Mitchell's Cockatoo
Psittacidae	*Polytelis*	*alexandrae*	Princess Parrot
Cacatuidae	*Nymphicus*	*hollandicus*	Cockatiel
Psittacidae	*Melopsittacus*	*undulatus*	Budgerigar
Psittacidae	*Barnardius*	*zonarius*	Australian Ringneck
Psittacidae	*Psephotus*	*varius*	Mulga Parrot
Psittacidae	*Neopsephotus*	*bourkii*	Bourke's Parrot
Cuculidae	*Cuculus*	*pallidus*	Pallid Cuckoo
Cuculidae	*Chrysococcyx*	*osculans*	Black-eared Cuckoo
Cuculidae	*Chrysococcyx*	*basalis*	Horsfield's Bronze-Cuckoo
Cuculidae	*Scythrops*	*novaehollandiae*	Channel-billed Cuckoo
Strigidae	*Ninox*	*novaeseelandiae*	Southern Boobook
Tytonidae	*Tyto*	*alba*	Barn Owl
Podargidae	*Podargus*	*strigoides*	Tawny Frogmouth
Aegothelidae	*Aegotheles*	*cristatus*	Australian Owlet-nightjar
Caprimulgidae	*Eurostopodus*	*argus*	Spotted Nightjar
Halcyonidae	*Todiramphus*	*pyrrhopygia*	Red-backed Kingfisher
Halcyonidae	*Todiramphus*	*sanctus*	Sacred Kingfisher
Meropidae	*Merops*	*ornatus*	Rainbow Bee-eater
Alaudidae	*Mirafra*	*javanica*	Singing Bushlark
Hirundinidae	*Cheramoeca*	*leucosternus*	White-backed Swallow
Hirundinidae	*Hirundo*	*neoxena*	Welcome Swallow

Hirundinidae	*Hirundo*	*nigricans*	Tree Martin
Hirundinidae	*Hirundo*	*ariel*	Fairy Martin
Motacillidae	*Anthus*	*novaeseelandiae*	Richard's Pipit
Campephagidae	*Coracina*	*novaehollandiae*	Black-faced Cuckoo-shrike
Campephagidae	*Coracina*	*maxima*	Ground Cuckoo-shrike
Campephagidae	*Lalage*	*sueurii*	White-winged Triller
Petroicidae	*Petroica*	*goodenovii*	Red-capped Robin
Petroicidae	*Melanodryas*	*cucullata*	Hooded Robin
Petroicidae	*Microeca*	*fascinans*	Jacky Winter
Pachycephalidae	*Pachycephala*	*rufiventris*	Rufous Whistler
Pachycephalidae	*Colluricincla*	*harmonica*	Grey Shrike-thrush
Pachycephalidae	*Oreoica*	*gutturalis*	Crested Bellbird
Dicruridae	*Rhipidura*	*fuliginosa*	Grey Fantail
Dicruridae	*Rhipidura*	*leucophrys*	Willie Wagtail
Cinclosomatidae	*Psophodes*	*occidentalis*	Chiming Wedgebill
Cinclosomatidae	*Psophodes*	*cristatus*	Chirruping Wedgebill
Cinclosomatidae	*Cinclosoma*	*castaneothorax*	Chestnut-breasted Quail-thrush
Cinclosomatidae	*Cinclosoma*	*cinnamomeum*	Cinnamon Quail-thrush
Pomatostomidae	*Pomatostomus*	*temporalis*	Grey-crowned Babbler
Pomatostomidae	*Pomatostomus*	*superciliosus*	White-browed Babbler
Sylviidae	*Eremiornis*	*carteri*	Spinifexbird
Sylviidae	*Cisticola*	*exilis*	Golden-headed Cisticola
Sylviidae	*Cincloramphus*	*mathewsi*	Rufous Songlark
Sylviidae	*Cincloramphus*	*cruralis*	Brown Songlark
Maluridae	*Malurus*	*splendens*	Splendid Fairy-wren
Maluridae	*Malurus*	*lamberti*	Variegated Fairy-wren
Maluridae	*Malurus*	*leucopterus*	White-winged Fairy-wren
Maluridae	*Amytornis*	*striatus*	Striated Grasswren
Maluridae	*Amytornis*	*purnelli*	Dusky Grasswren
Pardalotidae	*Pyrrholaemus*	*brunneus*	Redthroat
Pardalotidae	*Smicrornis*	*brevirostris*	Weebill
Pardalotidae	*Gerygone*	*fusca*	Western Gerygone
Pardalotidae	*Acanthiza*	*apicalis*	Inland Thornbill
Pardalotidae	*Acanthiza*	*uropygialis*	Chestnut-rumped Thornbill
Pardalotidae	*Acanthiza*	*robustirostris*	Slaty-backed Thornbill
Pardalotidae	*Acanthiza*	*chrysorrhoa*	Yellow-rumped Thornbill
Pardalotidae	*Aphelocephala*	*leucopsis*	Southern Whiteface
Pardalotidae	*Aphelocephala*	*nigricincta*	Banded Whiteface
Neosittidae	*Daphoenositta*	*chrysoptera*	Varied Sittella
Climacteridae	*Climacteris*	*affinis*	White-browed Treecreeper
Meliphagidae	*Acanthagenys*	*rufogularis*	Spiny-cheeked Honeyeater
Meliphagidae	*Manorina*	*flavigula*	Yellow-throated Miner
Meliphagidae	*Lichenostomus*	*virescens*	Singing Honeyeater
Meliphagidae	*Lichenostomus*	*keartlandi*	Grey-headed Honeyeater
Meliphagidae	*Lichenostomus*	*plumulus*	Grey-fronted Honeyeater
Meliphagidae	*Lichenostomus*	*penicillatus*	White-plumed Honeyeater
Meliphagidae	*Melithreptus*	*gularis*	Black-chinned Honeyeater
Meliphagidae	*Lichmera*	*indistincta*	Brown Honeyeater
Meliphagidae	*Phylidonyris*	*albifrons*	White-fronted Honeyeater
Meliphagidae	*Conopophila*	*whitei*	Grey Honeyeater

Meliphagidae	*Certhionyx*	*niger*	Black Honeyeater
Meliphagidae	*Certhionyx*	*variegatus*	Pied Honeyeater
Meliphagidae	*Ephthianura*	*tricolor*	Crimson Chat
Meliphagidae	*Epthianura*	*aurifrons*	Orange Chat
Dicaeidae	*Dicaeum*	*hirundinaceum*	Mistletoebird
Pardalotidae	*Pardalotus*	*rubricatus*	Red-browed Pardalote
Pardalotidae	*Pardalotus*	*striatus*	Striated Pardalote
Passeridae	*Emblema*	*pictum*	Painted Finch
Passeridae	*Taeniopygia*	*guttata*	Zebra Finch
Ptilonorhynchidae	*Chlamydera*	*maculata*	Spotted Bowerbird
Dicruridae	*Grallina*	*cyanoleuca*	Magpie-lark
Artamidae	*Artamus*	*leucorynchus*	White-breasted Woodswallow
Artamidae	*Artamus*	*personatus*	Masked Woodswallow
Artamidae	*Artamus*	*superciliosus*	White-browed Woodswallow
Artamidae	*Artamus*	*cinereus*	Black-faced Woodswallow
Artamidae	*Artamus*	*minor*	Little Woodswallow
Artamidae	*Cracticus*	*torquatus*	Grey Butcherbird
Artamidae	*Cracticus*	*nigrogularis*	Pied Butcherbird
Artamidae	*Gymnorhina*	*tibicen*	Australian Magpie
Corvidae	*Corvus*	*coronoides*	Australian Raven
Corvidae	*Corvus*	*bennetti*	Little Crow
Corvidae	*Corvus*	*orru*	Torresian Crow
Hylidae	*Cyclorana*	*australis*	Giant Frog
Hylidae	*Cyclorana*	*cultripes*	Knife-footed Frog
Hylidae	*Cyclorana*	*maini*	Main's Frog
Hylidae	*Cyclorana*	*platycephala*	Water-holding Frog
Myobatrachidae	*Limnodynastes*	*spenceri*	Spencer's Frog
Hylidae	*Litoria*	*caerulea*	Green Tree-frog
Hylidae	*Litoria*	*rubella*	Red Tree-frog
Myobatrachidae	*Neobatrachus*	*aquilonius*	Northern Burrowing Frog
Myobatrachidae	*Neobatrachus*	*centralis*	Trilling Frog
Myobatrachidae	*Notaden*	*nichollsi*	Desert Spadefoot Toad
Tachyglossidae	*Tachyglossus*	*aculeatus*	Echidna
Dasyuridae	*Antechinomys*	*laniger*	Kultarr
Dasyuridae	*Pseudantechinus*	*macdonnellensis*	Fat-tailed Antechinus
Dasyuridae	*Dasycercus*	*cristicauda*	Mulgara
Dasyuridae	*Ningaui*	*ridei*	Wongai Ningaui
Dasyuridae	*Planigale*	*ingrami*	Long-tailed Planigale
Dasyuridae	*Sminthopsis*	*crassicaudata*	Fat-tailed Dunnart
Dasyuridae	*Sminthopsis*	*hirtipes*	Hairy-footed Dunnart
Dasyuridae	*Sminthopsis*	*longicaudata*	Long-tailed Dunnart
Dasyuridae	*Sminthopsis*	*macroura*	Stripe-faced Dunnart
Dasyuridae	*Sminthopsis*	*ooldea*	Ooldea Dunnart
Dasyuridae	*Sminthopsis*	*youngsoni*	Desert Dunnart
Notoryctidae	*Notoryctes*	*typhlops*	Marsupial Mole
Peramelidae	*Chaeropus*	*ecaudatus*	Pig-footed Bandicoot
Peramelidae	*Isoodon*	*auratus*	Golden Bandicoot
Thylacomyidae	*Macrotis*	*lagotis*	Bilby
Phalangeridae	*Trichosurus*	*vulpecula*	Common Brushtail Possum
Macropodidae	*Lagorchestes*	*conspicillatus*	Spectacled Hare-wallaby

Macropodidae	*Lagorchestes*	*hirsutus*	Rufous Hare-wallaby
Macropodidae	*Macropus*	*robustus*	Euro
Macropodidae	*Macropus*	*rufus*	Red Kangaroo
Macropodidae	*Onychogalea*	*lunata*	Crescent Nailtail Wallaby
Macropodidae	*Petrogale*	*lateralis*	Black-footed Rock-wallaby
Pteropodidae	*Pteropus*	*scapulatus*	Little Red Flying-fox
Megadermatidae	*Macroderma*	*gigas*	Ghost Bat
Hipposideridae	*Hipposideros*	*ater*	Dusky Horseshoe-bat
Emballonuridae	*Taphozous*	*hilli*	Hill's Sheathtail-Bat
Molossidae	*Mormopterus*	*planiceps*	Southern Freetail-bat
Molossidae	*Mormopterus*	*planiceps*	Southern Freetail-bat
Molossidae	*Mormopterus*	*planiceps*	Southern Freetail-bat
Molossidae	*Nyctinomus*	*australis*	White-striped Freetail-bat
Vespertilionidae	*Chalinolobus*	*gouldii*	Gould's Wattled Bat
Vespertilionidae	*Chalinolobus*	*morio*	Chocolate Wattled Bat
Vespertilionidae	*Vespadelus*	*baverstocki*	Inland Forest Eptesicus
Vespertilionidae	*Vespadelus*	*finlaysoni*	Finlayson's Cave Bat
Vespertilionidae	*Vespadelus*	*vulturnus*	Little Forest Eptesicus
Vespertilionidae	*Scotorepens*	*greyii*	Little Broad-nosed Bat
Vespertilionidae	*Nyctophilus*	*geoffroyi*	Lesser Long-eared Bat
Vespertilionidae	*Vespadelus*	*pumilus*	Eastern Forest Bat
Muridae	*Leggadina*	*forresti*	Forrest's Mouse
Muridae	*Mus*	*musculus*	House Mouse
Muridae	*Notomys*	*alexis*	Spinifex Hopping-mouse
Muridae	*Notomys*	*longicaudatus*	Long-tailed Hopping-mouse
Muridae	*Pseudomys*	*desertor*	Desert Mouse
Muridae	*Pseudomys*	*hermannsburgensis*	Sandy Inland Mouse
Muridae	*Leporillus*	*apicalis*	Lesser Stick-nest Rat
Muridae	*Rattus*	*tunneyi*	Pale Field-rat
Muridae	*Rattus*	*villosissimus*	Long-haired Rat
Muridae	*Zyzomys*	*pedunculatus*	Central Rock-rat
Canidae	*Canis*	*familiaris*	Dingo
Canidae	*Vulpes*	*vulpes*	Fox (feral)
Felidae	*Felis*	*catus*	Cat (feral)
Equidae	*Equus*	*asinus*	Donkey (feral)
Equidae	*Equus*	*caballus*	Horse (feral)
Bovidae	*Bos*	*taurus*	Cattle (feral)
Bovidae	*Capra*	*hircus*	Goat (feral)
Camelidae	*Camelus*	*dromedarius*	Camel (feral)
Leporidae	*Oryctolagus*	*cuniculus*	Rabbit (feral)
Gekkonidae	*Crenadactylus*	*ocellatus*	Clawless Gecko
Gekkonidae	*Diplodactylus*	*ciliaris*	Spiny-tailed Gecko
Gekkonidae	*Diplodactylus*	*conspicillatus*	Fat-tailed Diplodactylus
Gekkonidae	*Diplodactylus*	*elderi*	Jewelled Gecko
Gekkonidae	*Diplodactylus*	*galeatus*	
Gekkonidae	*Diplodactylus*	*intermedius*	Eastern Spiny-Tailed Gecko
Gekkonidae	*Diplodactylus*	*stenodactylus*	Crowned Gecko
Gekkonidae	*Diplodactylus*	*taeniatus*	White-striped Gecko
Gekkonidae	*Diplodactylus*	*tessellatus*	Tesselated Gecko
Gekkonidae	*Gehyra*	*montium*	

Gekkonidae	*Gehyra*	*purpurascens*	
Gekkonidae	*Gehyra*	*variegata*	Tree Dtella
Gekkonidae	*Hemidactylus*	*frenatus*	Asian House Gecko
Gekkonidae	*Heteronotia*	*binoei*	Bynoes Gecko
Gekkonidae	*Heteronotia*	*planiceps*	
Gekkonidae	*Lucasium*	*damaeum*	Beaded Gecko
Gekkonidae	*Nephrurus*	*amyae*	
Gekkonidae	*Nephrurus*	*levis*	
Gekkonidae	*Oedura*	*marmorata*	Marbled Velvet Gecko
Gekkonidae	*Rhynchoedura*	*ornata*	Beaked Gecko
Gekkonidae	*Underwoodisaurus*	*milii*	Thick-tailed Gecko
Pygopodidae	*Delma*	*borea*	
Pygopodidae	*Delma*	*nasuta*	Sharp-snouted Legless Lizard
Pygopodidae	*Delma*	*tincta*	
Pygopodidae	*Lialis*	*burtonis*	Burtons Legless Lizard
Pegopodidae	*Pygopus*	*nigriceps*	Hooded Scaly Foot
Agamidae	*Ctenophorus*	*caudicinctus*	Ring-tailed Dragon
Agamidae	*Ctenophorus*	*isolepis*	Military Dragon
Agamidae	*Ctenophorus*	*nuchalis*	Central Netted Dragon
Agamidae	*Lophognathus*	*gilberti*	Gilberts Dragon
Agamidae	*Lophognathus*	*longirostris*	Long-nosed Water Dragon
Agamidae	*Moloch*	*horridus*	Thorny Devil
Agamidae	*Pogona*	*minor*	Dwarf Bearded Dragon
Agamidae	*Pogona*	*mitchelli*	
Agamidae	*Pogona*	*vitticeps*	
Agamidae	*Tympanocryptis*	*cephalus*	
Agamidae	*Tympanocryptis*	*lineata*	
Agamidae	*Tympanocryptis*	*tetraporophora*	
Varanidae	*Varanus*	*acanthurus*	Ridge-tailed Monitor
Varanidae	*Varanus*	*brevicauda*	
Varanidae	*Varanus*	*eremius*	
Varanidae	*Varanus*	*giganteus*	Perentie
Varanidae	*Varanus*	*gilleni*	Pygmy Mulga Monitor
Varanidae	*Varanus*	*gouldii*	Sand Goanna
Varanidae	*Varanus*	*spenceri*	Spencers Monitor
Varanidae	*Varanus*	*tristis*	
Scincidae	*Carlia*	*amax*	Two-Spined Rainbow Skink
Scincidae	*Carlia*	*munda*	Striped Rainbow Skink
Scincidae	*Carlia*	*triacantha*	Three-Spined Rainbow Skink
Scincidae	*Cryptoblepharus*	*carnabyi*	Caranaby's Snake-Eyed Skink
Scincidae	*Cryptoblepharus*	*plagiocephalus*	Aboreal Snake-Eyed Skink
Scincidae	*Ctenotus*	*alacer*	Lively Ctenotus
Scincidae	*Ctenotus*	*grandis*	Grand Ctenotus
Scincidae	*Ctenotus*	*greeri*	Greer's Ctenotus
Scincidae	*Ctenotus*	*helenae*	Helen's Ctenotus
Scincidae	*Ctenotus*	*leonhardii*	Leondardi's Ctenotus
Scincidae	*Ctenotus*	*pantherinus*	Leopard Ctenotus
Scincidae	*Ctenotus*	*piankai*	Pianka's Ctenotus
Scincidae	*Ctenotus*	*quattuordecimlineatus*	Fourteen-Lined Ctenotus
Scincidae	*Ctenotus*	*regius*	Royal Ctenotus

Scincidae	*Ctenotus*	*robustus*	Robust Ctenotus
Scincidae	*Ctenotus*	*saxatilis*	Rock Ctenotus
Scincidae	*Ctenotus*	*schomburgkii*	Schomburk's Ctenotus
Scincidae	*Ctenotus*	*tanamiensis*	Tanami Ctenotus
Scincidae	*Cyclodomorphus*	*branchialis*	Slender Blue-tongued Lizard
Scincidae	*Egernia*	*inornata*	Desert Egernia
Scincidae	*Egernia*	*kintorei*	Kintore's Egernia (Great Desert Skink)
Scincidae	*Egernia*	*margaretae*	Rock Egernia
Scincidae	*Egernia*	*striata*	Striated Egernia
Scincidae	*Eremiascincus*	*fasciolatus*	Narrow-Banded Sand Swimmer
Scincidae	*Eremiascincus*	*richardsonii*	Broad-Banded Sand Swimmer
Scincidae	*Lerista*	*bipes*	Two-Toed Lerista
Scincidae	*Lerista*	*desertorum*	Desert Lerista
Scincidae	*Lerista*	*frosti*	Frost's Lerista
Scincidae	*Lerista*	*labialis*	Sand Lerista
Scincidae	*Lerista*	*xanthura*	Yellow-Tailed Lerista
Scincidae	*Menetia*	*greyii*	Grey's Menetia
Scincidae	*Morethia*	*boulengeri*	Boulenger's Snake-Eyed Skink
Scincidae	*Morethia*	*ruficauda*	Red-Tailed Snake-Eyed Skink
Scincidae	*Tiliqua*	*multifasciata*	Centralian Blue-Tongued Lizard
Typhlopidae	*Ramphotyphlops*	*bituberculatus*	
Typhlopidae	*Ramphotyphlops*	*centralis*	
Typhlopidae	*Ramphotyphlops*	*diversus*	
Typhlopidae	*Ramphotyphlops*	*endoterus*	
Typhlopidae	*Ramphotyphlops*	*grypus*	
Boidae	*Aspidites*	*melanocephalus*	Black-headed Python
Boidae	*Aspidites*	*ramsayi*	Woma Python
Boidae	*Liasis*	*olivaceus*	Olive Python
Boidae	*Liasis*	*stimsoni*	
Colubridae	*Dendrelaphis*	*punctulata*	Green Tree Snake
Elapidae	*Acanthophis*	*pyrrhus*	Desert Death Adder
Elapidae	*Demansia*	*psammophis*	Yellow-Faced Whip Snake
Elapidae	*Furina*	*ornata*	Orange-naped Snake
Elapidae	*Pseudechis*	*australis*	King Brown or Mulga Snake
Elapidae	*Pseudonaja*	*modesta*	Ringed Brown Snake
Elapidae	*Pseudonaja*	*nuchalis*	Western Brown Snake or Gwarder
Elapidae	*Pseudonaja*	*textilis*	Common or Eastern Brown Snake
Elapidae	*Simoselaps*	*anomalus*	Northern Desert Banded Snake
Elapidae	*Simoselaps*	*incinctus*	
Elapidae	*Simoselaps*	*semifasciatus*	Half -girdled Snake
Elapidae	*Suta*	*punctata*	Little Spotted Snake
Elapidae	*Suta*	*suta*	Myall or Curl Snake
Elapidae	*Vermicella*	*annulata*	Bandy Bandy

APPENDIX 4 – Soil descriptions

"A1"
"Coastal dune formations with small plains: dunes of deep calcareous sands (Uc1.11)--drifting and non-drifting phases; smaller areas of shallow red-brown sandy soils (Uc6.13) on dune limestones; small areas of siliceous sands (Uc1.22) and plains of deep calcareous sands (Uc1.11) some of which have peaty surfaces in favoured low-lying situations. Occurs on sheet(s): 1"
"A2"
"Coastal dunes and plains with some swamps: dunes of calcareous sands (Uc1.11) and also siliceous sands (Uc1.22); plains of various saline soils (unclassified) and lesser areas of brown calcareous earths (Gc1.1 and Gc1.2). Dune crests are often bare and mobile in the area of Sheet 10. Occurs on sheet(s): 1,10"
"A3"
"Coastal dune formations with limestone ridges, plains, and swamps: calcareous sands (Uc1.11) and red and brown shallow porous loamy soils (Um6.23 and Um6.24) on limestone; with siliceous sands (Uc1.2) on dunes; and small areas of shallow dark clays (Ug5.11), dark shallow porous loamy soils (Um6.21), and various saline soils (unclassified) in the lower-lying situations. Occurs on sheet(s): 1"
"A4"
"High rolling coastal dunes of deep calcareous sands (Uc 1.11) with cup-like hollows of deep calcareous sands (Uc1.11), both drifting and non-drifting phases, also with sheet limestone exposed in places. Occurs on sheet(s): 2"
"A5"
"Coastal dunes of deep calcareous sands (Uc1.11), with small areas of shallow red-brown sandy soils (Uc6.13); intervening low-lying areas of leached sands (Uc2.3) and some swampy areas with undescribed soils. Occurs on sheet(s): 2"
"A6"
"Coastal dunes of deep calcareous sands (Uc1.11) and small plains of leached sands (Uc2.2) with low dunes of (Uc4.11) and (Um4.1) and swampy areas of undescribed soils. Occurs on sheet(s): 2"
"A7"
"Coastal dunes: dunes of deep calcareous sands (Uc1.11)--drifting and non-drifting phases, smaller areas of shallow red-brown sandy soils (Uc6.13) on inland dune slopes. Occurs on sheet(s): 2"
"A8"
"Coastal dunes: dunes of deep calcareous sands (Uc1.11) drifting and non-drifting phases--with leached sands (Uc2.21), (Uc2.33), and (Uc4.3) becoming progressively more prominent and in the order given, away from the coast. Occurs on sheet(s): 2"
"A9"
"Present beach system of dunes and estuaries: relatively unstable dunes of calcareous sands (Uc1.11) or siliceous sands (Uc1.21) passing inland to more stable dunes and flatter sandy areas of siliceous sands (Uc1.21) and/or leached sands (Uc2.2 and Uc2.3); some estuarine areas of plastic clays (Uf6.5 or Uf6.6) with sand D horizons. As mapped, areas of unit Ca7 are included. Soil dominance varies locally between (Uc1.11) and (Uc1.21) soils. Occurs on sheet(s): 3"
"A10"
"Gently undulating coastal plain (less than 25 ft above sea level) with the present low coastal fore-dunes grading into older dunes and sand plain remnants: chief soils are calcareous sands (Uc1.12), possibly (Uc1.11), and siliceous sands (Uc1.22 and Uc1.21). Various leached (Uc2) sands occur on the older dunes and sand plain. As mapped, small areas of adjoining units, notably Ca9 and Tb83, are included. Occurs on sheet(s): 4"
"A11"
"Low young coastal dunes parallel to the present coastline and less than 25 ft above sea level: chief soils are calcareous sands (Uc1.11) in association with siliceous sands similar to those of unit B20. Occurs on sheet(s): 4"
"A12"
"Similar to unit A11 but with areas of mud flats as for unit J5; and trachyte plugs and dykes of (Uc2.12), (Um4.1), and (Dd1.41) soils and rock outcrops. Occurs on sheet(s): 4"
"A13"
"Coastal dune formations backed by the low-lying deposits of inlets and estuaries: chief soils are calcareous sands (Uc1.11) on the dunes. Associated are various (Uc), (Um), (Uf), (Ug), and acid peat (O) soils in the swale behind the coastal dunes, similar to unit Kf10. Occurs on sheet(s): 5,6"
"A14"
"Coastal dunes: chief soils are calcareous sands (Uc1.11) on the strongly undulating slopes of the dunes. Associated are small areas of other soils including (Uc6.12) on limestone and (Dr2.61) on gneissic outcrops. Occurs on sheet(s): 5"
"A15"

"Coastal dunes and their intervening swales with saline flats, swamps, and lakes; some lunettes; some estuarine areas: chief soils seem to be calcareous sands (Uc1.11) on the recent dunes fronting the coast, and siliceous sands (Uc1.21) on the older dunes and lunettes. Associated are possibly some (Uc2.2) and (Uc4.2) soils and there are various undescribed soils around the saline flats and swamps, around estuarine areas, and on aeolianite. As mapped, areas of unit Ca26 are included, particularly on headlands. Occurs on sheet(s): 5"
"A16"
"Broad swales between units A13 and B24, and characterized by salt lakes: chief soils are shallow calcareous sands (Uc1.11) with aeolianite occurring as a continuous substrate within 12 in. of the surface. Occurs on sheet(s): 5"
"A17"
"Coastal dune formations overlying aeolianite: chief soils are calcareous sands (Uc1.11) on the dunes. Associated are small areas of other undescribed soils on limestone, possibly (Uc1.22) and (Uc1.42). Combined to the north with unit A18. Occurs on sheet(s): 6"
"A18"
"Coastal calcareous sands, largely (Uc1.12), with a seaward fringe of (Uc1.11)of unit A17, all overlying a core of aeolianite limestone which is steep and has some cliff faces. Some bare limestone and shallow (Uc1.23) soils and intervening saline flats with probably (Um1.1) and (Um1.3) soils. Occurs on sheet(s): 6"
"A19"
"Brown calcareous dune sands (Uc1.12); aeolianite not evident but there are numerous playas, locally called birridas, floored by saline (Um1) soils and kopi gypsum. Occurs on sheet(s): 6"
"A20"
"Low dunes and old beach ridges marginal and mostly parallel to the coastline; the dUnes rarely exceed 10 ft in height and may be separated by shallow swales; beach rock may outcrop on the coastal margins. All except the rear dunes are shelly throughout or at shallow depth. Dominant soils are calcareous sands (Uc1.11) with some dark and brown sands (Uc1.13, Uc1.14) also occurring. At the rear of the dune systems siliceous forms (Uc1.21) and (Uc5.11) usually occur and occasionally (Uc5.23) and (Uc4.21). The better-developed swales have dark loams (Um1.13), occasionally (Uf1.3) and (Uf6.33). Included in the unit, as mapped, are small areas of salt pans of unit Io1, and cracking clays of unit II12. Occurs on sheet(s): 7"
"AA1"
"Dunes and sandhills: jumble and teardrop dunes and sandhill chains of brown sands (Uc5.11 and Uc5.12) with small areas of crusty loamy soils (Dr1.33) and sandy alkaline yellow mottled soils (Dy5.83) in interdune flats. Other soils include (Dy4.83). Occurs on sheet(s): 1"
"AA2"
"Dunes and sand-hills: generally, low broad dunes with a few sand-hills of brown sands (Uc5.11, Uc5.12) and interdune valleys and plains of brown calcareous earths (Gc); a few hills of bare rock; saline flats, clay pans, and gypsum dunes are variable features. Occurs on sheet(s): 1,10"
"AA3"
"Dune formations: jumble and teardrop dunes of brown sands (Uc5.11) which are more calcareous throughout than those of units AA1 and AA2. Occurs on sheet(s): 1"
"AA4"
"Gently undulating plains: dominant soils are deep reddish sands (Uc5.11), with associated (Uc1.23 and Uc1.22) and (Uc5.21 and Uc5.23). Adjacent to stream lines are some low dunes with much deeper sands (Uc1.22 and Uc1.23). Slightly elevated ridges have sandy red duplex soils (Dr3.33) and (Dr2.43), while lower sites have yellow sandy duplex soils (Dy3.43), (Dy3.42), (Dy2.43), and (Dy2.33). Small areas of sandy red earths (Gn2.12) and cracking clays (Ug5.34 and Ug5.24) are included in the unit. Occurs on sheet(s): 4"
"AA5"
"Moderate to gently undulating lands occurring as wide valleys between dissected sandstone ranges; some residual mesas and low hills occur: dominant soils are deep sands, chiefly (Uc5.11) with mottled subsoils, but many areas of (Uc1.21) also occur. Small areas of deep sandy-surfaced duplex soils (Dy5.41), (Dy5.81), and (Dy3.41) occur, as well as small areas of earthy sands (Uc5.22). Occurs on sheet(s): 4"
"AA6"
"Hilly or high hilly lands, often with very steep slopes and always with numerous large granite tor outcrops: dominant soils are gritty brown sands of variable depth (Uc5.11). Commonly associated are other gritty sands (Uc2.21), (Uc4.2), (Uc2.22), and (Uc1.21) and coarse sandy red earths (Gn2.12, Gn2.14, and Gn2.15). On some lower hill slopes sandy duplex soils occur, chiefly (Dr2.11), (Dr2.12), (Dr2.22), and similar (Dy2) soils. Occurs on sheet(s): 4,7"
"AA7"
"Stony hills on granite--often with little soil cover: shallow stony sands (Uc5.11) are dominant but small areas of (Dr2.32) soils also occur. Occurs on sheet(s): 6"
"AA8"

"Low ranges on gneiss with extensive bare rock outcrop: shallow stony sands (Uc5.11) are dominant but (Um5.41) soils also occur along with occasional small areas of (Dr2.32) soils. Occurs on sheet(s): 6"
"AA9"
"Stony hills on gneiss with frequent bare rock areas: shallow stony sands (Uc5.11) are dominant. Other soils include (Um5.41) as well as (Dr2.33 and Dr2.32). Occurs on sheet(s): 6"
"AA10"
"Small gently undulating sand plains occurring in close association with unit Oc57: sands (Uc5.11) are dominant. Occurs on sheet(s): 6"
"AA11"
"Ranges of conglomerates, sandstone, shale, and dolomite sometimes capped by ferruginous duricrust or by Robe pisolite iron ore formation; there are large areas without soil cover: chief soils appear to be shallow loamy sands (Uc5.11) along with shallow stony loams (Um5.51); (Dr2.33) soils are also present. (Um5.52), (Gn2.12), and (Um5.11) soils occur in the narrow valley plains; and (KS-Gn2.11) occur on areas of duricrust and Robe pisolite. Occurs on sheet(s): 6"
"AA12"
"Ranges on conglomerate; extensive areas without soil cover and when present, soils are shallow and stony: dominant soils are non-coherent sands (Uc5.11). Occurs on sheet(s): 6"
"AA13"
"Sand dunes and flats: chief soils are shallow sands (Uc5.12) overlying limestone on the flats and also in dunes, with some areas of loose calcareous sands (Uc1.13) in the form of parallel dunes. There are some calcareous earths (Gc1.21) adjoining unit DD21. There is a fringe of recent shelly sands (Uc1.12) adjoining the coast. Occurs on sheet(s): 6"
"AA14"
"Gently undulating upland overlying limestone with a few dune formations and some limestone outcrop: chief soils are sands (Uc5.12) overlying a carbonate pan with some loose calcareous sands (Uc1.13) in dunes, and shallow loamy (Um) soils overlying limestone. Occurs on sheet(s): 6"
"AA15"
"Low fixed coastal sand dunes: dominant soils are deep sands (Uc5.1l) of the older dunes. The near-coastal dunes have (Uc4.21), (Uc4.31), (Uc1.21), and (Uc1.23) sands with some calcareous (shelly) sands (Uc1.11 or Uc1.12) on the frontal dunes. The unit, as mapped, may include small areas of salt pans and mangroves. Occurs on sheet(s): 7"
"AA16"
"Low ranges and steep hills on granites, with extensive areas of bare rock; small valley plains are included: chief soils appear to be shallow stony sands (Uc5.1 l) but small areas of (Dr2.32) and (Gn2.12) soils also occur. Occurs on sheet(s): 10"
"AA17"
"Gently undulating lands with low broad sandy rises and narrow elongated clayey depressions. Many of the depressions are inundated after heavy rains: dominant soils are moderately deep to deep sands (Uc5.13) with an indurated pan or D horizon at 36-48 in. Sandy red earths (Gn2.11) and lesser yellow earths (Gn2.21) occur on the lower slopes of the broad rises, and deep cracking clays, chiefly (Ug5.24) and (Ug5.34), occupy the depressions. Occurs on sheet(s): 10"
"AB1"
"Gently undulating sand plains with many shallow playa-like depressions, clay pans, and shallow ephemeral salt lakes, also some low dunes: the plains have red earthy sands (Uc5.21) often with an earthy or calcareous hard pan at moderate depths; other soils include (Uc5.22) and (Gn2.13 and Gn2.23). The low dunes may have (Uc1.23) soils in addition to the above. The playa-like depressions and clay pans have various massive-surfaced clay soils, chiefly (Ug5.6, Ug5.5) and (Ug 6.5). Undescribed saline soils are associated with the salt lakes. Occurs on sheet(s): 3,4"
"AB2"
"Gently undulating sandy plains with an occasional low dune: dominant soils are deep red earthy sands (Uc5.21) with lesser areas of (Uc5.22). Other sandy soils are associated, chiefly (Uc1.22), (Uc1.23), and (Uc5.11). Near the margins of the unit sandy red earths (Gn2.12) occur. Occurs on sheet(s): 4"
"AB3"
"Undulating to low hilly dissected plateau slopes often flanking areas of unit AC2, or occupying a zone between units AC2 and AB4: chief soils on the slopes are red earthy sands (Uc5.21). Associated are (Uc5.22) soils on ridges and (Uc2.21) soils in the centre of valleys, apart from limited areas of swamps in which occur diatomaceous earths. Occurs on sheet(s): 5"
"AB4"
"Slopes flanking main trunk valleys; breakaways are common. There are two common sequences of soils: (i) on smooth slopes below breakaways red earthy sands (Uc5.21) occur, occasionally with (Gn2.12) soils and sometimes (Uc2.21) soils in the adjacent valley floors; (ii) on dissected slopes below breakaways red earthy sands (Uc5.21) occur but with some (Um6.21) soils on chalk outcrops, and further down slope are areas of (Dr), (Db), (Dy), and

(Dd) soils, such as (Dr4.22), (Db2.22), (Dy3.12), and (Dd2.43) while adjacent valley floors also have (Dr) and (Db) soils. Areas of diatomaceous earths occur on some valley floors. Occurs on sheet(s): 5"
"AB5"
"Sandy outwash plains from granitic areas with some gentle undulations and Wanderie banks: chief soils are shallow red earthy sands (Uc5.21), shallow red earths (Gn2.12), and red earthy loams (Um5.3). A red-brown hardpan is common at depths from 18 to 40 in. The (Uc5) soils may contain ironstone gravels. Inclusions of elements of adjacent units are likely. Occurs on sheet(s): 5,6"
"AB6"
"Sandy outwash plains from granites, gneisses, and allied rocks with numerous small waterways: chief soils are shallow red earthy sands (Uc5.21) with small areas of shallow red earths (Gn2.12) and red earthy loams (Um5.3). A red-brown hardpan commonly occurs at depths of less than 40 in. Some ironstone gravels may be present. Small areas of adjacent units may be included. Occurs on sheet(s): 5,6,10"
"AB7"
"Similar to unit AB6 but with pediments and breakaways of unit BE3 on ridges and slopes above the plains in a recurring pattern. Occurs on sheet(s): 5,10"
"AB8"
"Sandy plains often with low dunes: chief soils are red earthy sands (Uc5.21). No red-brown hardpan encountered to depths of 40 in.. Occurs on sheet(s): 5,6,10"
"AB9"
"Sand plains and dunes marginal to and slightly dissected below unit JK13: chief soils are probably red earthy sands (Uc5.21) on both dunes and plains with brown sands (Uc4.22), and siliceous sands (Uc1.22) of unit JK13, assuming local dominance. Some (Gn) soils of unit My56 occur on the eastern margins. Occurs on sheet(s): 6"
"AB10"
"Undulating sand dune formations generally underlain by aeolianite and with a few marl swamps nearer the coast: chief soils are red earthy sands (Uc5.21) and red and brown sands (Uc4.23, Uc4.22). Loamy (Um) soils occur in the swamps. Occurs on sheet(s): 6"
"AB11"
"Dune and swamp country forming a seaward margin to unit AB10: chief soils are red earthy sands (Uc5.21) and red and brown sands (Uc4.23, Uc4.22) on the dunes; with shallow loams (Um1.3), sands (Uc1.2) overlying marl, and kopi gypsum in the swamp pans. Occurs on sheet(s): 6"
"AB12"
"Isolated sand dunes aligned along the coast and related to dunes of unit AB10: chief soils are red earthy sands (Uc5.21). As mapped, areas of adjacent units are included. Occurs on sheet(s): 6"
"AB13"
"Broad sand plain with occasional sand dune formations: chief soils are red earthy sands (Uc5.21), with only minor occurrences of loose red sands (Uc1.23) and (Uc5.11) on the dunes. Minor areas of sandy red earth (Gn2.1) soils may occur adjacent to unit Mx13. Occurs on sheet(s): 6"
"AB14"
"Upland sand plains with occasional dunes and minor inclusions of associated plains units: chief soils are red earthy sands (Uc5.21) with red sands (Uc5.11) and (Uc1) on the dunes; both (Gn) and (Um) soils of associated units occur. Occurs on sheet(s): 6,10"
"AB15"
"Sand plains and dunes of the Kennedy Range: chief soils are probably red earthy sands (Uc5.21) with loose red sands (Uc1.23) and (Uc5.11) on the dunes. Associated are likely to be interdune plains of sandy red earths (Gn2.11) and minor areas of (Dr2) soils. Occurs on sheet(s): 6"
"AB16"
"Broad flat or gently undulating plains with parallel sand ridges and dunes: chief soils of the plains are red earthy sands (Uc5.21) with red sands (Uc1), (Uc5.11), and (Uc5.21) on the dunes. There are areas of red duplex (Dr) soils adjacent to unit Oc40 and red earths (Gn2) adjacent to unit Mz22. Occurs on sheet(s): 6"
"AB17"
"Similar to unit AB16 but with a larger percentage of red sand dune soils: chief soils of the interdune plains are red earthy sands (Uc5.21) with red sands (Uc5.11) and (Uc1); and with red sands (Uc1.23) and (Uc5.11) on the dunes. Occurs on sheet(s): 6"
"AB18"
"Broad plains with many red sand dunes: chief soils of the plains are red earthy sands (Uc5.21) with red earths (Gn2.1), both overlying red-brown hardpan in places. There are extensive parallel red sand dunes with (Uc1.23) and (Uc5.11) soils. Occurs on sheet(s): 6"
"AB19"

"Extensive sandy plains: chief soils are red earthy sands (Uc5.21) with extensive areas of red earths (Gn2.12) and with some hard red soils (Dr) along creek lines. Similar to unit AB21 but without sandstone residuals. Occurs on sheet(s): 6"
"AB20"
"Isolated sand plains and dune fields: chief soils are red earthy sands (Uc5.21) with loose red sands (Uc1.23) on the dunes. Occurs on sheet(s): 6,10"
"AB21"
"Pindan country--gently undulating sand plain with a few small rocky sandstone residuals; no external drainage: chief soils are red earthy sands (Uc5.21), with associated (Uc5.11) and hummocks of siliceous sands (Uc1.23). Occurs on sheet(s): 6,9,10"
"AB22"
"Gently undulating sand plain as for unit AB21 but with many rocky sandstone residuals: chief soils are red earthy sands (Uc5.21), with (Uc5.11) and (Uc1.23) as for unit AB21. Associated are bare rock and shallow sands, probably (Uc1.4), of the sandstone residuals. Occurs on sheet(s): 9,10"
"AB23"
"Gently undulating sand plain with a few small rocky sandstone residuals; some dunes; some clay pans and dry lakes with calcrete (kunkar): chief soils are red earthy sands (Uc5.21) with associated (Uc5.11). Red siliceous sands (Uc1.23) occur on the dunes; and possibly (Um5.11) and (Gc) soils close to clay pans and lakes, and especially on calcrete. Occurs on sheet(s): 9"
"AB24"
"Sand plain and low sandy plateaux with some drainage-ways; rock outcrop common on residuals: chief soils are gravelly red earthy sands (Uc5.21) and gravelly yellow earths (Gn2.21) with associated (Uc5.11) soils. Low-lying areas have (Dy2.43) soils. There are some hummocks of (Uc1.23) soils. Occurs on sheet(s): 9"
"AB25"
"Gently undulating sand plain with residuals of silicified limestone; mainly rock outcrop on the residuals: chief soils on plains are deep red earthy sands (Uc5.21) and siliceous sands (Uc1.23) with some red earths (Gn2.11) and sandy alkaline yellow mottled soils (Dy5.43) in the lower sites. Occurs on sheet(s): 9"
"AB26"
"Sand plain with longitudinal sand dunes and some active drainage-ways: chief soils are red earthy sands (Uc5.21) associated with (Uc5.22) and (Uc5.1 l) soils on the plains, with dunes and hummocks of red sands (Uc1.23). Some (Gn2.21) and (Dy5.32) soils occur in lower sites often with a heavy surface layer of ferruginous gravel. Occurs on sheet(s): 9"
"AB27"
"Sand plain and dune fields often with a stony scalded surface; no external drainage: chief soils on the plains are red earthy sands (Uc5.21) and red earths (Gn2.12), with yellow earths (Gn2.21) and neutral hard red soils (Dr2.22). There are some elongated dunes of red sands (Uc1.23). Occurs on sheet(s): 9"
"AB28"
"Gently undulating country derived from sandstone with some very bouldery low hills: chief soils are red earthy sands (Uc5.21) with smaller areas of yellow earthy sands (Uc5.22) on gentle slopes and crests. Other soils include siliceous sands (Uc1.2), (Gn1.12), and sandy yellow mottled soils (Dy5.42). Occurs on sheet(s): 8,9"
"AB29"
"Gently undulating plains: chief soils are red earthy sands (Uc5.21) with some yellow earthy sands (Uc5.22) on gently sloping plains and some siliceous sands (Uc1.2) in flood-plain areas. Other soil occurrences include small areas of shallow ironstone-gravelly (KS-Uc) sands on low gravelly rises; and very small areas of (Gn2) soils, such as (Gn2.4) on broad shallow drainage floors and (Gn2.13) with calcretes (kunkar). As mapped, small areas of units B33 and BA5 are included. Occurs on sheet(s): 8,9,10"
"AB30"
"Gently undulating sand plains with poorly developed dune formations in some parts; ironstone gravels and block laterite may occur at depth below the soils: chief soils are red earthy sands (Uc5.21) in association with smaller areas of yellow earthy sands (Uc5.22). Other soil occurrences include various shallow stony sands such as (KS-Uc1.2), (KS-Uc1.41), and (KS-Uc5.21) on crests and slopes; some (Gn2) soils such as (Gn2.12) and (Gn2.21) that may margin the unit where it adjoins cracking clay plains; and small seasonally flooded flats of (Uc) and (Gn2) soils. As mapped, areas of unit BV1 are included. Occurs on sheet(s): 8"
"AB31"
"Flat to gently undulating sand plains with some low broad sand rises and intervening swales; some small alluvial flats; some clay pans; and some stone-covered ridges: chief soils are red earthy sands (Uc5.21) on the plains and swales. Associated are red siliceous sands (Uc1.23) on the sand rises. Small areas of sandy red earths such as (Gn2.12) occur on the plains, in the swales, and on the alluvial flats. Other soils include shallow (< 12 in.) stony (Uc1.23) on the stone-covered ridges. Occurs on sheet(s): 8,10"
"AB32"

"Sandy plains: chief soils are red earthy sands (Uc5.21). Associated are yellow earthy sands (Uc5.22) and siliceous sands (Uc1.21). Small areas of the soils common to units JY2, Mw32, and Mr8 are usually present also. Occurs on sheet(s): 8"
"AB33"
"Sandy plateaux and their remnants developed on ferruginous sandstones, conglomerates, and quartz sand stones; margined by rocky knolls and steep slopes similar to unit JV1 in places: chief soils seem to be rec earthy sands (Uc5.21) on the flat to gently sloping plateau crests, sometimes showing a very subdued dune relief. Associated are (Uc5.22), (Gn2.14), and other (Gn2) soils on the crests and slopes together with the shallow gravelly and sandy soils of unit JV1 on steep slopes; and other sandy soils such as (K-Uc4.2) on some ridges. Occurs on sheet(s): 8"
"AB34"
"Gently undulating sand plains with small stream valleys and some clay flats: chief soils are probably red and yellow earthy sands (Uc5.21 and Uc5.22). Associated are small clay flats of (Ug5) soils similar to those of unit 006, and probably some (Gn2) soils along stream valleys. Occurs on sheet(s): 8"
"AB35"
"Gently undulating plains with low moderately steep marginal scarps: dominant soils are deep red earthy sands (Uc5.21), with important areas of similar sands (Uc5.22), (Uc5.23), (Uc4.2), sandy red earths (Gn2.12), and sandy yellow earths (Gn2.22). Deep weakly coherent sands (Uc5.11) occur on slight rises and near small streams; these may be locally dominant adjacent to unit JJ11. Occasionally in some depressions are shallow nodular sands (Uc4.3) with a massive ironstone layer at shallow depths. On small areas of sandstone outcrop marginal to unit JJ11 are shallow sands (Uc5.11), (Uc4.2), (Uc2.12), and sandy red or yellow earths (Gn2.14) and (Gn2.24). Occurs on sheet(s): 7,10"
"AB36"
"Very gently undulating alluvial plains, sometimes dissected by shallow drainage lines with low levees: dominant soils are deep brown loamy fine sands or fine sandy loams (Uc5.21). The associated soils differ according to their position on the plain; on the back slopes uniform loams (Um5.52) occur, while near the downstream margins of the unit are loamy red earths (Gn2.12, Gn2.13), together with some loamy duplex soils (Db1.13), (Dr2.13), and (Dy2.43), which may also occur in better-defined old drainage channels dissecting the alluvial plain. Occurs on sheet(s): 7"
"AB37"
"Undulating lands with long gentle slopes: dominant soils are deep red earthy sands (Uc5.21) with lesser (Uc4.22). On lower slopes yellow sands (Uc5.22) may occur, and small areas of bleached sands (Uc2.21) occur in shallow drainage lines. Marginally there are areas of sandy red earths (Gn2.11, Gn2.14) or sandy duplex soils (Dy3.42). Occurs on sheet(s): 7"
"AB38"
"Moderately to strongly undulating lands with occasional isolated low hills with much massive granite outcrop: dominant soils are deep red earthy sands (Uc5.21), with (Uc4.22) and lesser (Uc4.21) soils closely associated. Deep bleached sands (Uc2.21) and (Uc2.12) are common in slight depressions and on lower slopes. Sandy or loamy red or yellow earths (Gn2.15) and (Gn2.25) are common on the more gently sloping areas. Occurs on sheet(s): 7"
"AB39"
"Gently undulating plain dominated by longitudinal dunes of varying frequency; some exposures of ironstone gravels on low rises occur in the dune swales: chief soils are red earthy sands (Uc5.21) on dune slopes, and interdune plains with red siliceous sands (Uc1.23) on the dunes. Other soils include (KS-Uc5.21) on the gravelly rises where an ironstone (laterite) duricrust is present at about 18 in. depth; and (Um5.11) on small included areas of calcrete (kunkar). Occurs on sheet(s): 10"
"AB40"
"Gently undulating plain slightly more elevated than unit AB39, and dominated by longitudinal dunes, many exposures of ironstone gravels and some breakaways capped by ironstone (laterite) duricrust: chief soils are red earthy sands (Uc5.21), with red siliceous sands (Uc1.23) on the dunes. There is an increased amount of (KS-Uc5.21) soil compared with unit AB39, and locally it may become dominant. Occurs on sheet(s): 10"
"AB41"
"Undulating areas on chert breccia with frequent rock outcrops; these areas are elevated above the main drainage-ways but are lower relatively than adjacent ranges: chief soils are shallow red earthy sands (Uc5.21). Occurs on sheet(s): 10"
"AB42"
"Upland sand plain associated with extensive areas of unit AB41: chief soils are red earthy sands (Uc5.21). Occurs on sheet(s): 10"
"AB43"

"Pediplains on granite with some granitic residuals, tors, and bosses; occasional longitudinal dunes; some areas of hard calcrete (kunkar): chief soils are probably red earthy sands (Uc5.21). Other soils are (Gn2.1) and (Dr2.32) on the plains, (Uc1.2) on the dunes, and probably (Um5.1 l) on the calcrete. Occurs on sheet(s): 10"
"AB44"
"Plains with a variable, but usually high, proportion of longitudinal sand dunes, and with some clay pans; scattered sandstone hills and laterite residuals are fairly common: chief soils are probably red earthy sands (Uc5.21) along with red sands (Uc5.11) and (Uc1.23) on the dunes. There may be some areas of (Gn2.1), (Dr2.32), and (Um5.51) soils associated with the hills, while (KS-Gn2.1) soils are probably associated with the laterite residuals. Occurs on sheet(s): 10"
"AB45"
"Plains with some longitudinal dunes: chief soils are probably red earthy sands (Uc5.21) together with some red earths (Gn2.1), while (Uc1.23) sands occur on the dunes. Occurs on sheet(s): 10"
"AB46"
"Valley plains with longitudinal dunes and clay pans: chief soils are probably red earthy sands (Uc5.21) in the interdune areas, with (Uc1.23) sands on the dunes. Other soils may occur. Occurs on sheet(s): 10"
"AB47"
"Plains and dunes--longitudinal and ring dunes with interdune corridors and plains; occasional salt pans: chief soils are the red earthy sands (Uc5.21) of the interdune plains and corridors. Associated are the red sands (Uc1.23) of the dunes which may also cover some interdune areas, where they may overlie laterite, or silcrete, or calcrete (kunkar). Other soils include (Gn2.12) on some plain areas. There may be small inclusions of units BY6, My99, SV10, AY2, and AY1. Occurs on sheet(s): 10"
"AB48"
"Very gently undulating plain traversed by longitudinal dunes: chief soils are the red earthy sands (Uc5.21) of the interdune areas and the red siliceous sands (Uc1.23) of the dunes. Other soils include (Gn2.13) in some interdune areas, (Um5.11) on calcrete (kunkar), and shallow often gravelly (Uc) soils on small rocky outcrop areas which may be remnants of unit AY4. Occurs on sheet(s): 10"
"AB49"
"Plains with a variable proportion of longitudinal sand dunes and scattered residuals of hard sedimentary rocks and laterites: chief soils are red earthy sands (Uc5.21) on the interdune areas and red sands (Uc1.23) on the dunes. Other soils may occur. Occurs on sheet(s): 10"
"AB50"
"Plains with scattered dunes and small breakaways of unit BY7: chief soils are red earthy sands (Uc5.21), some containing ferruginous nodules, some underlain by a red-brown hardpan. Other soils include (Gn2.12) on the plains and (Uc1.23) on the dunes. Occurs on sheet(s): 10"
"AB51"
"Plains with scattered dunes: chief soils are red earthy sands (Uc5.21), some containing ferruginous nodules, some underlain by a red-brown hardpan. There are small alluvial plains of (Gn2.12) and (Dr) soils. Other soils include the red sands (Uc1.23) of the dunes. Occurs on sheet(s): 10"
"AB52"
"Plains and dunes: chief soils are red earthy sands (Uc5.21) on the plains and interdune areas. Associated are the red siliceous sands (Uc1.23) of the dunes, which are of longitudinal and ring form and have mobile crests in places. Occurs on sheet(s): 10"
"AB53"
"Dune fields--gently undulating plains with linear dunes. There are areas of calcrete (kunkar) of variable extent, pans, lakes, depressions, and springs; and some isolated hilly residuals: chief soils are red earthy sands (Uc5.21) on the dune slopes and between the dunes and red siliceous sands (Uc1.23) on the dune crests and upper slopes. Other soils include (Gn2.12), sometimes covered with an ironstone scree in the interdune plains; some (Um5.11), (Uc1.3), and possibly (Gc) soils on the calcrete; and (KS-Uc5.21) soils on the residuals. Occurs on sheet(s): 10"
"AB54"
"Gently undulating plains with linear dunes in some areas; there are also variable areas of calcrete (kunkar); pans, depressions, and lakes; and some isolated hilly residuals: chief soils are red earthy sands (Uc5.21). Associated are calcareous loams (Um5.11), (Uc1.3), and probably (Gc) soils on the calcrete; (Uc1.23) sands on the dunes; and small areas of other soils. Occurs on sheet(s): 10"
"AB55"
"Broad, very gently undulating upland (tableland) elevated above adjacent dune fields; some low laterite-capped residuals showing exposures of sedimentary rocks; some dunes, some salt lakes and pans: chief soils are red earthy sands (Uc5.21), with some areas of ironstone gravels (KS-Uc5.21) having laterite duricrust at about 18in. Other soils include (Gn2.11, Gn2.12, and Gn2.13), and (Um5.11) on included calcrete (kunkar). Occurs on sheet(s): 10"
"AB56"

"Plains extensively covered with longitudinal dunes; some hilly residuals with rock outcrops: chief soils are red earthy sands (Uc5.21) on the broad interdune plains and red siliceous sands (Uc1.23) on the dunes. Other soils include (KS-Uc) on the residuals. Occurs on sheet(s): 10"
"AB57"
"Plains with scattered dunes: chief soils are red earthy sands (Uc5.21). Associated are some (Gn2.12) soils and (Uc1.23) sands on the dunes. Occurs on sheet(s): 10"
"AB58"
"Sandy plains: chief soils are red earthy sands (Uc5.21). Associated are (Gn2.12) soils on the plains and (Uc1.23) sands on occasional dunes. Occurs on sheet(s): 10"
"AB59"
"Sandy plains with some dunes: chief soils are red earthy sands (Uc5.21) and red siliceous sands (Uc1.43) on the plains. Other soils include (Uc1.23) on dunes and (Gn2.1) and (Dr1) on the plains. Occurs on sheet(s): 10"
"AB60"
"Plains with many dunes often relatively short and of irregular shape: chief soils are red earthy sands (Uc5.21). Associated are red siliceous sands (Uc1.23) on the dunes and red earths (Gn2.12, Gn2.13) on the plains. Occurs on sheet(s): 10"
"AB61"
"Plains flanking ranges; some stony hills similar to unit BA21 are included: chief soils are red earthy sands (Uc5.21). Associated are (Gn2.12) and (Um5.52) soils. Occurs on sheet(s): 10"
"AB62"
"Sandy plains with alluvial areas along waterways; occasional dunes: chief soils are red earthy sands (Uc5.21). Associated are (Uc1.23) sands on the dunes and deep (Uc1.43) sands on alluvial areas. Occurs on sheet(s): 10"
"AB63"
"Plains with variable areas of ridges, broad undulating rises, mesas, and calcareous depressions: chief soils are red earthy sands (Uc5.21), with red earths (Gn2.12, Gn2.13) on the plains. Associated are (Dr1.33) and (Dr1.43) soils, occasionally with gilgais and often mantled with stones and gravels on the rises and also on the slopes of mesas and ridges; shallow stony sands (Uc1.4) on the upper slopes of ridges and mesas; and some (Um5.11) and possibly (Gc) soils in calcareous depressions. Occurs on sheet(s): 10"
"AB64"
"Plains with occasional short dunes, and hilly areas with rock outcrops: chief soils are red earthy sands (Uc5.21). Associated are (Uc1.23) sands on dunes; possibly (Gn2.12) soils on the plains; and some shallow stony (Uc) soils on the hills. Occurs on sheet(s): 10"
"AB65"
"Sandy plains generally flanking granitic ranges; some tors and outcrops of sandstones and quartzites, and also some lateriteand silcrete-capped ridges, may occur sporadically. There are some shallow stream valleys and small salt pans; some rubbly calcrete (kunkar) mounds; some sand dunes of variable frequency of occurrence: chief soils are red earthy sands (Uc5.21), with red earths (Gn2.12, Gn2.13) on the plains. Associated are (Uc1.23) sands on the dunes; some (Um5.11), (Uc1.3), and possibly (Gc) soils on the calcrete mounds; and some (Dr1) soils on the plains. Occurs on sheet(s): 10"
"AB66"
"Plains with frequent dunes; some calcrete (kunkar) mounds; occasional granitic and sandstone outcrop; occasional laterite and silcrete breakaways: chief soils are red earthy sands (Uc5.21) on the plains, with some red earths (Gn2.12, Gn2.13). Associated are (Uc1.23) sands on the dunes and (Um5.11) soils on the calcrete mounds. Occurs on sheet(s): 10"
"AB67"
"Broken terrain on schists and sandstones with some low laterite-capped buttes and benches and high limestonecapped mesas; soils are variable: chief soils are probably red earthy sands (Uc5.21) in areas of gentler relief. Associated are stoneand gravel-mantled (Dr1.33) soils with some gilgai depressions of (Ug5.3) soils on slopes; (Uc1.3) and (Um5.11) soils on calcretes; and some (Gn2.12) soils. Occurs on sheet(s): 10"
"AB68"
"Sandy plains: chief soils are red earthy sands (Uc5.21), sometimes with a clay D horizon, and firm red deep sands (Uc1.43). Associated are (Gn2.12, Gn2.13) soils; some (Dr1) soils; and some (Uc1.23) sands on dunes. As mapped, small areas of unit BF1 and some hilly areas with shallow (Uc1.43) soils and rock outcrops are included. Occurs on sheet(s): 10"
"AB69"
"Sandy plains as for unit AB68 interspersed with stony plains as for unit Nb11. Occurs on sheet(s): 10"
"AB70"
"Sandy plains dotted with small hills and plateau remnants: chief soils are red earthy sands (Uc5.21) and firm red deep sands (Uc1.43). Associated are shallow red stony sands (Uc1.43), with rock outcrop on the hills and plateau remnants, and (Uc1.23) sands on included dunes. Occurs on sheet(s): 10"

"AB71"
"Plains and hills: chief soils are red earthy sands (Uc5.21) on the plains. Associated are shallow (Uc1.4) soils on the hills, and possibly deep (Uc1.43) and (Gn2.12) soils on the plains. Occurs on sheet(s): 10"
"AB72"
"Undulating plains on granite broken by narrow quartz ridges: chief soils are Fitty red earthy sands (Uc5.21). Associated are stoneand gravel-mantled (Dr1.33) and (Dr1.43) soils marginal to the ridges, and (Gn2.12) soils on the plains. There is a variable stone and gravel scatter throughout as well. Occurs on sheet(s): 10"
"AB73"
"Plain: chief soils are red earthy sands (Uc5.21) and red earths (Gn2.13, Gn2.12). Associated are various (Uc) soils, including deep (Uc1.43) and (Uc1.3). Occurs on sheet(s): 10"
"AB74"
"Very gently undulating plains with low levees adjacent to old stream channels; occasional low semi-active sand dunes may also occur: dominant soils are deep red earthy sands (Uc5.21) on the plains, with deep loose red sands (Uc1.23) on the levees and dunes. Associated marginally are red loams (Um6.24) and deep red cracking clays (Ug5.38), both of which have a scalded surface. Data are limited. Occurs on sheet(s): 10"
"AB75"
"Flood-plains: chief soils are deep red earthy sands (Uc5.21) and deep red sands (Uc1.43). Associated are various (Dr) soils, such as (Dr1.83), and (Gn2) soils, such as (Gn2.12, Gn2.13). Occurs on sheet(s): 10"
"AB76"
"Plains and dunes, sometimes with low silcrete-covered rises or hills: chief soils are red earthy sands (Uc5.21). Associated are (Gn2.12) soils on the plains and (Uc1.23) soils on the dunes. Other soils include (Um5.51) on the silcrete rises and hills. Occurs on sheet(s): 10"
"AB77"
"Generally similar to unit AB76 but with numerous clay pans of grey cracking clays (Ug5.2) and (Ug5.5). Other soils such as (Dy2.32) are likely, especially marginal to the plains and dunes. Occurs on sheet(s): 10"
"AB78"
"Sandy plains with some dunes and clay pans: chief soils are red earthy sands (Uc5.21) and deep red siliceous sands (Uc1.43) on the plains. Associated are (Uc1.2) sands on the dunes and (Ug5.2), (Ug5.5), and (Ug5.6) clays in the clay pans. Occurs on sheet(s): 10"
"AB79"
"Sandy plains with some alluvial areas along streams; there are many small dunes: chief soils are red earthy sand (Uc5.21) on the plains and (Uc1.23) on the dunes. Other soils may occur locally. Occurs on sheet(s): 10"
"AB80"
"Sandy plains underlain extensively by calcrete (kunkar) often at very shallow depths (< 12 in.); there are some dunes: chief soils are probably shallow red earthy sands (Uc5.21), but shallow sands (Uc1.4) and (Uc1.2) with calcrete at a depth of 4-12 in. are very common. Associated are (Uc1.23) sands on the dunes and (Gc1.12 Gc1.22) soils on the plains. Occurs on sheet(s): 10"
"AB81"
"Uneven plains on limestones: chief soils are probably the red earthy sands (Uc5.21) of the flats and hollows where some (Gn2.12) soils may occur also. Bare limestone with some areas of shallow (Uc1.43) sands is extensive. Occurs on sheet(s): 10"
"AB82"
"Dune fields--very gently undulating plains dominated by longitudinal dunes; small outcrops of calcrete (kunkar) occur in the interdune swales: chief soils are red earthy sands (Uc5.21) with an alkaline soil reaction trend and often with calcrete at about 24in. They occur in the swales along with some (Uc5.11) soils. Associated are (Uc1.23) soils on the dunes, (Gn2.13) soils in the swales, and (Um5.11) soils on calcrete outcrops. Occurs on sheet(s): 10"
"AB83"
"Plains with occasional low dunes: chief soils are red earthy sands (Uc5.21) with an alkaline soil reaction trend and calcrete (kunkar) at depth. Associated are (Gn2.13) soils; (Um5.11) soils on calcrete outcrops; and (Uc1.23) and (Uc5.21) soils on the dunes. Occurs on sheet(s): 10"
"AC1"
"Gently sloping to gently undulating plateau areas, or uplands, on granites, gneisses, and allied rocks, with long gentle slopes and, in places, abrupt erosional scarps, some granitic bosses, and tors; and irregularly traversed by narrow shallow valleys and flats: chief soils are yellow earthy sands (Uc5.22) and sandy yellow earths (Gn2.21, Gn2.22) on depositional sites, and ironstone gravels (KS-Uc4.11) together with (Uc4.11) and (Uc2.12), both containing ironstone gravels on erosional sites where they are underlain by hardened mottled-zone material. Soil dominance varies locally. Associated are shallow valleys and flats of the various (Dy) soils of unit Ya28 and pediments of unit Mx41 in the area of Sheet 10; small areas of other soils are likely. This unit has similarities with unit Ms8 of Sheet 5. As mapped, areas of adjacent units are included. Occurs on sheet(s): 5,10"
"AC2"

"Gently undulating plateau underlain by sedimentary rocks: chief soils are yellow earthy sands (Uc5.22) with siliceous sands (Uc1.22). Associated are patches of (KS-Uc2.12) and (Dy5.84) soils; and (Uc2.21) soils in some shallow valley floors. Occurs on sheet(s): 5"
"AC3"
"Gently undulating plateau underlain by sedimentary rocks: chief soils are yellow earthy sands (Uc5.22) with a higher clay content than those of unit AC2. Associated are patches of (KS-Uc2.12), (Dy5.84), and gravelly (Dy5.82) soils; minor areas of (Uc1.22) soils; and inclusions of unit Ub101 soils near areas of major dissection. Occurs on sheet(s): 5"
"AC4"
"Gently undulating plateau underlain by sedimentary rocks: chief soils are yellow earthy sands (Uc5.22) and siliceous sands (Uc1.22), with moderate areas of ironstone gravelly soils (Dy5.81 and Dy5.84) and (KS-Uc2.12) soils. Similar to unit AC2 but more (Dy) soils occur. Occurs on sheet(s): 5"
"AC5"
"Broad, gently undulating plain with sand dunes; occasional small lakes; occasional outcrops of quartzite particularly towards the eastern margin: chief soils are yellow earthy sands (Uc5.22) with some siliceous sands (Uc1.22). Associated are gravelly (Dy5.41) soils as well as some (Dy3.41 and Dy3.42) soils. Occurs on sheet(s): 5"
"AC6"
"Gently undulating plain with salt lakes; some sandy lunettes: chief soils are yellow earthy sands (Uc5.22) with siliceous sands (Uc1.22). Associated are (Dy2.42) soils in former lake beds. Occurs on sheet(s): 5"
"AC7"
"Low hilly to hilly terrain with outcrops of quartzite: chief soils are yellow earthy sands (Uc5.22). Associated are areas of hard acidic and neutral yellow mottled and red mottled soils (Dy3.81 and Dy3.82) and (Dr3.41 and Dr3.42) respectively. Occurs on sheet(s): 5"
"AC8"
"Undulating dune landscape: chief soils are yellow earthy sands (Uc5.22) but some siliceous sands (Uc1.22) may be associated. Occurs on sheet(s): 5"
"AC9"
"Gently undulating plateau underlain by sedimentary rocks; some dune tracts in places; some breakaways at margins; some areas of block laterite: chief soils are yellow earthy sands (Uc5.22). Associated are some (KS-Uc5.22) soils; (Uc1.22) soils on dunes; some (Dy3.62) soils of unit Uc2 in the western part of the area; and small plains of units My46 and Mx11. Occurs on sheet(s): 5,6"
"AC10"
"Ridge and slope terrain on granites, gneisses, and allied rocks: chief soils on the ridges seem to be yellow earthy sands (Uc5.22) in association with (KS-Uc4.11) soils and some sandy yellow earths (Gn2.21). Associated are a variety of shallow (Dy) and (Dr) soils, such as (Dy3.62), (Dy5.42), and (Dr3.42) on the slopes. Some similarities with unit AC1 but more slopes with shallow (Dy) and (Dr) soils are present. Occurs on sheet(s): 5"
"AC11"
"Undulating to hilly areas on gneissic rocks: chief soils seem to be shallow yellow earthy sands (Uc5.22) on crests in association with short dissection slopes of unit F8 soils and small plains of shallow red earthy sands (Uc5.21) and shallow red earths (Gn2.12). Some red-brown hardpan is evident, especially in the northern portions of the unit. Occurs on sheet(s): 5"
"AC12"
"Undulating to low hilly areas on granites, gneisses, and allied rocks with some rock outcrops, and intervening small sandy plains: chief soils seem to be shallow and ironstone-gravelly forms of yellow earthy sands (Uc5.22) and (KS-Uc5.22) on the crests. Associated are short, often abrupt, dissection slopes of various (Uc), (Um), and shallow (Dr) and (Dy) soils; and small plains of (Uc5.21) and (Gn2.12) soils often underlain by red-brown hardpan at shallow depths. Small areas of units Fa4 and My45 may be included. Occurs on sheet(s): 5"
"AC13"
"Gently sloping plains with some low to steep laterite ridges; laterite boulders; narrow valleys: chief soils are probably yellow earthy sands (Uc5.22), often deep, but shallow forms containing laterite boulders and gravels occur too. Associated are (Uc5.21) sands on flat areas as for unit AB33. Other soils include red earths (Gn2.12 and Gn2.14); yellow earths (Gn2.24); some (Uc1.2) and/or (Uc2.2) soils flanking small stream valleys; and some (Uc2.12) sands on laterite. There are probably some areas similar to units Mw32 and Mr8 as well as inclusions of the soils of units MY2 and BY1. Occurs on sheet(s): 8"
"AC14"
"Gently sloping plains with areas of laterite and broken by hills, ridges, and mesas; mainly on sandstones, siltstones, or granites: chief soils are probably yellow earthy sands (Uc5.22) as for unit AC13. Associated are (Gn2.1) soils as for unit MY2 and shallow sands (Uc4.1) and (Uc1.4) with rock outcrop on the hills and ridges. As mapped, areas of unit BY1 are included. Occurs on sheet(s): 8"

"AC15"
"Plains with some incised streams and some flat valleys and spillways subject to local flooding: chief soils are yellow earthy sands (Uc5.22) with sandy yellow earths (Gn2.21), both may contain some ironstone gravels. Associated are some red earthy sands (Uc5.21), ironstone gravels (KS-Uc4.11), and sandy red earths (Gn2.1) as well as the red earths of unit My77. Other soils include (Uc2.2) close to sandstone outcrops and various (Uc) and (Um) soils along valley side slopes of the incised streams. As mapped, small areas of adjacent units, especially unit AC16, are included. Occurs on sheet(s): 8"
"AC16"
"Gently undulating terrain with stony spurs: chief soils are probably yellow earthy sands (Uc5.22) with sandy yellow earths (Gn2.21). Associated are (KS-Uc4.1) and (Uc4.1) soils as well as the soils of unit AC15. Occurs on sheet(s): 8"
"AC17"
"Gently undulating sandy plains and flood-plains; stony surface cover in places: chief soils are probably yellow earthy sands (Uc5.22) with a variety of sandy yellow earths such as (Gn2.24) and (Gn2.61). Associated are flood-plain areas of variable size similar to unit Mb15. Occurs on sheet(s): 8"
"AC18"
"Gently undulating sandy plains as for unit AC17, with hilly areas of units BY2 and JJ31 and narrow floodplains as for unit Mb15: chief soils are probably yellow earthy sands (Uc5.22). Occurs on sheet(s): 8"
"AC19"
"Gently undulating sandy plains with broad low rises having massive nodular laterite exposed mainly on low scarped margins: dominant soils are shallow sands overlying massive laterite. Chief forms are (Uc5.22), (Uc5.23), and (Uc4.21) with associated (Uc5.21), (Uc4.22), and (Uc2.12). Some (Uc1.21, Uc1.22, and Uc1.23) soils also occur. All soils may have ironstone nodules throughout the profile. On some of the flatter areas sandy yellow earths (Gn2.22 and Gn2.21), occasionally (Gn2.62), and red earths (Gn2.12) occur. Sandy, and some loamy, grey earths (Gn2.81), (Gn2.94) and yellow mottled duplex soils (Dy3.81) occur in shallow depressions. Occurs on sheet(s): 7,8"
"AC20"
"Gently undulating plains: dominant soils are deep yellow earthy sands (Uc5.22) with similar sands (Uc5.23), (Uc5.21), (Uc5.11), and (Uc4.22) associated; these may be locally dominant. Commonly occurring are deep sandy yellow earths (Gn2.22, Gn2.21, Gn2.23, Gn2.24), (Gn2.61), and (Gn2.74) and red earths (Gn2.15, Gn2.11, and Gn2.14). Some grey earths (Gn2.94) and (Gn2.81, Gn2.82) occur in lower sites. Deep grey-brown cracking clays (Ug5.24, Ug5.25, and Ug5.22), uniform clays (Uf6.33), and loamy duplex soils (Dy2.13) and (Db1.13) occur in broad depressions. Occurs on sheet(s): 7,10"
"AC21"
"Gently undulating plains with numerous sandy rises and shallow sandy stream beds: dominant soils are deep yellow earthy sands (Uc5.22), with lesser similar sands (Uc5.23), (Uc5.21), (Uc4.2), and (Uc5.11). Associated soils, which may be locally dominant, are deep sandy earths (Gn2.63), (Gn2.23), (Gn2.43), (Gn2.83), (Gn2.64), and (Gn2.82). Also occurring in some lower areas are deep bleached sands (Uc2.22), and occasionally (Uc5.13) soils. On the levees of the larger streams are sandy red earths (Gn2.11) and yellow earths (Gn2.21). Occurs on sheet(s): 7"
"AC22"
"Gently undulating to undulating lands with some sandstone ridges: most soils have ironstone nodules throughout the profile, the dominant ones being shallow to moderately deep sands (Uc5.22), associated with (Uc5.11), (Uc2.12), and (Uc4.2) soils overlying massive nodular laterite at shallow to moderate depths. Associated are (Uc5.21) and some sandy red or yellow earths (Gn2.11) and (Gn2.21). Occurring adjacent to drainage lines are sandy and loamy grey or yellow earths (Gn2.94), (Gn2.74), and (Gn2.24). Occurs on sheet(s): 7"
"AC23"
"Gently undulating plains: dominant soils are probably deep loose yellowish earthy sands (Uc5.22), but other deep sands (Uc4.21, Uc4.22) and (Uc2.21) are also common. Closely associated on slightly higher sites are sandy yellow earths (Gn2.64) and (Gn2.24), and red earths (Gn2.14). Data are fairly limited. Occurs on sheet(s): 7"
"AC24"
"Dunes and plains with some granitic outcrop and considerable surface cover of ironstone gravels; some calcrete (kunkar) in low-lying sites: chief soils are yellow and red earthy sands (Uc5.22, Uc5.21) on the plains. Associated are (Uc1.22) and possibly other (Uc1.2) sands on the dunes. They sometimes contain ironstone gravel. Other soils may occur. Occurs on sheet(s): 10"
"AD1"
"Stream levees, small flood-plains, and infilled channels: dominant soils are deep yellowish brown earthy sands (Uc5.23), with closely associated similar yellow sands (Uc5.22). On some small flood-plains are deep loams (Um5.52), with lesser sandy grey earths (Gn2.82), and yellow earths (Gn2.22, Gn2.21); these soils are usually stratified at depth. Occurs on sheet(s): 7"

"AD2"
"Moderately to strongly undulating lands with broad ridge crests; occasional low hilly areas with granite outcrop also occur: dominant soils are moderately deep coarse sands, chiefly (Uc5.23), but with (Uc5.22, Uc5.21) and (Uc4.2) also occurring. Commonly associated are areas of moderately deep bleached sands (Uc2.12). Adjacent to rock outcrop shallow sands (Uc4.11) and (Uc2.12) occur. Occurs on sheet(s): 7"
"AY1"
"Gently undulating upland (tableland) with much ironstone gravel on the surface; some breakaways (mesas, buttes, and bluffs) capped by ironstone (lateritic) duricrust; there is some local marginal transgression by longitudinal dunes from adjacent units: chief soils are ironstone-gravelly varieties of shallow red earthy sands (KS-Uc5.21) and shallow siliceous sands (KS-Uc1.23), with ironstone duricrust at a depth of about 18 in. These soils occur on crest, upper, and mid slopes, generally with (Uc5.21) soils in lower situations and (Uc1.23) soils on the dunes. Other soils may occur. Occurs on sheet(s): 10"
"AY2"
"Dissected lateritic upland (tableland) of flat to hilly topography with shallow detrital valleys and pediment slopes; there are also low escarpments of breccia and laterite; lateritic mesas and buttes; and stone-strewn ridges on the interfluves with block laterites; stone and gravel pavements are common; there are occasional small tracts of dunes: chief soils are shallow stony and/or gravelly sands and sandy loams (KS-Uc5.21), (KS-Uc1.43), and (K-Uc5.21) on the flat to convex upland surfaces. Often these soils are less than 18 in. deep and may be underlain by large amounts of ironstone gravel and boulder beds of mixed materials. Other soils include (Um1.43) and (Um5.3) on slopes, (Um5.3) and (Gn2.12) sometimes underlain by a redbrown hardpan in shallow valleys, (Uc5.21) in valleys, and (Uc1.23) on dunes. Occurs on sheet(s): 10"
"AY3"
"Broad undulating upland (tableland) elevated above the adjacent plains and dunes; scarps, pediments, mesas, and buttes are common: chief soils are ironstone-gravelly varieties of red earthy sands (KS-Uc5.21) often on ferruginous duricrust, and red earthy sands (Uc5.21). Associated are (Gn2.11, Gn2.12, and Gn2.13) soils, the last two occurring particularly below breakaways, and (Uc5.21) and (Uc1.23) on interdune and dune areas respectively, in the broader valleys. Occurs on sheet(s): 10"
"AY4"
"Scarpland elevated above surrounding plains and dunes and characterized by breakaways (mesas, buttes) and low stony hills frequently capped by lateritic duricrust; some sedimentary rocks are exposed: chief soils are ironstone-gravelly varieties of red earthy sands (KS-Uc5.21) overlying duricrust within 2 ft and occurring above the breakaways. Associated are (Uc5.21) and (Gn2.13) soils on pediments below the breakaways, the latter occasionally underlain by calcrete; and (Uc1.22, Uc1.23) and (Uc5.21) soils on included small dunes. Occurs on sheet(s): 10"
"AZ1"
"Undulating to low hilly areas on granites, gneisses, and allied rocks: chief soils are ironstone-gravelly forms of shallow earthy sands (KS-Uc5.22) on crests where small patches of (Gn2.1) soils occur. Associated are shallow (Uc), (Um), (Dy), and (Dr) soils on slopes. Gravel pavements are common throughout. Occurs on sheet(s): 5"
"AZ2"
"Undulating laterite plateau developed on shales and sandstones: chief soils are ironstone gravels (KS-Uc5.22) and (KS-Uc1.43) on the higher country with much bare rock in places. Associated are (Dy3.42) and (Dy2.32) soils in lower-lying sites with much ironstone gravel on their surfaces. Occurs on sheet(s): 9"
"AZ3"
"Dissected basalt plateau with laterite capping; some broad valley plains. The main soil unit is the lateritic plateau crests with ironstone gravels (KS-Uc5.22) and associated (Uc1.22) and (KS-Uc1.43) soils, but in the northern portions shallow lateritic red earths (KS-Gn2.11) with block laterite are very common. The poorly drained flats at the laterite level have hard alkaline yellow soils (Dy2.43), sometimes containing much ferruginous gravel. In the dissected areas the upper slopes have shallow stony (Um6) soils changing to (Gn3.1) soils downslope. Small areas of cracking clays (Ug5.24) occur along valley floors. Occurs on sheet(s): 9"
"Aa1"
"Plains: basin plains (swamps) most probably of friable acid dark soils (Dd3.11) having shallow peaty surface horizons and with (Dy) soils around the margin of the basin plain. Occurs on sheet(s): 2"
"Ab1"
"Flat to gently sloping plateau remnants at low to moderate elevation: friable neutral and alkaline dark soils (Dd3.12, Dd3.13, and Dd3.43), sometimes in gilgai association with dark clays (Ug5.14); small areas of friable neutral brown soils (Db3.12) and minor areas of hard neutral red soils (Dr2.12). Occurs on sheet(s): 2"
"Ab2"
"Gently undulating area of friable neutral dark soils (Dd3.12) and cracking dark clays (Ug6.1), possibly with other soils as well. Occurs on sheet(s): 2"
"Ac1"

"Plain: broad flats of friable alkaline dark mottled soils (Dd4.43) with (Dd4.13 and Dd4.23); low sandy rises of leached sands (Uc2.33); small plateau areas of dark cracking clays (Ug6.16) and grey cracking clays (Ug6.2); many minor areas of other soils unclassified. Occurs on sheet(s): 2"
"B1"
"Dunes and small plains: dunes and plains of siliceous sands (Uc1.22) and some limestone dunes with small areas of red-brown sandy soils (Uc6.13) and red shallow porous loamy soils (Um6.24) and exposed limestones. Occurs on sheet(s): 1"
"B2"
"Plain with sand-ridges and outcrops of limestone: plains of siliceous sands (Uc1.21) and sandy alkaline yellow mottled soils (Dy5.83); some dunes of leached sand (Uc2.33) and outcrops of limestone with small areas of shallow red-brown sandy soils (Uc6.13). Occurs on sheet(s): 1"
"B3"
"Dunes of siliceous sands (Uc1.21 and Uc1.22) along coast and lake frontages with dunes of leached sands (Uc2.2) and small plains of sandy yellow mottled soils (Dy5.8) inland from them, also swampy areas--some saline--with peats (O) and other undescribed soils. Occurs on sheet(s): 2"
"B4"
"Dunes of siliceous sands (Uc1.2) along the coast with areas of leached sands (Uc2.3) inland from them. Occurs on sheet(s): 2"
"B5"
"Coastal plains with dunes, swamps, and lakes: plains and dunes of siliceous sands (Uc1.2) and silty soils (Um1) and plains of clay soils (Uf) and (Ug); some terrace remnants where the plains merge with the stream valleys of dark, deep, porous loamy soils (Um6.12) on the lower terraces, and hard alkaline soils (Dr2.23) on the higher terraces. Occurs on sheet(s): 2"
"B6"
"Rugged hills of siliceous sands (Uc1.21 and Uc1.22) with many rock outcrops, and flanked in places by colluvial slopes of siliceous sands (Uc1.21 and Uc1.22) with smaller areas of hard acidic red soils (Dr2.21). Occurs on sheet(s): 2"
"B7"
"Hilly areas with rock outcrops and bounded by steep scarps: hill slopes of siliceous sands (Uc1.2) with smaller areas of hard neutral yellow mottled soils (Dy3.42), some of which have highly organic A horizons. Occurs on sheet(s): 2"
"B8"
"Hilly: steep hills of siliceous sands (Uc1.2) with many rock outcrops, and between the hills low ridges of hard yellow mottled soils (Dy3.4) with some rock outcrops, with hard alkaline yellow mottled soils (Dy3.43) on the colluvial apron flanking the whole urea. Occurs on sheet(s): 2"
"B9"
"Present beach system of dunes and estuaries: dunes of siliceous sands (Uc1.21) backed by slopes of siliceous sands (Uc1.21) and/or leached sand soils (Uc2.2 and Uc2.3); other soils include (Dy5.81) and acid peats (O). As mapped, small areas of units NY1 and NY2 are included. Occurs on sheet(s): 3,4"
"B10"
"Low dunes, sandy banks, or flat sandy rises slightly elevated above the surrounding clay plains and often related to functional or non-functional drainage lines: soils are mainly siliceous sands (Uc1.21, Uc1.22, and Uc1.23) with (Uc4.2) soils. Associated are various (D) soils such as (Dy5.42), (Dy5.43), (Dy3.42), and (Dy3.43) flanking the dunes and sandy rises. As mapped, small areas of units Si2, Ro3, and CC17 may be included. Compare unit B11 near Narrandera (Sheet 3). Occurs on sheet(s): 3,4"
"B11"
"Sandhills and sand sheets: chief soils are siliceous sands (Uc1.22 and Uc1.23). Associated are sandy neutral and alkaline yellow mottled soils (Dy5.42 and Dy5.43) and other, undescribed soils. As mapped, narrow areas of unit Gb5 occur along the river. Compare unit B10, south-west Queensland. Occurs on sheet(s): 3"
"B12"
"Dunes and sandy plains with some dunes: chief soils are siliceous sands (Uc1.23) and/or (Uc1.22) with other sandy soils such as (Uc1.43), and less commonly (Uc5.21), and (Uc2.34) marginal to clay plains. Associated are various earth soils (Gn2.12), (Gn2.13), (Gn2.83), and occasionally (Gn2.22). As mapped, small areas of clay pans (Dr1.33) and cracking clays (Ug5.2 and Ug5.3) may be included. Occurs on sheet(s): 3,4"
"B13"
"Elevated sand plains with low dunes: chief soils are siliceous sands (Uc1.22 and Uc1.23) often overlying ironstone gravel or billy (silcrete) boulders. Associated soils are earthy sands (Uc5.2) and red earths (Gn2.12) especially near the margins of the unit. Occurs on sheet(s): 3"
"B14"

"Low sandy ridges of modified dune form and flat to very gently undulating plains: dominant soils are deep red siliceous sands (Uc1.23), with lesser areas of (Uc5.22 and Uc5.21) earthy sands. Associated are sandy or loamy red duplex soils (Dr2.33) with some similar (Db1) and (Dy2) soils. Also occurring are small areas of sandy red earths (Gn2.12). Occurs on sheet(s): 4"
"B15"
"Level plains with some broad low dunes adjacent to present and prior drainage-ways: dominant soils are deep reddish sands (Uc1.23 and Uc1.22), with some (Uc5.11). Red or grey duplex soils (Dr2.33) and (Dy2.33) occur marginally. As mapped, small areas of cracking clays (Ug5.22 and Ug5.32) and plastic clay soils (Uf6.31 and Uf6.33) are included, together with some sandy red earths (Gn2.12). Occurs on sheet(s): 4"
"B16"
"Sand dunes at 50-150 ft above sea level orientated to direction of south-east trade winds, and with some higher dunes to 250 ft and some swampy depressions: chief soils of the dunes are siliceous sands (Uc1.22 and Uc1.21). Other soils probably include small areas of (Uc2.2) and (Uc2.3) in low-lying sites, and acid peats (O) in some swampy depressions. Data are limited. Occurs on sheet(s): 4"
"B17"
"Low sand dunes from less than 25 to 50 ft above sea level parallel to the present coastline, and sometimes grading to undulating sandy sheets at 50-100 ft with a few higher dunes to 250 ft; some swampy depressions and lagoons: chief soils of dunes and sand sheets are siliceous sands (Uc1.22 and Uc1.21). Other soils probably include (Uc2.2) and (Uc2.3); acid peats (O) and (Dg4.81) soils in swampy depressions. Data are limited. As mapped, small areas of unit NX1 are included. Occurs on sheet(s): 4"
"B18"
"Low hilly to hilly sand-dune country with dune crests from 200 to 800 ft above sea level and local relief of up to 300 ft, blowouts, beach fore-dunes, sand cliffs, a few lakes: chief soils seem to be siliceous sands (Uc1.21) with leached sands (Uc2.21) that are often covered in part by sand drift from the (Uc1.21) dunes. Other soils include (Uc1.22) on beach fore-dunes, some deep (Uc2.21) soils and (Uc2.33) and acid peats (O) in lower-lying situations. Old red and yellow sand bands are evident in the sand cliffs; buried and/or fossil organic hard pans similar to those present in (Uc2.33) soils occur in places also. As mapped, small areas of units Ca10 and Cb33 are included. Occurs on sheet(s): 4"
"B19"
"Dunes and swales, some swampy flats and coastal mud flats: chief soils are siliceous sands (Uc1.21) on high coastal fore-dunes behind which are leached sands (Uc2.2 and Uc2.3) in a low dune-swale terrain. Small areas of (O) and (Dg) soils are likely. Occurs on sheet(s): 4"
"B20"
"Young coastal dunes less than 25 ft above sea level, parallel to the coastline; dune and swale relief in places: chief soils are siliceous sands (Uc1.21) on the crests and slopes of the higher dunes. Associated are (Uc2.23) sands in swales and (Uc1.11) sands on youngest fore-dunes. Minor soil occurrences include (Uc2.21) on low dunes, (Dy5.51) in depressions, and (Uc4.2) on old dunes. Small areas of units J5 and Tb121 are included locally. Occurs on sheet(s): 4"
"B21"
"Young coastal dunes as for unit B20 but with considerable local inclusions of the soils of unit Ca18. Occurs on sheet(s): 4"
"B22"
"Level or very gently undulating sandy plains: dominant soils are deep red sands (Uc1.23), with lesser (Uc1.43) and (Uc5.21). Closely associated are areas of sandy red earths (Gn2.12), lesser sandy yellow earths (Gn2.22), and yellow earthy sands (Uc5.22). Occurs on sheet(s): 4"
"B23"
"Sandy plains, modified low dunes, and slightly elevated sand-filled prior stream channels: dominant soils are deep sands (Uc1.23), (Uc1.21), (Uc1.22), with lesser (Uc5.21) and (Uc5.11). Associated are sandy red earths (Gn2.12 and Gn2.13) and loamy duplex soils (Dr2.12), (Dr2.22), and (Dy2.33). Also occurring in the unit, as mapped, are deep grey clays (Ug5.24), most of which are subject to flooding and some of which may be strongly gilgaied. This unit is closely associated with unit Qa15. Occurs on sheet(s): 4"
"B24"
"Undulating dune landscape underlain by aeolianite which is frequently exposed; small swales of estuarine deposits are included: chief soils are siliceous sands (Uc1.22) with smaller areas of brown sands (Uc4.22) and leached sands (Uc2.21) in the wetter sites. Associated are various (Uc), (Um), (Uf), (Ug), and acid peat (O) soils in the swales, similar to unit Kf10. Occurs on sheet(s): 5"
"B25"
"Coastal dunes, some salt lagoons and flats: chief soils seem to be siliceous sands (Uc1.21) on dunes fronting the beach and backed at least in the southern portions of the unit by low dunes of leached sands (Uc2.21). Calcareous

dunes (Uc1.11) could be present especially in the northern portion of the unit, but no data are available. The soils of the saline and calcareous flats fringing the lagoons have not been described. Occurs on sheet(s): 5"
"B26"
"Undulating dune landscape underlain by aeolianite which is exposed in places: chief soils are siliceous sands (Uc1.22) with some shallow grey-brown sandy soils (Uc6.11). Other (Uc) soils such as (Uc4.22) are likely but have not been recorded. As mapped, small areas of adjoining units may be included. Occurs on sheet(s): 5"
"B27"
"Low terrace associated with main stream channels: chief soils are loose sands (Uc1.22) with some (Um5.11) soils on patches of calcrete (kunkar). Occurs on sheet(s): 6,10"
"B28"
"Dune fields--largely stable linear dune fields with swales opening locally into sand plains dune lineation is generally E.-W. but in the area west of 123 deg E. Longitude the trend is NW.-SE.; some pans and depressions; some isolated residual sandstone hills: chief soils are the red siliceous sands (Uc1.23) of the dune crests and flanks. Red earthy sands (Uc5.21) and possibly red earths (Gn2.12) sometimes containing ironstone gravel are associated in the swales and sand plains. Other soils include (Gn2.21) and/or (Gn2.61), sometimes containing ironstone gravels, in low sites; (Dy1.33) and (Dy1.43) and possibly similar (Dr1) soils in depressions; and (Uf) or (Ug) soils in pans. Occurs on sheet(s): 9,10"
"B29"
"Dune fields as for unit B28 but with considerable areas of residual sandstone hills and ranges: chief soils are probably red siliceous sands (Uc1.23) together with (Uc5.21) sands as for unit B28. Associated are bare rock and shallow sands, probably (Uc1.4) on the sandstone residuals which may be dominant locally. Occurs on sheet(s): 9"
"B30"
"Dune fields as for unit B28 but with considerable areas of clay pans and salt pans: chief soils are probably red siliceous sands (Uc1.23) together with (Uc5.21) sands as for unit B28, but locally with more extensive areas of (Dy1.33), (Dy1.43), probably similar (Dr1) soils, and (Uf) or (Ug) soils. Occurs on sheet(s): 9,10"
"B31"
"Gently undulating sandy plains with very small areas of low bouldery sandstone hills: chief soils are deep red and yellow siliceous sands (Uc1.23 and Uc1.22). Associated soils include (Uc2.2), (Uc4.21), (Dy5.42), and sandy (Gn2.14) soils, while some (Uc5.21 and Uc5.22) sands may also occur. Occurs on sheet(s): 8,9"
"B32"
"Dune fields of parallel linear dunes, reticulate dunes and/or irregular dunes: chief soils are the red siliceous sands (Uc1.23) of the dunes which have stable flanks and partially mobile crests. Associated are (Uc5.21) sands in the swales with small areas of (Gn2.13) soils with calcrete (kunkar); (Gn2.12) soils; shallow (Uc) soils on calcrete (kunkar); some gypsum deposits; and some (Dr) soils. Some narrow valleys as for unit B33 may be included. Occurs on sheet(s): 8,10"
"B33"
"Dry sandy valleys with areas of calcrete (kunkar) and gypsum deposits: chief soils are siliceous sands (Uc1.2) with areas of earthy sands (Uc5.2) and (Gn2) soils, such as (Gn2.13), associated with calcrete (kunkar). Occurs on sheet(s): 8,10"
"B34"
"Coastal dune systems generally consolidated but with many mobile areas; sometimes with a central core of limestone or ancient coral: chief soils are siliceous sands (Uc1.21 and Uc1.22) but calcareous sands (Uc1.1) also occur in places. Other soils are likely where the limestone core has been exposed by erosion. Small plains of adjoining units Jw1 or Io1 respectively are included where they occur between dunes. Some areas of unit AC15 are included on Groote Eylandt. Occurs on sheet(s): 8"
"B35"
"Low dunes and old beach ridges parallel to the coastline, now fixed by vegetation: dominant soils on the inland, more extensive, systems are deep loose siliceous sands, chiefly (Uc1.21), but with (Uc1.23, Uc1.22) occurring in some localities. In the smaller shallow swales deep sands (Uc1.21) and (Uc5.11) are also common, but in wider swales clays occur, chiefly (Uf6.41) but occasionally (Ug5.16). A narrow zone of more recent shelly dunes normally occurs where the unit is adjacent to the coast; these have deep (Uc1.11 or Uc1.13 and Uc1.14) soils. In some areas broad slightly elevated old beach ridges have (Uc4.21) soils. Small salt pans with (Uf6.41), (Uf6.51), and (Uf6.61) saline clays are often included in the unit. Occurs on sheet(s): 7"
"B36"
"Extensive areas of siliceous sand dunes aligned in a NE-SE. direction, normally transverse to the coastline. The dunes are often of elongated parabolic form, with numerous ridges up to 50 or 100 ft high fixed by vegetation. In general the height of the dunes tends to decrease towards the northern extremities of the unit. The noses and less commonly the trailing arms of the parabolic dunes often have active advancing areas of spilling sand; other less regular areas of active blow-outs also occur. Shallow freshwater lakes are common, particularly in swales or within the areas of the parabolic dunes. The soils of the dunes are deep loose white sands (Uc1.21), with a slightly

darkened organic A horizon where the dunes are fixed by vegetation; many dunes have a core of organic-cemented sand and this is usually exposed on lake floors. Associated with the dune systems, particularly in the occurrences around and to the north of Shelburne Bay, are fairly extensive vegetated sand plains with only occasional lo. Occurs on sheet(s): 7"
"B37"
"Undulating irregular old vegetated dunes and sand-covered ridges: dominant soils are probably deep to moderately deep sands (Uc1.21), with some deep bleached sands (Uc2.21) in lower flatter sites. In parts of the unit small areas of the basement rocks of unit Fu25 may be exposed. Data are extremely limited. Occurs on sheet(s): 7"
"B38"
"Moderately to strongly undulating densely vegetated old high dunes which are inland from, and approximately parallel to, the coastline: dominant soils are deep loose sands (Uc1.21) with moderately organic A1 horizons; these soils occur both on the irregular dune ridges and in the interdune swales. In the northern occurrences of the unit relief is less, and there probably are areas of deep bleached sands (Uc2.21) associated. Data are limited. Occurs on sheet(s): 7"
"B39"
"Dunes, plains, and salt pans in narrow valleys: chief soils are probably siliceous sands (Uc1.23) and (Uc5.13). Associated are variable areas of the soils of units BB21, Nb8, and SV5. Occurs on sheet(s): 10"
"B40"
"Dune fields--longitudinal and ring dunes, some small clay pans; chief soils are red siliceous sands (Uc1.23) on the dunes, some of which have mobile crests. Associated are red earthy sands (Uc5.21) in some interdune areas. There are small inclusions of units AY2 and BY6 in some areas. Occurs on sheet(s): 10"
"B41"
"Dune fields--longitudinal and ring dunes with variable inclusions of residual hills; some small clay pans: chief soils are red siliceous sands (Uc1.23) on the dunes and red earthy sands (Uc5.21) in interdune areas. Small areas of other soils including (KS-Uc) soils on the residuals occur also. Occurs on sheet(s): 10"
"B42"
"High sand dunes with narrow corridor plains and occasional small open plain areas; occasional outcrops of sandstones, laterites, and silcretes; some calcareous mounds: chief soils are red siliceous sands (Uc1.23) -- note the hue of these sands changes from 2.5YR in the north to 5YR in the south. Associated are (Uc5.21) and (Gn2.12, Gn2.13) soils in the corridor plains. As mapped, small areas of units My117, My116, SV13, and BB25 may be included. Occurs on sheet(s): 10"
"B43"
"Dune fields with dunes generally trending NW. to SE.; dune crests are inclined to drift readily; narrow interdune swales and corridor plains: chief soils are red siliceous sands (Uc1.23), but yellow (Uc1.22) and white (Uc1.21) siliceous sands and also some (Uc5.1) sands occur too. In general there is a grading from red to yellow and white sands from north to south; white sands are more common also in proximity to drainageways, pans, and lakes and grade through yellow to red sands away from these situations. Soils of the interdune areas are variable, and include sands such as deep (Uc1.43) and (Uc5.21); earths such as (Gn2.12); cracking clays such as (Ug5.2) and (Ug5.3); other clays such as (Uf6.12); and other soils including (Dy) soils. There are also small inclusions of sandstone hills, mesas, clay pans and clay flats. Occurs on sheet(s): 10"
"B44"
"Gently undulating plains: dominant soils are moderately deep to deep red sands and loamy sands (Uc1.23) which often have a dense sandy clay D horizon at moderate depths. Associated are areas of deep sandy red earths (Gn2.12, Gn2.13) and loamy red duplex soils (Dr2.33, Dr2.32) and occasionally similar (Dr1) soils. In some areas there are occasional narrow linear semi-active low dunes. Data are limited. Occurs on sheet(s): 10"
"B45"
"Linear semi-active relict sand dunes with wide interdune swales: dominant soils of the dunes are deep loose red sands (Uc1.23), or occasionally light brown sands (Uc1.22). The swales may have a range of soils, nearly always with a scalded surface. They include compacted sands (Uc1.23), sandy red earths (Gn2.13, Gn2.12), loamy duplex soils (Dr2.33, Dr2.13), uniform clays (Uf6.13, Uf6.12), or occasionally cracking clays (Ug5.34). In some areas shallow clay pans occur between the dunes. Data are fairly limited. Occurs on sheet(s): 10"
"B46"
"Gently undulating lands with short slopes and broad flat sandy rises: dominant soils are very loose deep sands (Uc1.21) on the crests, with other deep sands (Uc4.21), (Uc4.24), and some (Uc2.21) on higher slopes. A range of loamy and sandy duplex soils, chiefly (Dy2.33), (Dy2.43), (Dy3.33), and (Dy3.43) occur on lower slopes and in drainage lines. Occurs on sheet(s): 10"
"B47"
"Dune fields with clay corridors between the dunes: chief soils are siliceous sands (Uc1.22, Uc1.23, and Uc1.21). Associated are the (Ug5.2) and (Ug5.5) clays of the interdune corridors. Other soils may occur. Occurs on sheet(s): 10"

"B48"
"Dune fields with interdune corridors in which cracking clays and/or crusty loamy soils may occur; some clay pans: chief soils are siliceous sands (Uc1.22, Uc1.23, and Uc1.21) on the dunes. Associated are grey and brown clays (Ug5.2) and (Ug5.3) and crusty loamy soils (Dr1.32, Dr1.33) in interdune areas; (Ug5.5) and (Ug5.2) clays in clay pans; and (Uc1.41) soils on the flanks of some dune areas. Other soils are likely. Occurs on sheet(s): 10"
"B49"
"Dune fields: chief soils are the siliceous sands (Uc1.2) of the dunes which may be mobile in part. Other soils are likely. Occurs on sheet(s): 10"
"B50"
"Small longitudinal dune fields or dune chains: chief soils are the siliceous sands (Uc1.22, Uc1.23) of the dunes. Associated are a variety of soils on dune flanks including (Gc) and (Gn2.13) soils. Occurs on sheet(s): 10"
"B51"
"Dune fields with variable interdune corridors and plains: chief soils are the siliceous sands of the dunes (Uc1.22, Uc1.23, and Uc1.21), some of which have mobile crests. Associated are the grey clays (Ug5.2) of the plains and interdune areas which may be dominant locally. Other soils include (Uf1) and (Um1) soils in allvuial zones and possibly (Gn2.1), (Gc), and (Dr1.3) soils in interdune areas and on dune flanks. Occurs on sheet(s): 10"
"B52"
"Dune fields with small plains: chief soils are the siliceous sands (Uc1.2), notably (Uc1.23), of the dunes. Associated are the deep sands of the plains (Uc5.21) and (Uc1.43). Other soils include (Gn2.1) and (Dr1.3). Occurs on sheet(s): 10"
"B53"
"Dunes and plains with some small rough hilly areas of unit BA27: chief soils are the red siliceous sands (Uc1.23) of the dunes. Associated are the (Gn2.13) soils of the plain areas. Occurs on sheet(s): 10"
"B54"
"Dune fields of large longitudinal sand dunes and interdune plains: chief soils are probably red siliceous sands (Uc1.23) on the dunes. Associated are (Uc5.21) and (Gn2.12) soils on the interdune plains. Occurs on sheet(s): 10"
"B55"
"Confused sand dune country with some small clay pans: chief soils are siliceous sands (Uc1.2), possibly with other (Uc) soils. Other soils include (Ug5.2) and (Ug5.5) in the clay pans. Occurs on sheet(s): 10"
"B56"
"Dune fields with small clay pans: chief soils are the siliceous sands of the dunes (Uc1.2) and the grey clays (Ug5.5) and (Ug5.2) of the clay pans. Other soils may occur. Occurs on sheet(s): 10"
"B57"
"Irregularly oriented dunes with areas of stony and/or sandy plains: chief soils are siliceous sands (Uc1.2) on the dunes and (Dr1.33, Dr1.32, and Dr1.43) soils on the plains often covered with sand drift. Other soils including (Gc) and (Gn2.1) soils may occur. Occurs on sheet(s): 10"
"B58"
"Dune fields--irregularly oriented often short dunes: chief soils are siliceous sands (Uc1.2). Other soils may occur. Occurs on sheet(s): 10"
"B59"
"Dune fields with distributary stream channels in the interdune areas; some clay pans: chief soils are the siliceous sands (Uc1.2) of the dunes. Associated are (Ug5.2) clays in interdune areas and (Ug5.5) clays in clay pans. Other soils may occur. Occurs on sheet(s): 10"
"B60"
"Dune fields with variable interdune corridors and plains; some clay pans; some transit seasonal drainage-ways: chief soils are the sands of the dunes (Uc1.22, Uc1.23, and Uc1.21) with (Uc5.11, Uc5.12) which may be dominant locally. Associated are (Gn2.1) and probably (Gc) soils in interdune areas with (Ug5.2), (Ug5.3), and (Ug5.5) clays in clay pans, clay flats, and along some drainage-ways. Occurs on sheet(s): 10"
"B61"
"Sand dunes with narrow corridor plains and occasional small open plain areas; occasional outcrops of sandstones, laterites and silcretes, and calcretes: chief soils are red siliceous sands (Uc1.23). Associated are small plains as for unit AB80, and less often some (Gn2.12, Gn2.13) soils in interdune areas. This unit is transitional to unit B42. Occurs on sheet(s): 10"
"B62"
"Sand dunes with narrow corridor plains; some seasonal swamps or lakes; some small plain areas: chief soils are red siliceous sands (Uc1.23) and brown sands (Uc5.11, Uc5.12), especially in the southern parts of the unit. Associated are (Uc5.21) and (Gc1.22, Gc1.12) soils of the plain and corridor areas. There is some variation throughout this unit but data are limited. Occurs on sheet(s): 10"
"BA1"

"Rocky ranges and hills of granulite (metamorphic) rock: chief soils are shallow stony sands and sandy loams (Uc1.43). Associated are red earths (Gn2.12, Gn2.13) on the gentler slopes and in flatter areas between ridges. As mapped, small areas of unit DD14 are probably included. Occurs on sheet(s): 5,10"
"BA2"
"Mountainous sandstone country with narrow valleys cut into basalt: main soils are shallow sands (Uc1.42) with rock outcrop in elevated areas. Associated are (Dy5.42) soils in swampy depressions; some ironstone gravels (KS-Uc4.2) on broad plains; (Gn3.11 and Gn3.12) soils on basalt with shallow (Um5) soils on steep basalt slopes. Occurs on sheet(s): 9"
"BA3"
"Rugged stony country--ridges, cuestas, and plateaux--formed in sandstone, quartzite, shale, and some limestone; rock outcrops are common: chief soils are shallow, often stony, sands and sandy loams (Uc1.43) and (Uc4.1), also some loams (Um4.1). There are also small areas of shallow, often stony, (D) soils such as (Dr3.21) and (Dy2) on mid and lower slopes; small areas of (Gn2) soils such as (Gn2.1); and (Gn2.2) and (Gn2.4) occur in inter-ridge areas. Small valleys of various (D) soils such as (Dy2.33), (Db1.43), and (Dr2.33) may be present locally. Occurs on sheet(s): 8,9"
"BA4"
"Rugged sandstone hills and plateaux, with many sandstone outcrops: chief soils are shallow, often stony, sands and sandy loams (Uc1.43) and (Uc4.1) with areas of shallow, often stony, (D) soils such as (Dr3) and (Dy2). Other soils include (Uc1.23) and (Uc5.21), and possibly some (Gn2) soils. Occurs on sheet(s): 8,9"
"BA5"
"Stony hills and ranges largely derived from sandstone and having flanking sand plains: chief soils are pockets of shallow stony sands and sandy loams (Uc1.43) and (K-Uc1.43) among the sandstone outcrops. Associated are small areas of red earthy sands (Uc5.21) on the gently sloping plains and valley floors. Other soils include (Gn2) soils such as (Gn2.2) on the valley floors. Occurs on sheet(s): 8,9,10"
"BA6"
"Rugged stony country--ridges, cuestas, and plateaux with some sloping or low hilly dissected areas on sandstone, quartzite, shale, and some limestone; many rock outcrops: chief soils are shallow sandy, often stony, soils (Uc1.43) and (Uc4.1) together with shallow, often stony, loamy soils (Um4.1 and Um4.2). Associated are shallow, often stony (Dr2.11, Dr2.12, Dr2.13) and (Dy2.21 and Dy2.22) soils on all slopes and commonly in complex with the (U) soils. Valley plains are narrow and of limited extent; some have (Dr2.12, Dr2.13), and other (D) soils as for unit Qal8, and some (Uc1.21, Uc1.22, and Uc1.23) soils. Other minor soils are (Gn2.1) and (Gn2.2). As mapped, small areas of adjoining units are included locally. Occurs on sheet(s): 8,9"
"BA7"
"Rough rocky hills and dissected plateaux developed on greywacke, sandstone, and conglomerate; scarps, cliffs, and gorges are a feature; large areas of bare rock are common: chief soils are shallow sands such as (Uc1.4) and (Uc4.1). Other soils include (Uc2.12), (Um1.4), (Um4.1), (Uc4.2); (Uc1.2) on sandy fans; (Dy5.8) on very gentle slopes; some (Gn2) soils; and possibly other soils such as (Gn3.12), (Ug5), and (Um6) on included basalts. Occurs on sheet(s): 8"
"BA8"
"Ranges and/or prominent ridges developed mainly on sandstones, siltstones, and shales; rock outcrops are common; narrow valleys: chief soils are shallow sands and sandy loams (Uc1.4), (Uc4.1), and (Uc4.2). Small areas of units AC13 and BY1 are included. The soils of the valleys have not been described. Occurs on sheet(s): 8"
"BA9"
"Mature dissected plateau on sandstone, marginally with locally produced "castle" topography; large areas of bare rock; some narrow valleys: chief soils are a variety of shallow sands, often gravelly and stony, such as (Uc1.4), (Uc4.1), and (Uc4.2). Other soils may occur. There are small inclusions of the soils common to units My76 and JJ31; and also narrow valleys of unit Mb15. Occurs on sheet(s): 8"
"BA10"
"Dissected sandstone plateau of high, stony, often steep-sided hills; large areas of bare rock outcrop: chief soils are shallow gritty and stony sands such as (Uc1.4), (Uc1.2), and (Uc4.1). Other soils may occur. Occurs on sheet(s): 8"
"BA11"
"Low stony or gravelly ridges and uplands on sandstones, quartzites, greywacke, and siltstones with small flanking plains: chief soils are shallow stony and/or gravelly sands (Uc1.43) and (K-Uc1.43). Associated soils are (KS-Uc5.21) on gravel ridges; (Uc5.21) on flats; (Gn2.12) and (Gn2.21) on plain areas; and some (Uc1.23) in alluvial areas. Occurs on sheet(s): 8,10"
"BA12"
"Dissected plateaux, mesas, and buttes on sandstone, siltstone, and conglomerate; very extensive rock outcrop; some narrow drainage-ways: chief soils are shallow stony and/or gravelly sands and sandy loams (Uc1.43) and (K-Uc1.4). Small areas of many other soils are likely, especially (Uc1.23) and (Uc5.21). Occurs on sheet(s): 8,10"

"BA13"
"Flat-topped but often steep-sided hills and ranges on sandstones, siltstones, and shales; many rock outcrops; some gently sloping areas and valleys: chief soils on the hill slopes are stony sands and loams, such as (Uc1.4) (Uc1.2), (Uc2.12), (Um1.4), and (Um4.1). Associated are small areas of (Uc1.23), (Uc5.21), (Gn2), and some stone-covered (Dr1.33) and (Dr1.43) soils on lower slopes and in valleys. Small areas of unit My80 may be included. Occurs on sheet(s): 8,10"
"BA14"
"Dissected sandstone plateau often of hilly relief; bare rock outcrops common; narrow steep-sided valleys. Chief soils are a variety of shallow, often gravelly and stony, sands (Uc1.4), (K-Uc1.4), (Uc4.2), and ~K-Uc4.1). Small flat-topped remnants of units Cd25 or My78 occur on some drainage divides. Small areas of adjoining units are included locally. Occurs on sheet(s): 8"
"BA15"
"Rugged ridges, domes, hills, cuestas, and plateaux mainly on sandstones; some granites, bare rock slopes, and steep-sided gorges: chief soils are a variety of shallow, often gravelly and stony, sands (Uc1.4), (K-Uc1.4), (Uc4.1), (Uc4.2), and (K-Uc4.1). Some lateritic remnants including (KS-Uc) soils occur on drainage divides. Small areas of units JJ34, JJ35, JJ36, and Fz23 are included locally. Occurs on sheet(s): 8"
"BA16"
"Ridges with steep scarp slopes developed on sandstones and including some rounded hills on volcanic rocks: chief soils are shallow, often gravelly and stony, sands (Uc1.4), (K-Uc1.4), (Uc4.1), and (K-Uc4.1). Small areas of other soils including the soils of unit JK17 are likely. Occurs on sheet(s): 8"
"BA17"
"Flat-topped but sometimes steep-sided hills with extensive areas of bare rock--sandstones and other sedimentary rocks, but including some volcanics: chief soils are shallow stony sands and sandy loams (Uc1.43) and (Uc1.23). Associated are probably some (Uc5.2) and (Gn2.1) soils on flanking slopes and plains. Dunes of red sands (Uc1.23) transgress some areas, and areas of unit MY4 may be included in the more easterly occurrences of this unit. Occurs on sheet(s): 10"
"BA18"
"Hilly areas on sedimentary rocks and with much bare rock exposed: chief soils are probably shallow stony sands and sandy loams (Uc1.43) and (Uc1.23). Other soils may occur. Occurs on sheet(s): 10"
"BA19"
"Hilly to steep hilly ranges on quartzite with much bare rock: chief soils are shallow stony sands, sandy loams, and sandy clay loams (Uc1.43) and (Um1.43). Other soils include (Um5.3) and shallow (Gn2.12), underlain by a red-brown hardpan on lower slopes and drainage floors. Variable gravel and stone pavements are common. Occurs on sheet(s): 10"
"BA20"
"Stony hills of quartzite and sediments with flanking pediments and valleys; lateritic duricrust caps some hills: chief soils are shallow stony sands (Uc1.43) and gravels (KS-Uc5.21) and (K-Uc1.43) on the hills where there are frequent rock outcrops. Associated are (Uc5.21) in the valleys, with lesser areas of (Gn2.11, Gn2.12) soils. Occurs on sheet(s): 10"
"BA21"
"Steep hills and ranges on sedimentary and some metamorphic, volcanic, and granitic rocks; bare rock outcrop is common; some gorges: chief soils are probably shallow and often stony sandy loams and sandy clay loams (Uc1.43) and (Um1.43) on the hill slopes. Other soils including deeper forms of (Uc1.43), (Uc5.21), and (Gn2.12) occur on the pediments and narrow valley plains. Occurs on sheet(s): 10"
"BA22"
"Hills and plains on granites; tors common; also some gneissic ridges; extensive areas of bare rock; chief soils are shallow stony sands (Uc1.43) and (Uc1.23) on the slopes and ridges. Associated are (Gn2.1), (Uc5.21), (Uc1.23), and some (Dr1) soils on the plains and areas of gentler relief. Occurs on sheet(s): 10"
"BA23"
"Hilly to undulating ridges and ranges on sandstone and quartzite; rock outcrops common; narrow valleys: chief soils are shallow stony sands (Uc1.43) often mantled by stones. Only minor areas of other soils such as (Uc5.21) occur. Occurs on sheet(s): 10"
"BA24"
"Hills and ridges of greywacke and schist, with their flanking plains: chief soils are the shallow stony sands (Uc1.4) and (Uc1.2) of the hills and ridges. Associated are (Uc5.21) and (Gn2.12) soils on the plains. Occurs on sheet(s): 10"
"BA25"
"Steep ranges and ridges with narrow valleys on sandstones, quartzites, and conglomerates; considerable areas of bare rock outcrop; chief soils are shallow stony sands (Uc1.4) and (Uc1.2). Minor areas of other soils including (Gn2.12) and (Uc5.21) occur. Occurs on sheet(s): 10"

"BA26"
"Steep narrow ranges on sandstones and quartzite with some shales; extensive areas of bare rock: chief soils are shallow stony sands (Uc1.43). Associated are (Gn2.1) and (Dr1) soils in intervening vales. Occurs on sheet(s): 10"
"BA27"
"Bold ranges, ridges, cuestas, and hills on sandstones and quartzites; extensive areas of bare rock: chief soils are shallow stony sands (Uc1.43). Associated in areas of gentler relief are a variety of soils including (Uc5.21) (Gn2.12), (Dr1.33), (Dr1.42), and deep (Uc1.43). As mapped, areas of unit BA42 are included. Occurs on sheet(s): 10"
"BA28"
"Bold ranges similar to unit BA27 but including broad areas of sandstone plateaux; very extensive areas of bare rock: chief soils are shallow stony sands (Uc1.43). Small areas of other soils are associated in areas of gentler relief as for unit BA27. Occurs on sheet(s): 10"
"BA29"
"Rugged mountain ranges on gneisses and schists; some basic intrusives; some bold quartzite and sandstone ridges; very extensive areas of bare rock; only small valley plains: chief soils are shallow stony sands (Uc1.43). Associated in the valleys are small areas of a variety of soils including deep (Uc1.43), (Um1.43), and (Gn2.1). As mapped, areas of unit BA42 are included. Occurs on sheet(s): 10"
"BA30"
"Low but bold rocky hills on gneiss and schist with intervening valley plains: chief soils are shallow sands (Uc1.43) and loams (Um1.43), with frequent rock outcrops. Associated are (Gn2.12), (Uc5.21), and deep (Uc1.43) soils in the valleys; and (Dr1.33), (Gn2.12), and (Uc1.31) soils on foot slopes. Occurs on sheet(s): 10"
"BA31"
"Hilly to strongly undulating ridges of sandstone, chert, dolomite, and siltstone with their flanking plains; frequent rock outcrop: chief soils are shallow stony sands (Uc1.4) and (Uc1.2), with (Uc5.21) on the flanking plains. Included are (Uc1.23) on occasional dunes. Occurs on sheet(s): 10"
"BA32"
"Granitic hills with extensive rock outcrop and intervening sandy plains: chief soils are the shallow stony sands (Uc1.43) and (Uc1.2) of the hills. Other soils include (Gn2.12, Gn2.11), (Uc5.21), and other (Uc) soils on the plains. Occurs on sheet(s): 10"
"BA33"
"Generally broken country, sometimes hilly, with some areas of steep and rugged relief; rock outcrop common: chief soils are shallow stony sands (Uc1.43) and other shallow (Uc) soils on the steeper areas generally. Associated are (Gn2.12, Gn2.13) soils on undulating areas; (Dr1.33) soils on pediments; and (Dr1.33) and (Ug5.3) soils in some valleys and lower slopes. Occurs on sheet(s): 10"
"BA34"
"Ranges and undulating plateaux on granitic rocks; rock outcrop is extensive: chief soils are shallow stony sands (Uc1.43) and (Uc1.23). Associated are (Uc5.21) and (Gn2.12) on flanking plains. Small areas of other soils are likely, especially in proximity to inclusions of basic rocks. Occurs on sheet(s): 10"
"BA35"
"Hilly sandstone ridges, mainly of bare rock with only pockets of soil: chief soils are shallow sands (Uc1.43) and (Uc1.23). Small areas of other soils may occur. Occurs on sheet(s): 10"
"BA36"
"Sandstone ridges in part transgressed by dunes; bare rock is extensive: chief soils are the shallow sands (Uc1.43) on the ridges and the (Uc1.23) sands of the dunes. Occurs on sheet(s): 10"
"BA37"
"Ranges and hills mainly on granitic rocks; rock outcrop is extensive: chief soils are shallow sands (Uc1.43) and (Uc1.23). Small areas of other soils occur, including (Uc5.21) on pediments and small plains. Occurs on sheet(s): 10"
"BA38"
"Sandstone ridges with much bare rock: chief soils are probably shallow sands (Uc1.43). Small areas of other soils are likely. Occurs on sheet(s): 10"
"BA39"
"Hilly lands on calcareous and quartzose conglomerates with very narrow valleys: chief soils are shallow stony soils, notably (Uc1.4), (Uc1.3), and (Um5); calcretes (kunkar) may occur below the soils. Small areas of other soils are likely. Occurs on sheet(s): 10"
"BA40"
"Low dissected plateaux on limestone, siltstone, and sandstone: chief soils are shallow stony sands (Uc1.4) and (Uc1.3) and possibly some loams (Um5). Small fringing fans and plains of (Gn2.12) and (Uc5.21) soils occur. Occurs on sheet(s): 10"
"BA41"

"Low sandstone plateaux; rock outcrops are fairly common: chief soils are shallow sands (Uc1.43). Small areas of other sand soils including (Uc5.21) occur in areas of gentler relief. Occurs on sheet(s): 10"
"BA42"
"Rugged mountain ridges, plateaux, and low hilly areas on limestone, dolomite, calcareous sandstones, siltstones, and sandstones; narrow valleys; some small plains; extensive rock outcrop: chief soils are shallow stony sands and loams (Uc1.43), (Uc1.3), and (Um5.51). Small areas of other soils, notably (Uc5.21) and (Gc) soils, may occur in areas of gentler relief. Small areas of unit My128 are included in eastern portions of this unit. Occurs on sheet(s): 10"
"BA43"
"Gently undulating stony plains on granite, schist, and gneiss with some low hills; some small sedimentary plains: chief soils are shallow stony sands (Uc1.43) and (Uc1.23) on the stony plains and hills. Associated are (Gn2.12, Gn2.13) and (Uc5.21) soils on the sedimentary plains. Occurs on sheet(s): 10"
"BA44"
"Broken terrain on dolomite, limestone, shale, and sandstone; rock outcrop is common: chief soils are shallow stony sands (Uc1.43), (Uc1.23), with some deeper varieties of (Uc1.43). Associated are (Gn2.12, Gn2.13), (Uc5.21), and (Gc) soils in valley areas. Inclusions of unit BA45 are likely. Occurs on sheet(s): 10"
"BA45"
"Low sandstone hills and broken limestone terrain; rock outcrop is common: chief soils are shallow stony sands (Uc1.43) and (Uc1.23). Associated are deep (Uc1.43) and (Uc5.21) soils in small valleys and plains. Occurs on sheet(s): 10"
"BA46"
"Hilly to undulating ridges transgressed by sand dunes on sandstone, shale, and claystone; some stoneand gravel-mantled areas: chief soils are probably shallow stony sands (Uc1.43) and (Uc1.2). Associated are (Dr1.33, Dr1.32, and Dr1.43) soils with stone mantles; and deep (Uc1.23) sands on the dunes. Other soils include (Uc5.21). Occurs on sheet(s): 10"
"BA47"
"Ridges in part covered with silcrete boulders and stones: chief soils are shallow stony sands (Uc1.43) and other shallow soils. Associated are (Uc5.21) and (Gn2.12) soils on slopes and flanking plains. Occurs on sheet(s): 10"
"BA48"
"Hills and ranges on schist, gneiss, quartzite, and a variety of other rocks: chief soils are shallow stony sands (Uc1.43) and possibly loams (Um1.43) and (Um5.11). Associated are possibly small areas of other shallow soils and also some (Dr1.33) and (Dr1.13) soils on pediments and tableland remnants. Occurs on sheet(s): 10"
"BA49"
"Low hilly terrain on granite with much rock outcrop: chief soils are shallow stony sands and sandy loams (Uc1.43) on the ridges and upper slopes. Associated are small areas of other soils including (Dr2.52) on lower slopes. Occurs on sheet(s): 10"
"BA50"
"Hilly terrain on quartzites, siltstones, and slates with some basic dykes and areas of basalt; rock outcrop is common; quartz gravel covers the surface in some places: chief soils are shallow sands and sandy loams (Uc1.43) and loams (Um1.43). Associated are other shallow soils including some (Dr1.3) soils on slopes and pediments. Occurs on sheet(s): 10"
"BA51"
"Ranges mainly on sandstones; there are some scarps, cliffs, pediments, and terraces; rock outcrops are common: chief soils are shallow sands and sandy loams (Uc1.43) and loams (Um1.43). Associated are (Dr1.33) and (Ug5.3) soils on pediments, and (Gn2.13) and (Gc1.12) soils on flatter sandy areas. Other soils may occur. Occurs on sheet(s): 10"
"BA52"
"Ranges with extensive rock outcrop mainly of sandstone, but a variety of other rocks including schists, phyllites, and quartzites occur; soils are typically shallow and sandy; valleys are narrow: chief soils are shallow sands (Uc1.43). Associated are (Um1.43) soils in some areas, and deep (Uc1.43) sands in the valleys. Small areas of a variety of other soils may occur. Occurs on sheet(s): 10"
"BA53"
"Hills and ranges with rock outcrop mainly of sandstone; valleys are generally narrow and sandy: chief soils are shallow sands and sandy loams (Uc1.43) and loams (Um1.43). Associated are pediments and slopes of unit Nb31. Other soils may occur. Occurs on sheet(s): 10"
"BA54"
"Hilly ranges on quartzite and shales: chief soils are probably shallow sands and sandy loams (Uc1.43) and possibly some loams (Um1.4). Red earths (Gn2.12) are likely to be associated in areas of gentler topography. Occurs on sheet(s): 10"
"BB1"

"Hills and plains: hills and ranges of rock outcrops and shallow calcareous loamy soils (Um5.11), and possibly other shallow soils including shallow varieties of (Dr1.32); flanked by pediments of crusty loamy soils (Dr1.13), (Dr1.33), and (Dr1.43); and interspersed by plains of brown calcareous earths (Gc) with saline soils (unclassified) in the lower-lying situations; some flood-plains of (Dr4.72) soils; some outwash plains of (Dr2.33) soils; a few dune tracts of brown sands (Uc5.11, Uc5.12). Occurs on sheet(s): 1,10"
"BB2"
"Hills, dissected tablelands, and valleys: hills of shallow calcareous loamy soils (Um5.11); crusty loamy soils (Dr1.13 and Dr1.33) on tableland remnants; and small valleys of crusty loamy soils (Dr1.33 and Dr1.43) with brown calcareous earths (Gc). Occurs on sheet(s): 1"
"BB3"
"Hills and ranges with extensive areas of rock outcrops and shallow calcareous loamy soils (Um5.11) with shallow dense loamy soils (Um5.41) and smaller areas of shallow porous grey loamy soils (Um6.22) and shallow porous brown loamy soils (Um6.23), also shallow hard alkaline red soils (Dr2.23); interspersed with pediments and small basin plains of hard alkaline red soils (Dr2.23) or crusty loamy soils (Dr1.33) or brown calcareous earths (Gc); and with various alluvial and colluvial soils (unclassified) in the valleys. Occurs on sheet(s): 1,10"
"BB4"
"Ranges of greenstones (basic igneous rocks) with some rock outcrops: the soils are shallow calcareous loamy soils (Um5.11) on the steeper slopes with cracking clays (Ug5.37) and (Ug5.2) on the more moderate slopes. Associated are the soils of unit MM15, some areas of which may be included. Data are limited. Occurs on sheet(s): 5"
"BB5"
"Rocky ranges and hills of greenstones--basic igneous rocks: chief soils seem to be shallow calcareous loamy soils (Um5.11) and similar soils such as (Um5.41) and (Um1.43) in Sheet 10 areas, with shallow brown and grey-brown calcareous earths (Gc1.12) and (Gc1.22) below which weathered rock occurs at shallow depths. Associated soils are not described but may include alkaline red earths (Gn2.13) and narrow valleys with (Ug5.38) soils in Sheet 10 areas. Occurs on sheet(s): 5,10"
"BB6"
"Undulating plain with some granitic tors and bosses, some salt pans and clay pans: chief soils are calcareous loams (Um5.11). Associated are some calcareous earths (Gc1.12) and red earths (Gn2.12) around the granitic bosses and tors. This unit is transitional between units DD14 and BB7. Occurs on sheet(s): 5"
"BB7"
"Very gently undulating plain with calcrete (kunkar) at shallow depth. Alternating broad, low, often rubbly ridges, and shallow flats both covered by calcareous loams (Um5.11) usually less than 12in. deep on the ridges and between 12 and 24 in. deep on the flats. Some patches of (Uc) soils on dunes adjacent to the coast are likely. Cliffs are a feature of a portion of the coastline. Data are limited. Occurs on sheet(s): 5,10"
"BB8"
"Undulating to low hilly areas associated with greenstones (basic igneous rocks): chief soils seem to be calcareous loams (Um5.11) and brown calcareous earths (Gc1.12) and (Gc1.22). Associated are microassociations of (Ug5.3) and (Dr2.33) soils with some gilgais in the relatively lower-lying sites. As mapped, soils of the adjoining units may be included. Occurs on sheet(s): 5"
"BB9"
"Narrow plain associated with the major river systems, usually occurring upstream of unit Oc47 and characterized by frequent outcrops of calcrete (kunkar): chief soils are probably brown calcareous loams (Um5.11) and calcareous earths (Gc1.12) and (Gc2.21). There are frequent inclusions of (Dr1) and (Dr2) soils of unit Oc47 and some (Gn2) soils associated with adjoining units, especially (Gn2.13) in Sheet 10 areas. Occurs on sheet(s): 6,10"
"BB10"
"Narrow coastal plain flanking unit Fy2; some saline flats and a few sand dunes: chief soils appear to be shallow loams on limestone (Um5.11) and (Um5.5 l) with sands (Uc5.11) also overlying limestone. There are some red sands (Uc5.1) in dunes and a coastal fringe of recent shelly sand (Uc1.11). Occurs on sheet(s): 6"
"BB11"
"Flat-topped residuals capped by calcrete (kunkar) and opaline silica of the Oakover formation: chief soils are shallow alkaline loams (Um5.11) along with red earths (Gn2.12). Occurs on sheet(s): 6,10"
"BB12"
"Rocky limestone ranges with broad valley floors; mainly rock outcrop on hill tops and upper slopes: chief soils are shallow calcareous loams (Um5.11) on lower slopes. Associated are (Ug5.24) soils with gilgai formation along valley floors. Occurs on sheet(s): 9"
"BB13"
"Undulating limestone and shale country with scattered low hills; mainly rock outcrop on hill tops and upper slopes: chief soils are shallow calcareous loams (Um5.11) with (Um6.3) and (Gc2) soils with much loose limestone. Plain areas have (Ug5.25) soils with much loose limestone. Occurs on sheet(s): 9"
"BB14"

"Low hilly to undulating dissected limestone country with some steep low hills and ridges separated by deeply incised stream channels; limestone outcrops are extensive: chief soils are probably shallow calcareous loams (Um5.11) on upper slopes of dissected areas with shallow red loams (Um6.24) on crests among limestone outcrops. Associated are (Um6.33) soils on the gentler mid slopes and some (Ug5.2) soils on lower slopes and in valleys. Loose stone forms an extensive surface cover. Occurs on sheet(s): 8,9"
"BB15"
"Undulating to low hilly limestone country with scattered outcrops and boulders of limestone: chief soils are shallow calcareous loams (Um5.11) on gently undulating areas with smaller areas of other shallow (Um) soils. Some areas of grey and brown cracking clays (Ug5.2 and Ug5.3) occur on gentle lower slopes. Occurs on sheet(s): 8,9"
"BB16"
"Gently sloping but uneven plains derived from limestone which outcrops irregularly: chief soils are calcareous loams (Um5.1 l) on gently sloping surfaces. Other soils include (Um6.33), sometimes covered by stones on gentle to moderate slopes; various (Ug5) soils such as (Ug5.14) and (Ug5.26) on gentle slopes and in narrow depressions; small pockets of shallow (Um6) soils on short irregular slopes of limestone benches; and some small areas of (Gn2.1) and (Gn3.13) soils. Occurs on sheet(s): 8"
"BB17"
"Uneven rough calcrete (kunkar) plains with small salt lakes and pans broken by variable proportions of longitudinal sand dunes and occasional low rises or hills: chief soils on the calcretes are probably calcareous loams (Um5.11) together with some brown calcareous earths (Gc1), with red earthy sands (Uc5.21) on the sandy areas. Other soils include (Uc1.23) on the dunes and shallow and sometimes gravelly (Uc) soils on the low rises and hills. Occurs on sheet(s): 10"
"BB18"
"Small valley plains with calcrete (kunkar) platforms; some small clay pans and salt pans: chief soils are calcareous loams (Um5.11) on the calcrete platforms with (Gn2.13) soils marginal to them. Small areas of soils of the adjoining units may occur. Occurs on sheet(s): 10"
"BB19"
"Valley plains with frequent outcrops of calcrete (kunkar); small lakes, clay pans, and salt pans: chief soils are probably calcareous loams (Um5.11), possibly with some (Gc) soils. Other soils include (Gn2.13), and (Dr1.33) and (Dr1.43) on the plains flanking the calcrete areas. Small areas of soils of the adjoining units may occur. Occurs on sheet(s): 10"
"BB20"
"Plains with low limestone ridges; moderate outcrop; thin stony pavements: chief soils are probably shallow calcareous loams (Um5.11). Associated are probably some (Ug5) soils with incipient gilgai in lower sites, and other shallow (Um) and (Uf) soils. Occurs on sheet(s): 10"
"BB21"
"Valley plains with a variety of soils: chief soils are probably shallow calcareous loams (Um5.11) associated with the calcrete (kunkar) platforms, together with sandy crusty loamy soils (Dr1.33) and (Dr1.43), also (Dr2.33) soils on the saline flats. Other soils include (Gn2.12) and (Um5.3) in marginal areas and the sands of unit B39. Occurs on sheet(s): 10"
"BB22"
"Calcrete (kunkar) platforms: chief soils are shallow calcareous loams (Um5.11) and sands (Uc1.3) and (Uc1.4) on the calcrete. Associated are (Gn2.13, Gn2.12) on drainage floors and (Uc5.21) on inclusions of sand plain. Occurs on sheet(s): 10"
"BB23"
"Plains on calcrete (kunkar) with stony calcrete rises: chief soils are calcareous loams and sands (Um5.11) and (Uc1.3). Associated are variable proportions of (Uc5.21), (Gn2.12), and (Dr1) soils. Occurs on sheet(s): 10"
"BB24"
"Plains on calcrete (kunkar); occasional salt pans: chief soils are shallow calcareous loams (Um5.11), with (Uc1.3) and (Gc) soils on the stony calcrete rises. Associated are sandy areas of (Uc5.21) and (Gn2.12) soils. Other soils may include (Gn2.13), (Um1.43), and (Uc1.43). Occurs on sheet(s): 10"
"BB25"
"Plains on dolomitic limestones and calcrete (kunkar); occasional dunes; occasional rock outcrops: chief soils are shallow calcareous loams (Um5.11) on the more rubbly areas, with shallow (Um1.43) and (Uc1.43) soils overlying hard calcrete and limestone. Other soils include (Uc1.23) on dunes and possibly some (Gn2.13) and (Uc5.21) soils. Occurs on sheet(s): 10"
"BB26"
"Low hilly to undulating limestone country: chief soils are shallow calcareous loams and sands (Um5.11) and (Uc1.3), together with some (Um5.51) soils. Associated on areas of gentler relief are (Gc1.22) and (Gc2.12) soils. Occurs on sheet(s): 10"

"BB27"
"Low hilly to undulating limestone country similar to unit BB26 but with areas of (Gn2.13) and (Dr1.33) soils. Occurs on sheet(s): 10"
"BB28"
"Low limestone plateaux; rock outcrop is common: chief soils are shallow stony loams and sands (Um5.11) and (Uc1.3). Small areas of other soils occur, including (Gc) soils on plateau areas of gentle relief; (Ug5.3) and (Dr1.33) with variable gravel pavement; and (Gc) soils in small valleys and plains. Occurs on sheet(s): 10"
"BB29"
"Gently undulating to undulating plains with many low limestone ridges with much outcrop: dominant soils of the higher landscape sites are very shallow highly calcareous gravelly loams (Um5.11), with other similar loams (Um5.61) and (Um1.3) also associated. In lower sites, particularly adjacent to drainage lines, loamy red earths (Gn2.13) and red duplex soils (Dr2.33) and (Dr2.43) are common. Data are fairly limited. Occurs on sheet(s): 10"
"BB30"
"Strongly undulating to low hilly lands, mostly with rounded crests and moderate benched slopes; limestone outcrop is very common: dominant soils are very shallow calcareous loams (Um5.11), with other similar calcareous loams (Um5.61) and (Um1.3) often associated. On flatter sites calcareous earths (Gc1.22), (Gc1.12), and (Gc2.22) are common. Data are fairly limited. Occurs on sheet(s): 10"
"BB31"
"Undulating broad low ridge and valley terrain with some higher narrow ridges mainly on limestones and shales; rock outcrops; stone and gravel mantles in places: chief soils are shallow calcareous loams (Um5.11) and earthy loams (Um5.51). Associated are (Gc2.12) and (Gc1.22) soils on areas of gentler relief and (Uc1.3) soils on areas of stronger relief. Other soils include various (Dr1) soils and (Uc5.21) and (Gn2.1) soils locally. Occurs on sheet(s): 10"
"BB32"
"Ranges and hills with extensive rock outcrop and shallow soils; stony pediments and small basin plains; some remnants of stony downs; narrow valleys, some with gorges: chief soils are shallow calcareous loamy soils (Um5.11) and other shallow soils such as (Um5.41), (Um1.43), and possibly some (Um6) soils. There are small areas of a wide range of soils, including (Dr1.33) and (Ug5.3) on stony downs remnants and pediments; (Dr2.33) and (Gc) soils on plains; and (Um5.12) and other (Um) and (Uc) soils in the valleys. Occurs on sheet(s): 10"
"BB33"
"Dissected low tablelands with mesas and buttes; some seasonal swamps; clay pans; valley plains: chief soils are shallow calcareous loams (Um5.11) on upland plains and mesas and buttes. Associated are (Gc) soils, especially (Gc1.12). There are small valleys similar to unit Mx39. Occurs on sheet(s): 10"
"BB34"
"Gently undulating terrain on limestone, probably with calcrete (kunkar). There are many almost circular depressions often joined together by other narrow linear depressions: chief soils are the shallow calcareous loams (Um5.11). Associated are (Gn2.12, Gn2.13) and possibly some (Uc5.21) soils in the circular depressions. Occurs on sheet(s): 10"
"BB35"
"Uneven plains on limestone, probably with calcrete (kunkar): chief soils are the shallow calcareous loams (Um5.11) of the slightly raised portions of the plain. Associated are the shallow (Gc1.12) and (Gc1.22) soils of the slightly depressed portions of the plain. Occurs on sheet(s): 10"
"BB36"
"Gently to very gently undulating plain on limestone of low broad rises alternating with broad flats. Calcrete (kunkar) is often present at a shallow depth: chief soils are shallow calcareous loams (Um5.11) that occur on the low broad rises along with much limestone rubble. Associated brown calcareous earths (Gc1.12) and (Gc1.22) are the dominant soils on the broad flats. Occurs on sheet(s): 10"
"BB37"
"Very gently undulating plain on limestone with calcrete (kunkar) at shallow depths: chief soils are shallow calcareous loams (Um5.11) between the limestone outcrops. Some brown calcareous earths (Gc1.12) and (Gc1.22) occur on lower flats but are not as common as in unit BB36. There are minor areas of red cracking clays (Ug) in small depressions. Occurs on sheet(s): 10"
"BB38"
"Undulating terrain on limestone, probably with calcrete (kunkar): chief soils are probably shallow calcareous loams (Um5.11). Associated are some (Gc1.12) and (Gc1.22) soils. Occurs on sheet(s): 10"
"BB39"
"Prominent ridges of basic rocks: chief soils are probably shallow calcareous loams (Um5.1 l) and other (Um) soils on the steeper slopes. Associated soils may include (Gc1.12) and (Gn2.13, Gn2.12) on gentler slopes, and (Ug5.3) clays in subjacent flats and depressions. Occurs on sheet(s): 10"
"BB40"

"Gently undulating tableland, or cuesta, on limestone, probably with calcrete (kunkar) and bounded by a scarp on its southern limits; some outcropping limestone; numerous clay pans: chief soils are probably shallow calcareous loams (Um5.11) with brown calcareous earths (Gc1.12) and (Gc1.22). Other soils may occur. Data are very limited. Occurs on sheet(s): 10"
"BB41"
"Rough undulating terrain on limestone, probably with calcrete (kunkar); outcrops are common: chief soils are shallow to very shallow calcareous loams (Um5.11). Other soils may occur. Data are limited. Occurs on sheet(s): 10"
"BC1"
"Riverine plains, terraces, and fans: chief soils are deep, red-brown loamy sands and clayey sands (Uc1.43). Associated are (Dr2.42) soils and small areas of other soils such as (Gn2.15), (Db1.23), and (Uc1.2). There are also some gravel deposits. Occurs on sheet(s): 5"
"BC2"
"Riverine plains: chief soils are red compact siliceous sands (Uc1.43) with a variety of other (Uc) soils, such as (Uc5.32), and including some dunes of (Uc1.23) and seasonally flooded areas of (Uc3.21). Small areas of a variety of other soils occur, including (Gn2.12), (Uc5.21), (Dr1.43), and (Db0.43). Occurs on sheet(s): 10"
"BC3"
"Levees flanking river courses: chief soils are sands (Uc1.43) and (Uc5.32), with some (Gn2.13) and (Um5.2) soils. Occurs on sheet(s): 10"
"BC4"
"Riverine plains with very narrow terraces in places: chief soils are red compact siliceous sands (Uc1.43) and other (Uc) soils including (Uc5.32). Associated on the terraces are various loamy soils including (Um1.3), other (Um), and possibly some (Gc) soils. Occurs on sheet(s): 10"
"BD1"
"Plains and levees, usually of small extent, flanking the main rivers: chief soils are recent loams (Um5.2, Um5.12), and sands (Uc5.32) close to the rivers; red earths (Gn2.13), (Dr4.13) soils, and light clays (Uf1.3) on more eroded areas. Occurs on sheet(s): 6"
"BD2"
"Terraces and levees flanking the main rivers: dominant soils are (Um5.2) but other soils of some importance are (Uc5.32) and (Gn2.13); while (Uc1.22) soils occur on the youngest terraces and there are limited areas of (Dr) soils. Occurs on sheet(s): 6"
"BD3"
"Steep dissected ranges on limestone, including areas of hard calcarenite; rock outcrop is common: chief soils are shallow loams (Um5.2) overlying limestone and there are also (Um1.1) soils and small areas of red sands (Uc5.21) and (Uc1.23). As mapped, areas of adjoining units are included. Occurs on sheet(s): 6"
"BE1"
"Generally undulating terrain on sedimentary rocks with mesas, buttes, low ironstone gravel ridges, block laterite, and a surface gravel pavement: chief soils seem to be shallow earthy loams (Um5.3) and shallow red earths (Gn2.12) both underlain by a red-brown hardpan at shallow depths (8-30 in.). Occurs on sheet(s): 5,6"
"BE2"
"Generally undulating terrain on granites with rocky granitic hills, bosses and tors, some breakaways, and a surface stone mantle: chief soils seem to be shallow earthy loams (Um5.3) underlain by a red-brown hardpan. Associated are shallow (Uc5.21 and Uc5.22) soils both underlain by a red-brown hardpan; some (Gn2.1) soils underlain by a red-brown hardpan; and shallow (Uc1.43) and (Um5.41) soils on the hills (no hardpan). The red-brown hardpan is often exposed in eroded sites and elsewhere is present between 8 and 40 in.. Occurs on sheet(s): 5,6,10"
"BE3"
"Broken slopes and ridges characterized by breakaways, generally on gneissic granites and allied rocks; ironstone gravel pavement variably present: chief soils seem to be shallow earthy loams (Um5.3) with some shallow (Gn2.12) soils, both underlain by a red-brown hardpan. Associated are a variety of (Dr1) soils, such as (Dr1.32), (Dr1.42), and (Dr1.82), and (Dr1.73) on outwash areas below the breakaways--these soils are often only 6-15 in. deep; some (Um5.11) and (Gc1.12) soils on calcrete (kunkar) platforms between shallow drainage-ways on the outwash areas below the breakaways; some (Um) and (Dr2.32) soils on pediments; and much mottledand pallid-zone material along the slope of the breakaway with some block laterite. Occurs on sheet(s): 5,6,10"
"BE4"
"Low granitic ranges and breakaways: chief soils seem to be shallow earthy loams (Um5.3) underlain by a redbrown hardpan. Portions of this unit are similar to unit BE2 and these areas are interspersed with breakaways similar to unit BE3. Occurs on sheet(s): 5"
"BE5"
"Ranges and their pedimented slopes, generally on metasediments, with a scattered ironstone gravel pavement: chief soils seem to be shallow earthy loams (Um5.3) underlain by a red-brown hardpan at less than 12 in. depth and

which in places contains veins of CaC03. Associated are a variety of soils including (Gn2.11 and Gn2.12) on flatter ridge crests; shallow (Uc) and (Um) soils on slopes with rock outcrops and ironstone gravel banks; and various shallow (Dr1) soils such as (Dr1.82) on slopes showing some salinity. Occurs on sheet(s): 5"
"BE6"
"Extensive flat and gently sloping plains, which sometimes have a surface cover of gravels and on which redbrown hardpan frequently outcrops: chief soils are shallow earthy loams (Um5.3), with associated (Gn) soils of units My5O and Mz23 of Sheet 6. As mapped, there are inclusions of units Oc47 and BB9. Occurs on sheet(s): 6,10"
"BE7"
"Undulating pediments that may be partially dissected; country rock is principally gneiss; occasional breakaways and some low stony ridges of gneiss and quartz dykes; there may be a surface cover of gravels: dominant soils are earthy loams (Um5.3) overlying red-brown hardpan at a shallow depth. Other soils include (Gn2.11) and (Uc5.21) over red-brown hardpan and small areas of (Dr2.32), which may or may not be underlain by red-brown hardpan. Occurs on sheet(s): 6"
"BE8"
"Partially dissected pediments extending out from areas of unit Fa7; there may be a surface cover of gravels. Earthy loams (Um5.3) are dominant; (Gn2.11 and Gn2.12) with red-brown hardpan at shallow depth are also present as well as small areas of (Dr2.72) and (Dr2.52) soils. Occurs on sheet(s): 6,10"
"BE9"
"Plains dominated by earthy loams (Um5.3) with red-brown hardpan at shallow depth: there are also large areas of (Uf6.71) and (Ug5.37) soils in lower situations. Narrow zones of (Um5.11) soils on calcrete (kunkar) are adjacent to many of the creek lines. Occurs on sheet(s): 6"
"BE10"
"Plains with clay pans: earthy loams (Um5.3) are dominant along with areas of (Gn2.12) and (Uc5.21) soils on red-brown hardpan; and (Uf6.71) soils are associated with the clay pans. Occurs on sheet(s): 6"
"BE11"
"Dissected cuestas with silcrete-capped summits on mudstone, shale, and sandstone; stony and gravelly pavements are common; rock outcrop occurs on the steep escarpment and summit surfaces: chief soils are probably shallow earthy loams (Um5.3) and shallow red earths (Gn2.12) underlain by red-brown hardpan on the gentler slopes. Associated are (Um1.43) and (Uc1.43) soils on the steeper slopes. Occurs on sheet(s): 10"
"BE12"
"Broad gently undulating plateau ridges and pediments with extensive gravel pavements, some small sandy plains, and small tracts of longitudinal dunes: chief soils are shallow earthy loams (Um5.3) and shallow red earths (Gn2.12) underlain by a red-brown hardpan. Associated are (K-Uc5.21) soils on the plateau ridges; (Uc5.21) underlain by red-brown hardpan on the sandy plainsand (Uc1.23) on the dunes. Small areas of units BY6 and AY2 may be included. Occurs on sheet(s): 10"
"BE13"
"Generally broken undulating terrain covered with silcrete stones and gravels, and with occasional sand dunes: chief soils are probably shallow earthy loams (Um5.3) and shallow red earths (Gn2.12) underlain by a redbrown hardpan. Associated are (Um5.51) soils on flatter areas; (Um1.43) on low stony ridges; (Dr1.3) soils on pediments; (Ug5.3) clays on small plains; and (Uc1.23) sands on dunes. Other soils may occur. Occurs on sheet(s): 10"
"BE14"
"Uneven undulating terrain with many small ridges, pediments, dissection slopes, and flats; silcrete boulders are common: chief soils throughout the sloping areas and upland plains are shallow earthy loams (Um5.3) below which red-brown hardpan occurs, and (Um5.51) soils with mottled rock below. Associated are (Gn2.12) and less commonly (Gn2.13), both underlain by red-brown hardpan on upland plains; and (Dr2.33) soils often underlain by red-brown hardpan on dissection slopes, pediments, and low-lying flat areas. Occurs on sheet(s): 10"
"BE15"
"Gently undulating to low hilly pediments with stony and gravelly pavements, and traversed by numerous seasonal streams: chief soils seem to be shallow earthy loams (Um5.3) with shallow red earths (Gn2.12), both underlain by red-brown hardpan. There are small inclusions of soils common to the adjoining units. Occurs on sheet(s): 10"
"BF1"
"Alluvial sandy plains with variable areas of sand dunes: chief soils of the plains are coherent calcareous sands (Uc1.31) and other deep sands (Uc1.43). Associated are variable areas of (Gn2.13, Gn2.12), (Uc5.21), and (Dr1.83) soils on the plains, sometimes underlain by calcrete; (Uc1.23) sands on the dunes; and (Um5.11) soils on calcretes. As mapped, small rugged hills of unit BA27 are included, especially in the southern portion. Occurs on sheet(s): 10"
"BG1"
"Valley plains, some of which have saline deposits: chief soils are calcareous loams (Um5.12) in association with (Gc) soils, especially (Gc1.12). Other soils occur. As mapped, small areas of adjacent units are included. Occurs on sheet(s): 10"

"BG2"
"Valley plains with some saline areas: chief soils are probably calcareous loams (Um5.12). Other soils may occur, including (Ug5.2) and (Ug5.5). Occurs on sheet(s): 10"
"BV1"
"Low hilly to hilly terrain on sandstone with many rock outcrops including some silcretes; some flat upland areas; irregular steep to moderate slopes; and narrow valleys: chief soils are stony and gravelly siliceous sands (K-Uc1.23). Associated are small areas of (Gn2.12) and (Uc5.21) soils on some flats and slopes; (Uc5.21) soils overlying laterite or ironstone gravel on small flat-topped ridges; (Uc1.23) soils in narrow southern valleys; and (Gn2.21) soils in narrow northern valleys. Some small inclusions of units AB30 and CC59 are likely. Occurs on sheet(s): 8"
"BX1"
"Dissected lateritic plateaux--mesas, buttes, and dissection scarps--formed on volcanic rocks and undifferentiated sedimentary rocks; often capped by lateritic materials including block laterite: chief soils are ironstone gravels with sandy (KS-Uc1.43) and earthy (KS-Gn3.12) and (KS-Gn2.12) matrices. Associated are gently undulating areas of (Ug5.38) soils, and some (Gn3.12) soils on mid and upper slopes in dissected areas. Occurs on sheet(s): 8,9"
"BX3"
"Lateritic residuals and their pediment slopes with small intervening valleys: chief soils are ironstone gravels in a sandy matrix (KS-Uc1.43) with much block laterite (vermicular type). Other soils include (Um5.3) on slopes and (Gn2.12) and (Uc5.21) in small valleys. Occurs on sheet(s): 10"
"BY1"
"Mesas on lateritized sediments; some laterite; exposures of mottledand pallid-zone materials: chief soils are shallow mixed gravels in sand and sandy loam matrices (K-Uc1.4), (K-Uc4.1), and ironstone gravels (KS-Uc1.4)and (KS-Uc4.1). Associated are areas of the soils common to units AC13 and MY2. As mapped, areas of units JJ29 and JJ28 may be included. Occurs on sheet(s): 8"
"BY2"
"Undulating hills with breakaway margins and narrow valleys developed on claystones and sandstones; much rock outcrop; some laterite: chief soils on the dissected hills are probably shallow mixed gravels, including rock chips, in sand and sandy loam matrices (K-Uc1.4) and (K-Uc4.1). Associated are yellow earth (Gn2.64) and (Gn2.74) with (Dy3.4) soils in the valleys. Other soils include stony and gravelly (Gn2.12) soils on flat areas and (Uc5.22) soils in some sandy colluvial sites. Occurs on sheet(s): 8"
"BY3"
"Mesas and their escarpments on siltstones, sandstones, and conglomerates; rock outcrops: chief soils are shallow gravelly and stony sands (K-Uc1.4) and (K-Uc4.1) with ironstone gravels (KS-Uc1.4) and (KS-Uc4.1) with block laterite and indurated mottledand pallid-zone materials. Associated are areas of unit My79 on undulating terrain above the escarpments and unit Ms15 on slopes below the escarpments. Occurs on sheet(s): 8"
"BY4"
"Undulating ridge and slope terrain on lateritized sediments; some rock outcrops: chief soils seem to be shallow sands usually containing large amounts of mixed and variable gravels (K-Uc1.4) or ironstone gravels (KS-Uc1.4), and also (Uc1.4) soils with some gravels on ridges and upper slopes generally. Associated are shallow to deep varieties of (Uc1.23), (K-Uc1.23), (Gn2.12), and (K-Gn2.12) soils on mid and lower slopes. Small areas of other soils are likely. Occurs on sheet(s): 8,10"
"BY5"
"Broad plateaux and mesas on siltstones, sandstones, and conglomerates dissected by many streamlines; some breakaway slopes; rock outcrops: chief soils are shallow gravelly and stony sands (K-Uc1.4) (K-Uc4.1), (KS-Uc1.4), and (KS-Uc4.1). Associated are small areas of yellow and red earths (Gn2.61), (Gn2.64), (Gn2.74), and (Gn2.12), often containing some ironstone gravels, on mid and lower valley slopes. Some lateritic remnants occur locally. Some areas of unit JJ34 are included in areas of greater dissection, also some ridges of unit Bz16. Occurs on sheet(s): 7,8"
"BY6"
"Scarpland--breakaways and residuals of various forms, cuestas, mesas, buttes, stony hillocks, and hills commonly with large bare slabs of silcrete; occasionally with rock outcrops, breccia, and pallid-zone materials; stone and gravel pavements are common; there is some marginal transgression by longitudinal sand dunes: chief soils are shallow stony sands, sandy loams, and loams (K-Uc1.43), (Uc1.43), (K-Um1.43), (Um1.43), and (Um5.3) often underlain by red-brown hardpan. Associated are (Uc5.21) soils. Occurs on sheet(s): 10"
"BY7"
"Scarpland--low lateritic breakaways on granites and gneisses: chief soils on the steeper slopes are probably shallow stony sands and sandy loams (K-Uc1.43) and (Uc1.43), possibly with some (Um5.3) soils. Associated on the gentler slopes are the soils of unit AB5O, possibly with some (Gn2.12) soils on small alluvial plains. Occurs on sheet(s): 10"
"Bz1"

"High hilly to mountainous, strongly dissected, sandstone ranges and plateaux with strong scarps and often deep narrow ravines: dominant soils are shallow stony sands (Uc1.21) but other shallow sands also occur-- (Uc1.23), (Uc5.11), (Uc4.1), (Uc4.2), and (Uc2.12). Shallow stony loams (Um1.43), (Um1.41), (Um4.1), (Um4.2), and (Um3.12) occur in many localities. On some slopes shallow stony duplex soils occur, chiefly (Dr2.41) and (Dy3.41). In valley floors sandy or loamy-surfaced duplex soils occur, chiefly (Dy3.42), (Dy3.32), (Dy2.42), (Dy2.32), and (Dd1.13). There are also areas of deep outwash sands (Uc1.21) and (Uc5.11). Occurs on sheet(s): 4"
"Bz2"
"Strongly undulating to low hilly lands with some high mesas with steep scarps: dominant soils are shallow, often gravelly, sands (Uc1.21) and (Uc5.11), (Uc4.11). Associated are shallow stony loams (Um1.41), (Um1.43), and (Um5.5). Also occurring are earths (Gn3.93), while duplex soils occur on more moderate slopes, chiefly (Dy2.43), (Db1.13), (Dr2.33), and (Dd1.43). Occurs on sheet(s): 4"
"Bz3"
"Moderate to strongly undulating elevated lands with some high mesa-like hills: dominant soils are shallow stony sands (Uc1.21) with lesser areas of (Uc2.12), (Uc5.11), and (Uc4.11) sands. Also occurring are deep sandy duplex soils (Dy5.41 and Dy5.81). On lower hill slopes and adjacent to drainage lines are loamy duplex soils (Dy2.42), (Dy2.43), (Dr2.33), and (Db1.13). Higher stony hills occurring in the unit have shallow loamy soils (Um1.43), (Um1.41), and (Um2.12). Occurs on sheet(s): 4"
"Bz4"
"High plateaux with steep-scarped margins and relatively narrow dissected valleys: dominant soils of the plateaux are sands (Uc1.21) and (Uc4.11), mostly shallow and with frequent sandstone outcrops. Smaller areas of loamy soils (Um1.41) and (Um4.2) also occur. In lower flatter areas away from plateau margins deep-surfaced sandy duplex soils (Dy5.41), (Dy5.42), (Dy5.81), and (Dy5.82) occur; on marginal slopes red loamy duplex soils (Dr2.31) are common, together with some gradational loamy soils (Gn). In wider valley floors sandy or loamy duplex soils (Dy3.42), (Dy3.43), and (Dy5.42) occur, together with areas of deep outwash sand (Uc1.21). Occurs on sheet(s): 4"
"Bz5"
"Elevated undulating to low hilly lands with many large rock outcrops: dominant soils are mostly shallow and often stony sands (Uc1.21), with other sandy soils occurring locally, chiefly (Uc5.11) and (Uc4.11). Small areas of shallow stony loams (Um1.41 and Um1.43) also occur together with areas of sandy red earths (Gn2.11, Gn2.12) or brown earths (Gn2.41). Occurs on sheet(s): 4"
"Bz6"
"Steep hilly to mountainous country: chief soils are shallow gritty sands (Uc1.21) with rock outcrops. Associated are (Dy2.21) soils on slopes, (Dy3.43) soils on colluvial aprons, and the soils of unit Ub70 in areas of milder relief. Occurs on sheet(s): 4"
"Bz7"
"Hilly or low hilly lands, often very strongly dissected with deep narrow ravines and steep-sided cliffs, massive sandstone outcrop is very common: dominant soils are shallow gravelly sands (Uc1.21), with other sand soils (Uc4.11) and (Uc2.12) associated. Also occurring are shallow stony loams (Um1.41, Um1.43), (Um2.12), and (Um4.1). Particularly near the margins, there may be small areas of sandy or loamy, red or yellow earths (Gn2.11, Gn2.12) and (Gn2.21). Occurs on sheet(s): 4,7"
"Bz8"
"Steep-sided low stony hills and high ridges with much sandstone outcrop: dominant soils are shallow very stony sands (Uc1.21), but with other sand soils (Uc4.11) and (Uc2.12) also occurring. Shallow stony loams (Um4.1), (Um1.43), and (Um2.12) are also closely associated. On lower slopes stony sandy duplex soils occur, chiefly (Dy2.42), (Dr2.42), (Dy3.42), and (Dy5.61). There may also be areas of deeper sands (Uc4.2). The hills and ridges often have a parallel orientation and the intervening valleys have sandy or loamy duplex soils (Dy3.43), (Dy2.43), (Dy5.42), and (Dy5.61). This unit is similar in topographic form to unit LK16. Occurs on sheet(s): 4"
"Bz9"
"Low hilly or strongly undulating lands with some lateritic or sandstone mesas: dominant soils are deep sands (Uc1.21), but on the low mesas are leached sands (Uc2.12) and sandy red earths (Gn2.11). On the outwash slopes sandy duplex soils (Dy5.41 and Dy5.42) occur. Data are limited. Occurs on sheet(s): 4"
"Bz10"
"Steep hilly dissected sandstone ranges with strong scarps and narrow ravines, separated by rolling to low hilly areas: chief soils seem to be shallow stony sands (Uc1.21) but other shallow sands (Uc4.1), (Uc4.2), and (Uc2.12) also occur. Shallow stony loams (Um1.4) and (Um4.1) occur in some localities. The included rolling to low hilly areas locally are similar either to unit Kb14 or to unit Sk14. Occurs on sheet(s): 4"
"Bz11"
"Steeply dissected areas around the lower Murchison River; steep cliffs with sandstone outcrops appear to be common: soils largely undescribed, but include shallow sand soils (Uc1.21) overlying sandstone. Occurs on sheet(s): 6"

"Bz12"
"Area marginal to, and rather less dissected than, unit Bz11. Soils largely undescribed but include loose siliceous sands (Uc1.21) as in unit Bz11, with some sandstone outcrops on hills, and sand soils (Uc2.21) and (Uc1.22) of unit Ca28. Minor areas of red duplex soils (Dr4.43) and (Dr2.12) and some neutral red earths (Gn2.12) and yellow sands (Uc4.2) of unit JK13 occur in the eastern portion of this unit. Occurs on sheet(s): 6"
"Bz13"
"Hilly to strongly undulating plateaux formed on sandstone; bare rock outcrop is frequent: chief soils are probably shallow siliceous sands (Uc1.23), with other undescribed (Uc) and (Um) soils of minimal pedological organization. Occurs on sheet(s): 6,10"
"Bz14"
"Dissected hilly to strongly undulating plateaux formed on sandstone; rock outcrop is frequent: chief soils, as in unit Bz13, are probably (Uc1.23) and other undescribed (Uc) and (Um) soils. There are some shallow loams (Um5.3); red earths (Gn2.11) on hardpan; and small areas of undescribed (Dr) soils. Occurs on sheet(s): 6"
"Bz15"
"Rocky hills and offshore islands of acid intrusive rock. Largely bare rock outcrop with pockets of shallow siliceous sands (Uc1.2) and loams (Um1). Occurs on sheet(s): 6"
"Bz16"
"Rugged hilly lands with steep slopes, some scarps and long rocky slopes; much bare rock (conglomeratic sandstone) outcrop: dominant soils are shallow very gravelly sands (Uc1.21), (K-Uc1.21), with associated (Uc4.21, Uc4.22) and (Uc5.21, Uc5.22). On outwash slopes are sandy yellow earths (Gn2.21, Gn2.22) and some red earths (Gn2.11, Gn2.12). Data are limited. Occurs on sheet(s): 7,8"
"Bz17"
"Strongly undulating or occasionally low hilly lands with much rock outcrop (sandstone and lateritized sandstone): all soils are shallow and very gravelly. Sands (Uc1.21), (Uc2.12), and (Uc5.23) are probably most common, but on the dissected laterite areas shallow loams (Um1.41) and (Um2.12) and shallow earths (Gn2.24) and (Gn2.44) are usually dominant. On flatter sites sandy yellow earths (Gn2.21) and bleached grey earths (Gn2.94) commonly occur. Data are very limited. Occurs on sheet(s): 7"
"Bz18"
"Low hilly to hilly lands with extremely rocky steep scree slopes: dominant soils are very shallow gravelly sands (Uc1.23, Uc1.21) and (K-Uc1.23, K-Uc1.21), with associated (Uc4.12), (Uc4.22), and (Uc1.43). In the valleys are sandy red or yellow earths (Gn2.1) and (Gn2.2), and occasionally some gravelly-surfaced red or yellow duplex soils (Dr2.12), (Dr2.4), and (Dy2.4). Occurs on sheet(s): 7"
"Bz19"
"High sandstone plateaux with prominent cliffs and steep rocky slopes, much dissected at the margins. Rock outcrop is very common and all soils have much gravel throughout the profile: dominant soils are very shallow gravelly sands (Uc1.23). Associated soils are (Uc4.12), (Uc4.22), and (Uc1.43), with some (Gn2.1) and (Gn2.2) soils in the valleys and occasionally gravelly-surfaced (Dr2.12), (Dr2.4), and (Dy2.4) soils. Occurs on sheet(s): 7,10"
"Bz20"
"Strongly undulating to low hilly lands with much granite outcrop: dominant soils are shallow sands (Uc1.23, Uc1.21), with associated (Uc4.12, Uc4.11) and lesser (Uc5.21). In lower sites sandy red duplex soils (Dr2.13) and sandy and loamy red earths (Gn2.11, Gn2.12) occur. Data are limited. Occurs on sheet(s): 10"
"CB1"
"Moderately undulating landscape with slight gilgai (few inches) formation: broad ridge tops and upper slopes of moderately shallow grey cracking clays (Ug5.22 and Ug5.23). Associated are: (i) some dark cracking clays (Ug5.13); (ii) various alkaline (D) soils, such as (Db1.43) and (Dd1.33); and (iii) in the lower-lying situations deeper grey cracking clays (Ug5.25 and Ug5.24) with small areas of (Dy3.43) soils. As mapped, small areas of units HG3 and Kb6 are included in some localities. Occurs on sheet(s): 3,4"
"CB2"
"Very gently undulating plains with grey and some brown clays with a very slight (few inches) gilgai micro-relief: on the low rises and slopes soils are of shallow to moderate depth, chiefly (Ug5.22, Ug5.26) and (Ug5.32). In lower sites deeper clays (Ug5.24, Ug5.25, Ug5.28, Ug5.29) and (Ug5.34) occur. The soils often contain much gypsum. Associated drainage lines have flood-plains with deep grey or brown clays as above, some massive clays (Ug5.5), and loamy duplex soils (Dr2.33), (Dr1.33), and (Dy2.33). These duplex soils may be wind-deflated to form clay pans. Also occurring in the unit in more elevated sites are friable uniform highly calcareous clays (Uf6.31, Uf6.33). Included in the unit, as mapped, are small low lateritic hilly remnants, often of mesa form, of unit Fz5. Occurs on sheet(s): 4,10"
"CB3"
"Gentle to moderately undulating or rolling lands: dominant soils are of moderate to shallow depth, chiefly grey clays (Ug5.22 and Ug5.23) but with important areas of dark clays (Ug5.13 and Ug5.14) or brown clays (Ug5.32).

A slight (6 12 in.) gilgai microrelief may occasionally be present and local surface accumulations of silcrete (billy) gravel may occur. Associated soils are mainly loamy duplex soils (Dy2.33 and Dy2.13), (Dd1.33 and Dd1.13), and (Db1.33 and Db1.13). On higher ridges and their slopes friable earths (Gn3.43 and Gn3.46) and uniform friable clays (Uf6.31, Uf6.32, and Uf6.33) occur together with (Gn3.93) in low sites. The soils of associated stream flood-plains are loamy duplex types (unit S14). There are a few small inclusions of unit Fz6. Occurs on sheet(s): 4"
"CB4"
"Broadly undulating lands with occasional high ridges or low flat-topped hills: dominant soils are cracking clays of moderate depth (2-3 ft), chiefly grey (Ug5.22 and Ug5.23) with smaller areas of brown clays (Ug5.32). In some areas a slight or moderate gilgai microrelief may be present (1-2 ft). Associated are higher ridges with loamy red duplex soils (Dr2.12 and Dr2.13) and smaller areas of (Db1.13) and (Dy2.33). These soils are mostly shallow and may be stony. Densely vegetated low hills or high ridges occurring in the unit have shallow stony clays (Uf6.31), (Uf6.33), and (Ug5.12). On the lower slopes of such areas friable earths (Gn3.93), (Gn3.13), and (Gn3.23) occur. Throughout the unit small alluvial valley plains occur with deep clay soils (Ug5.24 and Ug5.25) and (Ug5.15 and Ug5.16). Occurs on sheet(s): 4"
"CB5"
"Gentle to moderately undulating and rolling lands with some broad plains and low hills and ridges: chief soils are grey clays (Ug5.22 and Ug5.23) with locally important areas of dark clays (Ug5.13 and Ug5.14) or brown clays (Ug5.32). Some gilgai microrelief may be present and also some local accumulations of silcrete (billy) gravel may occur. Deeper grey and brown clays (Ug5.24) and (Ug5.34) occur on the broader plains. Various loamy duplex soils such as (Dy2.33), (Dd1.33), (Db1.33), and (Dr2.13) are present locally. On higher ridges and their slopes soils common to unit Mm11 are likely. Occurs on sheet(s): 4"
"CB6"
"Moderately undulating lands with widely spaced shallow valleys: dominant soils are shallow to moderately deep grey clays which often have a prominent linear gilgai on slopes. The chief forms are (Ug5.22) and (Ug5.23), but brown clays (Ug5.32, Ug5.33, and Ug5.37) and dark clays (Ug5.13) also occur. In valley floors deeper clays occur (Ug5.24), (Ug5.16), and (Ug5.34). Widely occurring on ridge crests and stronger slopes are thin-surfaced loamy duplex soils, chiefly (Db1.13), (Dr2.13), (Dr2.12), (Dy2.13), (Dy2.33), and (Dy2.43). These duplex soils often have a surface strew of small gravel fragments. Occurs on sheet(s): 4"
"CB7"
"Moderate to gently undulating plains with very broad shallow valleys: on middle and lower slopes grey clays of moderate depth are dominant, usually with pronounced linear gilgai. The chief forms are (Ug5.22) and (Ug5.23), with lesser areas of (Ug5.13) and (Ug5.32). In lower sites and on associated small alluvial plains deep clay soils occur, chiefly (Ug5.25), (Ug5.16), (Ug5.15), and (Ug5.24). On the broad ridge crests shallower brown or red-brown clays (Ug5.32 and Ug5.37) are prominent, together with thin-surfaced loamy duplex soils (Dr2.13), (Dr2.12), (Dy2.13), and (Db1.13). Also occurring in the unit are small alluvial plains of loamy duplex soils (Db1.33), (Dd1.33), and (Dy2.33), and occasional low basaltic hills with shallow stony soils (Uf6.32), (Uf6.31), (Ug5.12), and (Um6.31). Occurs on sheet(s): 4"
"CB8"
"Gently undulating plains: dominant soils are moderately deep grey clays (Ug5.22) with lesser brown clays (Ug5.32). Some deep clay soils (Ug5.24) also occur and these usually have a moderate gilgai microrelief. Closely associated and often occurring as linear bands are loamy duplex soils (Dy2.33), (Dy2.43), (Db1.13), (Db1.33), (Db1.43), and less commonly (Dr2.13 and Dr2.12). Occurs on sheet(s): 4"
"CB9"
"Gently undulating plains: dominant soils are moderately deep grey-brown cracking clays (Ug5.22), with lesser deep grey clays (Ug5.24). Associated soils are quartz-gravel-strewn clays (Uf6.31) and loamy duplex soils (Dy2.13), (Db1.13), and (Dr2.13). Occurs on sheet(s): 7"
"CB10"
"Gently undulating to undulating lands with gravely rises; dominant soils are moderately deep to deep dark grey-brown cracking clays (Ug5.22, Ug5.24, and Ug5.25). Associated are loamy duplex soils (Dy2.13, Dy2.12), (Dy3.12), (Db1.13, Db1.12), and (Db2.13). On the gravelly rises are moderately deep loamy nodular brown or yellow earths (Gn2.44, Gn2.43) and (Gn2.21); on lower slopes of the rises are loamy red duplex soils (Dr2.12, Dr2.11) and (Dr3.42). Occurs on sheet(s): 7"
"CB11"
"Undulating or occasionally moderately undulating lands with long slopes and broad ridge crests: dominant soils are moderately deep grey cracking clays (Ug5.22), with lesser (Ug5.26) and (Ug5.12). In lower sites deeper clays (Ug5.24) and (Ug5.16) occur. On some higher ridge crests small areas of gravelly red soils (Gn2.12), (Gn3.12), and (Dr2.12) occur. Around the margin of the unit are small areas of grey duplex soils (Dy2.43) and (Dy3.43). Occurs on sheet(s): 7"
"CB12"

"Gently undulating to undulating plains: dominant soils are slightly gilgaied (12-18 in.) moderately deep to deep yellowish grey cracking clays (Ug5.26). Associated are similar grey (Ug5.22) or brown (Ug5.33) clays, and occasionally massive forms (Ug5.5). Throughout the unit there are usually smaller areas of slightly gilgaied friable yellow or brown earths (Gn3.51) and (Gn3.71). Occurs on sheet(s): 7"
"CC1"
"Plain with low gilgais (few inches), swamps, lunettes, sandhillscracking grey clays, commonly (Ug5.24 and Ug5.25), and some cracking brown clays (Ug5.3) with crusty loamy soils (Dr1.43), (Dr1.13), (Dy1.13). Other soils with (D) and possibly (Ug) profiles may occur but descriptions are lacking. Saline swamps in low-lying situations. Description slightly modified from that given in Sheet 1. Occurs on sheet(s): 1,3"
"CC2"
"Riverine plains with low gilgais (few inches), numerous drainage-ways, and swamps: chief soils are cracking grey clays (Ug5.24) with other cracking clays including (Ug5.4) and (Ug5.5) which have a massive surface horizon. Associated are: on the plains and swamps, friable loamy soils (Um6) or friable earths (Gn3 or Gn4) or (Uf6) soils (available soil descriptions are inadequate); river levees of hard alkaline red soils (Dr2.33) and hard alkaline dark mottled soils (Dd2.33); sandhills of (Uc1.2) soils; and prior stream beds of coarse-textured soils (unclassified). As mapped, areas similar to portions of unit Oc3 may be included. Above description is slightly modified from that given in Sheet 1. Occurs on sheet(s): 1,3"
"CC3"
"Riverine plains with low gilgais (few inches), prior streams, and related features: chief soils are cracking grey clays commonly (Ug5.24 and Ug5.25) with small areas of cracking brown clays (Ug5.3) and other cracking clays with massive surface horizons (Ug5.4) and (Ug5.5). Associated are small areas of hard alkaline red soils (Dr2.33), hard alkaline brown soils (Db1.33), and hard alkaline yellow soils (Dy2.33) on low rises (domes), similar to portions of unit Oc3. Above description is slightly modified from that given in Sheets 1 and 2. Occurs on sheet(s): 1,2,3"
"CC4"
"Plains: gilgai plains of cracking grey clays (Ug5.2); dark cracking clays (Ug5.16); and cracking clays with bleached horizons (Ug3.2); also low rises of hard alkaline red soils (Dr2.33); minor areas of other soils including hard alkaline yellow mottled soils (Dy3.43); the area includes lakes and swamps with some lunettes (soils unclassified). See CC8 and CC9 also. Occurs on sheet(s): 1"
"CC5"
"Plain with some swamps: gilgai plain of cracking grey clays (Ug5.2) with small areas cracking brown clays (Ug5.3); dark clays (Ug5.16); red shallow porous loamy soils (Um6.24); and hard alkaline red soils (Dr2.33). Occurs on sheet(s): 1"
"CC6"
"Undulating with rounded hills: cracking grey and brown clays (Ug5.2 and Ug5.3) in association with hard alkaline yellow mottled soils (Dy3.43 and Dy3.83), gilgais are present; small areas of other soils including (Dd1) but otherwise these are unclassified. Incomplete data. Occurs on sheet(s): 1"
"CC7"
"Dissected tableland: cracking grey clays (Ug5.2) in gilgai association with cracking brown clays (Ug5.3) and hard alkaline yellow mottled soils (Dy3.43). Occurs on sheet(s): 1"
"CC8"
"Slightly gilgaied (few inches) plains with low rises and occasional dunes: gilgai plains of cracking grey clays (Ug5.24) with smaller areas of other cracking clays (Ug3.2), (Ug5.16), and (Ug5.3), and broken by low rises (low elongate dunes) of hard alkaline red soils (Dr2.33) which are locally dominant; dunes of deep siliceous sand (Uc1.2) occur close to some creek and river channels. Occurs on sheet(s): 1,2,3"
"CC9"
"Gilgai plains with some swampy areas and lunettes: gilgai plains of cracking grey clays (Ug5.2) with smaller areas of other cracking clays (Ug5.16 and Ug5.2) in association with hard alkaline yellow mottled soils (Dy3.43) and with low ridges of hard yellow mottled soils (Dy3.8) and sandy yellow mottled soils (Dy5.8); occasional dunes of deep siliceous sands (Uc1.2) and small areas of many other soils especially on lunettes. Occurs on sheet(s): 1"
"CC10"
"Dissected tablelands with volcanic cones: gilgai plains of cracking grey clays (Ug5.2) and hard alkaline yellow mottled soils (Dy3.43) and (Dy2.43) on the flatter tableland remnants; hard alkaline red soils (Dr2.13) around the volcanic cones and along upper valley slopes, while dark clays (Ug5.15) and basalt boulders occur on mid and lower valley slopes. Occurs on sheet(s): 1,2"
"CC11"
"Gently undulating dissected tablelands at low to moderate elevation: on the flatter tableland remnants, the gilgai plains with but few basalt boulders have cracking grey clays (Ug5.2) in association with hard yellow mottled soils (Dy3.43, Dy3.42, and Dy3.41) and (Dy3.13), while those gilgai plains with numerous basalt boulders have cracking dark clays (Ug5.14) in association with friable dark soils (Dd3.12) and hard yellow mottled soils (Dy3);

stony rises of friable loamy soils, especially (Um6.24, Um6.13, and Um6.21) with hard alkaline brown soils (Db1.13) on saddles between rises, and with gilgai areas of cracking dark clays (Ug5.14 and Ug5.13) spreading out from the base of the rises, occur either on the tableland plains or on their scarps where the (Um6) soils are the common ones; other undescribed soils occur on and around volcanic cones; bands of cracking dark clays (Ug5.15) occur along some of the narrow incised stream valleys. Ironstone gravels may occur in the surface horizons of the (D). Occurs on sheet(s): 2"
"CC12"
"Gently undulating, dissected tablelands at low elevations: the flatter tableland areas, the gilgai plains, have cracking grey clays (Ug5.2) in association with a variety of other soils including hard alkaline dark mottled soils (Dd2.33), hard alkaline yellow mottled soils (Dy3.33), (Dy2.1), and also possibly coarse cracking clays (Ug5.5), with small areas of hard alkaline brown mottled soils (Db2.33) in the better drained situations; with cracking dark clays (Ug5.14) which occur (l) among the sinuous flows of basalt boulders which are similar to very low stony rises, (2) on the steep slopes above the incised stream valleys, and (3) sometimes on stream terraces. Ironstone gravels may occur in surface horizons of (D) soils. Occurs on sheet(s): 2"
"CC13"
"Gently undulating plains with some stony rises and basalt hills: gilgai plains of cracking grey clays (Ug5.2) in association with hard alkaline yellow mottled soils (Dy3.33 and Dy3.43), hard alkaline dark mottled soils (Dd2.33), and hard alkaline yellow soils (Dy2), and also some swampy areas of cracking grey clays (Ug5.2); the stony rises are of irregular distribution and have friable loamy soils especially (Um6.21, Um6.41, and Um6.24) on the rises and usually gilgai areas of cracking dark clays (Ug5.13 and Ug5.14) at their base; soils of the basalt hills are classed with those of the plain; small areas of other undescribed red soils in the northern portion of the unit. Ironstone gravels may occur in surface horizons of (D) soils. Occurs on sheet(s): 2"
"CC14"
"Plains with low gilgais (few inches), swamps, and lagoons: chief soils are grey and brown cracking clays (Ug5.24) and (Ug5.3). Associated are the various (D) soils of unit Oc9 and undescribed soils of the wet places. Occurs on sheet(s): 3"
"CC15"
"River flood-plains with numerous distributary channels, meanders, billabongs, lagoons, and swamps: chief soils are plains of cracking clays (Ug5.2 and Ug5.3) with various undescribed soils including (Dr2.33) along the stream channels and "islands"of red earths (Gn2.12 and Gn2.13) between channels. Data are limited. Occurs on sheet(s): 3"
"CC16"
"Plains associated with major and minor functional and non-functional drainage-ways: slightly gilgaied (few inches) plains of cracking clays--chiefly grey clays (Ug5.24 and Ug5.25) on the open plains and in depressions, and brown clays (Ug5.35) on slight elevations--alternating with low domes or rises (?levee banks) in the plain of variable extent and having hard alkaline red and brown soils (Dr2.33) and (Db1.33) with other (D) soils as found in unit Oc12. Other features include small areas of unit B10 and possibly small areas of red earths (Gn2.13) as for unit Mx5. There is some local variation in soil dominance between the (Ug5) and the (D) soils. This unit may represent a broad transition between units Oc12 and CC17. Occurs on sheet(s): 3"
"CC17"
"Plains of slightly gilgaied (few inches) cracking clays associated with major and minor functional and non-functional drainage-ways: chief soils are grey clays (Ug5.24 and Ug5.25) and brown clays (Ug5.34 and Ug5.35). Associated features and soils are: (i) many small low domes or rises (often levee banks) related to old drainage-ways, with soils of units B10, Si2, and R03 north of about the CollarenebriMoree line (Sheet 3) and of unit Oc12 south of about this line--note that these low domes may give rise to apparent toposequences of soils locally; (ii) small areas of (Dd1.33) and (Dd1.43) soils along the eastern margins of this unit; (iii) some areas of dark clays (Ug5.15 and Ug5.16), especially in the Moree-Narrabri localities (Sheet 3) and possibly related to adjacent elevated basalt areas; (iv) some undescribed (?U) soils on recent terraces and flood-plains along some present streams; (v) some repeatedly flooded areas with grey clays (Ug5.5) having a massive surface; and (vi) some swamps and mar. Occurs on sheet(s): 3,4"
"CC18"
"Plains of slightly gilgaied (few inches) cracking clays associated with major and minor functional drainage-ways: chief soils are grey clays (Ug5.24 and Ug5.25) and brown clays (Ug5.34, Ug5.35, and Ug5.38). Parts of this unit may be flooded seasonally. Also included are: low wind-deflated domes of red and brown crusty loamy soils (Dr1.33 and Dr1.43) and (Db0.33) frequency of occurrence varies locally; some areas of unit Nb5; dunes of unit B12; and undescribed soils of the new terraces, levees, etc. along some major streams. It is likely that this unit represents a transition from unit CC17 to unit CC19. Boundaries are approximate. Occurs on sheet(s): 3"
"CC19"
"Plains of slightly gilgaied (few inches) cracking clays associated with major and minor functional and nonfunctional drainage-ways: chief soils are grey clays (Ug5.24, Ug5.25) and brown clays (Ug5.38, Ug5.34), the

dominance of grey and brown varying locally. Also included are small swampy basins of (Ug5.24) and possibly (Ug5.5) soils. As mapped, some clay pans (unit Nb3), sand dunes (unit B12 of Sheets 3 and 4), and red earths (unit Mx1) are included. Portions of this unit may be flooded seasonally. Occurs on sheet(s): 3,4,10"
"CC20"
"Gently undulating cracking clay plains with moderate to strong (2 4 ft) gilgai microrelief: chief soils are deep grey clays (Ug5.24) with smaller areas of (Ug5.25) and (Ug5.28) and some brown clays (Ug5.34). Soil reaction values of these cracking clays vary and comprise: (i) alkaline or neutral surfaces with acid subsoils (common); (ii) acid throughout (fairly common); and (iii) alkaline throughout (rare). In some areas (Dy2.33) and (Dy2.43) soils occur on the slightly raised flat areas between gilgai depressions or adjacent to small drainage-lines. As mapped, small areas of units B10, MM1, and Ro4 are included in Queensland, and unit Ro1 in the Narrabri area of New South Wales (Sheet 3). Occurs on sheet(s): 3,4"
"CC21"
"Gently undulating or level plains: dominant soils are deep clays with a moderate to strong gilgai microrelief (2-3 ft). Chief forms are grey (Ug5.24 and Ug5.25), with some brown (Ug5.34), or occasionally black (Ug5.16 and Ug5.17). Closely associated are thin-surfaced loamy duplex soils (Dd1.13) and (Dd1.33), with similar (Db1), (Dy2), (Dy3), and (Dr2) soils. Included in the unit, as mapped, are small areas of red earths (Gn2.12), which may have a gravel-strewn surface. The cracking clays have the three reaction trends listed for unit CC20. Occurs on sheet(s): 4"
"CC22"
"Gently undulating plains: dominant soils are deep clays with a moderate (1-2 ft) gilgai microrelief. Chief forms are grey clays (Ug5.24 and Ug5.28) with lesser brown clays (Ug5.34). Closely associated are non-gilgaied areas with loamy-surfaced duplex soils (Dy3.43), (Dy3.33), (Dy2.33), (Dy2.43), and (Db1.33). These occur either on slightly higher landscape sites or as small alluvial plains fringing drainage lines. Also occurring are small areas of friable earths (Gn3.23) and (Gn3.93); and occasional areas of loamy red earths (Gn2.11) may be included in the unit as mapped. The cracking clays have the three reaction trends listed for unit CC20. Occurs on sheet(s): 4"
"CC23"
"Level alluvial flood-plains associated with major streams, often dissected by numerous braided channels and mostly subject to irregular flooding: dominant soils are deep grey clays (Ug5.24 and Ug5.25) with smaller areas of black or brown clays (Ug5.15) and (Ug5.34); in certain areas the clays may be moderately gilgaied (1-2 ft). Other clays occurring (Ug5.5) and (Ug5.4) have a massive surface. Small levees adjacent to some stream channels have other uniform-textured soils (Uf6.32) and (Um5.4), together with small areas of loamy duplex soils (Dd1.13) and (Dy2.33). Occurs on sheet(s): 4"
"CC24"
"Plain: chief soils are grey cracking clays (Ug5.24 and Ug5.28) with some dark cracking clays (Ug5.16). Associated are (Dd1.33) and (Dd1.43) soils with thin crusty surfaces in gilgai complexes throughout the plain, which may be traversed by channels of (Ug5.16) soils also. Small areas of other soils (Uf6.3) occur. As mapped, small areas of unit Kb6 may be included locally. Occurs on sheet(s): 4"
"CC25"
"Alluvial plain with bordering colluvial fans and a few areas of smooth low hills: chief soils are grey cracking clays (Ug5.24) with some (Ug5.5) on the plain. There are gilgaied and non-gilgaied areas. Associated soils are (Ug5.16) and (Dd1.43) soils on the plain and (Dy3.43) soils on the hills. Minor soil occurrences are shallow and stony (Um6.12) and (Ug5.13) soils on included basalt flows; and (Uc4.1) soils on some hills. Occurs on sheet(s): 4"
"CC26"
"Gently undulating plains with included areas of small hills: chief soils are grey cracking clays (Ug5.24) with a gilgai microrelief. Associated are (Dy2.43) and (Dy3.43) soils bordering the clay areas. Minor soil occurrences include (Gn2.11) and (Gn3.11). There are some small inclusions of unit Tb100. Occurs on sheet(s): 4"
"CC27"
"Dissected rolling low hills: chief soils seem to be the grey clays (Ug5.24) of the depressions of large deep 3-ft gilgais on the puffs of which (Dy4.13) soils occur. Associated are (Dy2.13) and (Dr3.13) soils on slopes between the gilgai formations. Other soils include (Dy4.12), (Dy2.43), and (Db1.12) in the flatter lower-lying sites. Occurs on sheet(s): 4"
"CC28"
"Moderately undulating lands with gilgai microrelief (1-2 ft); the soil surface often has a billy gravel veneer: dominant soils are deep clays (Ug5.24) with lesser (Ug5.16). Associated are thin-surfaced loamy duplex soils (Dy2.33), (Dy2.43), (Dy2.13), and similar (Dd1) soils. On occasional high ridges gravel-strewn red loamy duplex soils (Dr3.43) and (Dr2.43) occur. The cracking clays have the three reaction trends listed for unit CC20. Occurs on sheet(s): 4"
"CC29"
"Level plains with moderate to strong gilgai microrelief (2 4 ft): dominant soils are grey or light grey deep clays (Ug5.24) with loamy duplex soils (Dy2.33) closely associated in non-gilgaied sites. Small flood-plains of (Dy2.43),

(Dy3.43), and (Dd1.43) occur adjacent to associated drainage lines. Included in the unit, as mapped, are small areas of loamy and sandy red earths (Gn2.12 and Gn2.13) and yellow earths (Gn2.22). The cracking clays have the three reaction trends listed for unit CC20. Occurs on sheet(s): 4"
"CC30"
"Gently undulating or level plains with moderate or occasionally strong (2-3 ft) gilgai microrelief: dominant soils are deep clays (Ug5.24) with also (Ug5.25), (Ug5.35), and occasionally (Ug5.16). Closely associated are thin-surfaced loamy duplex soils (Dy2.43), (Dy2.33), and similar (Dd1) soils. On some more extensive slightly higher areas deeper-surfaced gravel-strewn loamy duplex soils (Dy3.43) and (Dy3.33) are common. Very small areas of red earths (Gn2.12) may be included in the unit. The cracking clays have the three reaction trends listed for unit CC20. Occurs on sheet(s): 4"
"CC31"
"Level plains with a well-developed broad shallow (12-18 in.) gilgai microrelief: a complex of soils occurs; the puffs and roughly circular depressions have cracking clays (Ug5.24 and Ug5.29), sometimes with (Ug5.34 and Ug5.38) on the puffs. The intervening shelf areas have thin-surfaced loamy duplex soils (Dy2.33) and occasionally (Dr2.33). Also occurring in the unit, as mapped, are some level non-gilgaied clay plains (Ug5.24 and Ug5.29); other duplex soils that often occur as clay pans are (Dy2.43), (Dy2.33), and (Dd1.33); and occasional areas of sandy or loamy red earths (Gn2.12). The cracking clays have the three reaction trends listed for unit CC20. Occurs on sheet(s): 4,7"
"CC32"
"Gently undulating or level plains, often with slight to moderate gilgai microrelief (1-2 ft): dominant soils are deep grey clays (Ug5.24 and Ug5.25) with lesser deep brown clays (Ug5.34). Closely associated are fairly extensive areas of loamy duplex soils, chiefly (Dy2.33). Other soils occurring include friable brown clays (Uf6.34). The cracking clays have the three reaction trends listed for unit CC20. Occurs on sheet(s): 4"
"CC33"
"Level or very gently undulating clay plains with slight to moderate (1-2 ft) gilgai microrelief, occasionally stronger (2-4 ft). Where the unit is adjacent to major streams many small braided channels occur and C the area is subject to flooding. Dominant soils are deep grey clays (Ug5.24), occasionally (Ug5.28 and u Ug5.29), but areas of deep brown clays are commonly associated (Ug5.34). In some areas brown clays occur on the gilgai banks and grey clays in the depressions. Closely associated throughout the unit are areas of loamy duplex soils (Dy2.33), (Dy2.43), (Db1.33), (Db1.43), and (Db1.13), particularly adjacent to stream channels. As mapped, the unit includes small slightly higher islands of sandy or loamy red earths (Gn2.12 and Gn2.11), or less commonly yellow earths (Gn2.22). The cracking clays have the three reaction trends listed for unit CC20. Occurs on sheet(s): 4"
"CC34"
"Level or very gently undulating plains: a slight (6 12 in.) well-defined gilgai microrelief is present, giving a soil complex of grey clays (Ug5.24 and Ug5.28) on the puffs and loamy duplex soils (Dy2.43) in the depressions. The clays occupy the greater area of the unit. Associated are slightly higher rises of loamy yellow earths (Gn2.22) or grey earths (Gn2.94). The cracking clays have the three reaction trends listed for unit CC20. Occurs on sheet(s): 4"
"CC35"
"Alluvial plains associated with major streams; numerous braided channels may occur and many areas are subject to irregular flooding: dominant soils are deep grey clays (Ug5.24 and Ug5.25), with smaller areas of (Ug5.34) and (Ug5.5). Some clay soils possess a slight to moderate gilgai microrelief. Associated are lesser areas of thin-surfaced loamy duplex soils (Dd1.33), (Dy2.33), and (Dy2.43), and, less commonly, similar (Dr2) or (Db1) soils. The duplex soils may often be wind-deflated. Also occurring in the unit are occasional low sand dunes or sand-filled prior stream channels (Uc1.21). Occurs on sheet(s): 4"
"CC36"
"Broad level alluvial plains occasionally cut by braided stream channels: dominant soils are grey cracking clays with a very slight (few inches) gilgai microrelief; (Ug5.24) is probably most common but (Ug5.25), (Ug5.28), and (Ug5.29) also occur frequently. On some gently sloping sites brown cracking clays (Ug5.34 and Ug5.38) may occur. Closely associated are small areas of slightly higher thin-surfaced loamy duplex soils (Dy2.33) and (Dd1.33) that are often surface-eroded. Also occurring in some areas are slightly higher islands of sandy red earths (Gn2.12). Occurs on sheet(s): 4"
"CC37"
"Narrow alluvial plains dissected by many braided stream channels: dominant soils are grey clays, chiefly (Ug5.24 and Ug5.25), but (Ug5.28) and (Ug5.29) are also common. Closely associated are slightly higher areas of loamy duplex soils (Dy2.33), (Dy2.43), (Dd1.33), and lesser (Dr2.43) and (Dr2.33). Also occurring are small areas of moderately gilgaied (1-2 ft) cracking clays (Ug5.24) and small islands of sandy red earths (Gn2.12). Occurs on sheet(s): 4"
"CC38"
"Level alluvial clay plains associated with, and often dissected by, drainage lines: dominant soils are deep cracking clays often with a slight (46 in.) gilgai microrelief. The chief forms are (Ug5.24), (Ug5.29), (Ug5.28), (Ug5.25),

(Ug5.34), and (Ug5.38). Closely associated are numerous slightly higher areas of loamy duplex soils, chiefly (Dy2.33) and (Dy2.43) with lesser similar (Db1) and (Dr2) soils. Many old stream channels, slightly elevated broad dunes, or very low rises have sandy red and yellow earths (Gn2.12 and Gn2.22). Also included in the unit may be small areas of strongly gilgaied clays of unit CC31. Occurs on sheet(s): 4"
"CC39"
"Extensive level old alluvial plains that have a very slight (few inches) gilgai microrelief: dominant soils are deep grey clays (Ug5.25) with lesser (Ug5.24) and (Ug5.29). Also occupying important areas are deep brown clays (Ug5.34 and Ug5.35), some of which may have a gravelly surface.. Occurs on sheet(s): 4"
"CC40"
"Level plains: dominant soils are very deep clays with a slight (6-12 in.), or no, gilgai microrelief. The chief forms are grey (Ug5.25), occasionally (Ug5.28), (Ug5.29), and (Ug5.24), but brown clays (Ug5.34) are also common. These often have a loose granular surface layer up to 3 in. thick. Small areas of red-brown (Ug5.38) and dark clays (Ug5.15) also occur. Occurs on sheet(s): 4"
"CC41"
"Coastal plain with areas of mud flats, low broad rises, and fringing hill slopes: chief soils are grey cracking clays (Ug5.24), but other cracking clays such as (Ug5.16) are present. Associated are (Dy3.33) soils on the low rises and (Dy2.43) soils on the hill slopes. Minor soil occurrences are likely throughout. As mapped, areas of unit J6 may be included locally. Occurs on sheet(s): 4"
"CC42"
"Depressional plain with ill-defined drainage-ways: chief soils are deep grey cracking clays (Ug5.24) on the banks and puffs of gilgai formations. Associated are (Gn3.01) and (Gn3.04) soils in the depressions and melon-holes of the gilgai formations. Minor soil occurrences include (Dy2.42), (Ug5.16), (Dd1.41), and (Dy2.43). Occurs on sheet(s): 4"
"CC43"
"Alluvial plains with small areas of low broad rises or levees fringing major streams: chief soils are grey and dark cracking clays (Ug5.24) and (Ug5.16), possibly with areas of other (Ug5) soils similar to those found in unit CC23. Associated are various (D) soils, such as (Dy3.33) on rises, (Dy2.43) on terraces, and (Dd1.43) in shallow depressions. Areas of recent alluvial deposition (Uf1) and (Um1) occur around channels. Occurs on sheet(s): 4"
"CC44"
"Alluvial plains with prior stream channels, billabongs, and numerous small uneven and broken rises, ridges, and depressions: chief soils seem to be grey and dark cracking clays (Ug5.24) and (Ug5.16) with weak gilgai formation. Minor areas of many other soils, such as (Uc), (Um), and (Uf) on recent formations, and (Dy2.43) and (Dy3.33) on terraces and marginal slopes are likely. Layered soil materials may be common. Occurs on sheet(s): 4"
"CC45"
"Riverine plain: chief soils are grey cracking clays (Ug5.25) with small gilgais. Small areas of (D) soils are also likely. Occurs on sheet(s): 5"
"CC46"
"Riverine plain: chief soils are grey cracking clays (Ug5.25) with small gilgais and some dunes of siliceous sands (Uc1.22). As mapped, soils of adjacent units may be included. Occurs on sheet(s): 5"
"CC47"
"Stable flood-plain: main soils are grey cracking clays (Ug5.24) with minor areas of (Ug5.35) and gravelly (Dr2) soils. Stream channels are flanked by narrow zones of alluvium (Um5.4). Occurs on sheet(s): 9"
"CC48"
"Stony undulating basalt country: main soils are grey cracking clays (Ug5.24). Interfluves and rises have stony (Gn3.12) soils and some hills have shallow stony red (Um6.4) soils. Occurs on sheet(s): 9"
"CC49"
"Active flood-plains with extensive back plains, many channels, and some broad low ridges: chief soils are grey and brown clays (Ug5.24 and Ug5.25) and (Ug5.38 and Ug5.34) with some (Ug5.13) soils; while (Uf5.11) soils occur on narrow levees and (Dr2.33) soils on broad low ridges. Other soil occurrences include (Um5.51) and (Uc5.21) on the plains and intractable (Uf5) soils in channels and billabongs. Occurs on sheet(s): 9"
"CC50"
"Extensive plains developed from limestone: chief soils are cracking grey-brown clays (Ug5.24) and (Ug5.34) often with gilgai formation. Associated are shallow (Um5) soils associated with outcrops and small areas of (Dy5.42) soils on sandy rises. Occurs on sheet(s): 9"
"CC51"
"Gently undulating plains with low hilly interfluves, developed on basalt: chief soils on the plains are grey and brown cracking clays (Ug5.25) and (Ug5.38). Associated are (Gn3.12) soils on higher country flanking the plains and shallow stony (Gn3.1) and (Um6) soils on some interfluves. Occurs on sheet(s): 9"
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"CC52"
"Gently undulating plains with rock outcrops, developed on limestones, sandstones, and shales: main soils, developed on slopes and plains, are grey clays (Ug5.25) often with gilgais and much loose limestone in the profile. Small areas of (Um5) soils are associated with outcrops, and some (D) soils may occur. Occurs on sheet(s): 9"
"CC53"
"Flat to gently sloping flood-plains: chief soils are grey clays (Ug5.24) on the nearly flat plains with small areas of brown clays (Ug5.34). Associated are areas of (Um5.52), (Gn2.12), (Uc4.21), and (Uc1.43) soils on levee formations. Small areas of other soils such as (Dr2) occur marginal to adjoining units Fz20 and BA3. Various undescribed loamy and clayey soils occur in gully systems that may be quite steep. Alluvial deposits including micaceous sands may underlie the (Ug5) soils at depths of 7 to 10 ft. Occurs on sheet(s): 8,9"
"CC54"
"Alluvial plains with a light scatter of surface gravel and stone: chief soils are grey and brown cracking clays (Ug5.24, Ug5.28) and (Ug5.34). A weak gilgai microrelief is present. Other soils include yellow (Gn) soils such as (Gn2.6) in areas transitional to adjacent units. As mapped, small areas of adjoining units may be included. Occurs on sheet(s): 8,9,10"
"CC55"
"Gently sloping and undulating plains derived from intermediate and basic igneous rocks and usually mantled with stones: some low stony rises: chief soils are grey and brown clays including (Ug5.24), (Ug5.34, Ug5.37, and Ug5.38), and (Ug5.22 and Ug5.28) on moderate to gentle slopes sometimes with weak (< 6 in.) gilgai. Associated are small areas of units Gg5 and Mo23, both of which may merge with this unit. Minor areas of other soils are possible. Occurs on sheet(s): 8,9"
"CC56"
"Undulating basalt plains with a thin stone mantle; small areas of low stony rises: chief soils are grey and brown clays (Ug5.24) and (Ug5.34) on lower slopes with some black clays (Ug5.12, Ug5.13, and Ug5.15) on the middle slopes. Associated are shallow dark pedal clays (Uf6.22) on stony rises and upper slopes and (Gn3.12) soils on mid slopes. Occurs on sheet(s): 8,9"
"CC57"
"Flood-plains and swamps: chief soils are grey clays (Ug5.2), probably (Ug5.25 and Ug5.29), with thin (l~ in.) self-mulching surfaces. Associated are areas of (Ug5.5) and (Ug5.6) soils. There is moderate gilgai microrelief in places. Surfaces are often stone-strewn. Soils of unit Mb15 may occur as well. Occurs on sheet(s): 8"
"CC58"
"Plain developed on limestone, some of which may outcrop: chief soils are probably grey clays (Ug5.2) and (Ug5.5). Other soils may occur. Occurs on sheet(s): 8"
"CC59"
"Gently undulating to low hilly country with some low gravelly ridges: chief soils on the areas of gentler relief are grey and brown clays such as (Ug5.24) and (Ug5.34). Associated are shallow loams such as (Um6.22) on moderate slopes; shallow sands such as (Uc1.4) on steep slopes; and (Gn2.12) soils containing ironstone gravel on the low gravel ridges. Occurs on sheet(s): 8"
"CC60"
"Flat to gently undulating plains with widely spaced narrow drainage-ways, low gravelly (chert) rises with variable gilgai development, some shallow depressions, some stony rises, the proportion of which varies locally: chief soils are deep grey clays such as (Ug5.24, Ug5.25). Other soils include (Uf6.33) on gravelcovered calcareous rises and possibly small areas of (Ug5.3) soils along the southern margins of the unit. Small areas of units My80 and II6 of Sheet 8 and II9 may be included locally. Occurs on sheet(s): 8,10"
"CC61"
"Flat to gently undulating plains of grey clays (Ug5.24 and Ug5.25) of unit CC60 interspersed with low undulating rises of red earths (Gn2.12) of unit My80. Dominance between the two units varies locally. Occurs on sheet(s): 8"
"CC62"
"Gently undulating plains with scattered flat limestone boulders and stones; low irregular limestone rises and ridges; shallow depressions; some drainage-ways: chief soils are deep grey and brown clays such as (Ug5.25 and Ug5.24) and (Ug5.34). Associated are small areas of shallow soils on the limestone rises and ridges, including (Uc1.3), (Um6.23), and (Db3.13 and Db3.12). Occurs on sheet(s): 8,10"
"CC63"
"Gently undulating plains with very gravelly (chert) low rises and some limestone or dolomite outcrops; some shallow gilgais may occur: dominant soils are deep grey and brown clays (Ug5.25 and Ug5.24) and (Ug5.34), with lesser (Ug5.23 and Ug5.22). Associated on very gravelly areas are shallow-surfaced duplex soils (Db1.13), (Dr2.12), (Dr2.43), and (Dr2.33) and occasionally gravelly-surfaced clays (Uf6.33). Occurs on sheet(s): 7,8,10"
"CC64"
"Alluvial plains associated with major streams: dominant soils are deep grey-brown cracking clays (Ug5.24) with associated (Ug5.25) and (Ug5.34), sometimes with weak gilgai development. Adjacent to streams are levees with

deep loamy red earths (Gn2.13), and loamy-surfaced red duplex soils (Dr2.13) that are often calcareous throughout. Other loamy duplex soils (Dy2.13) and (Db 1 .13) also occur; these may be wind-eroded areas. Occurs on sheet(s): 7"
"CC65"
"Alluvial plains with many braided distributary stream channels, old levees, and infilled channels: dominant soils are deep grey-brown cracking clays (Ug5.25, Ug5.24); on levees and old filled channels are deep loamy red earths (Gn2.13) with some carbonate nodules throughout the profile. Adjacent to stream levees and on scalded areas are thin-surfaced loamy duplex soils (Dy2.13), (Dy2.33), (Dr2.13), and (Db1.13). Small areas of deep very dark greyish brown friable earths (Gn3.43), uniform loams (Um6.31), and uniform clays (Uf6.33) occur adjacent to some stream channels. Occurs on sheet(s): 7"
"CC66"
"Alluvial plains associated with major streams: dominant soils are deep grey-brown cracking clays (Ug5.25, Ug5.24, and Ug5.28) with lesser brown clays (Ug5.34). Small levees adjacent to some stream channels have other uniform-textured soils (Uf6.32, Uf6.33) and (Um5.52). Also associated are small areas of loamy duplex soils (Dy2.13), (Dy2.33), (Db1.13), (Dy3.13), and (Db1.43), which are often scalded. On levees of some major streams and channels are deep loamy red earths (Gn2.13) with some carbonate nodules throughout the profile, and small areas of loamy red duplex soils (Dr2.13, Dr2.12). Occurs on sheet(s): 7,10"
"CC67"
"Alluvial plains with some old infilled channels: dominant soils are deep grey-brown cracking clays (Ug5.25, Ug5.24), with lesser brown clays (Ug5.34, Ug5.35). Small areas have a weak gilgai microrelief, and in some depressions there are massive cracking clays (Ug5.5) and (Ug5.4). The chief soils on stream levees are deep loamy red earths (Gn2.12), with lesser (Gn2.42), and deep loams (Um5.52). Fringing the clays are loamy duplex soils (Dr2.13), (Db1.13), and (Dy2.13), which are often scalded. Some smaller levees have deep uniform clays (Uf6.31) and (Uf6.51). Deep sandy red earths (Gn2.13, Gn2.12) occasionally occur in old infilled channels, and there are occasional small gravelly rises with deep loamy yellow earths (Gn2.22). Occurs on sheet(s): 7"
"CC68"
"Moderately undulating to rolling lands: dominant soils are deep grey-brown cracking clays (Ug5.24, Ug5.25), with lesser (Ug5.16). These soils often have quartz gravels on the surface and occasionally a slight gilgai microrelief. Associated soils are gravel-strewn loamy-surfaced duplex soils (Dr2.12), (Dr2.13), (Dr3.12), (Dy2.12), and (Dy2.13). Some stream levees have deep loamy red earths (Gn2.12). Data are fairly limited. Occurs on sheet(s): 7"
"CC69"
"Rolling lands with isolated, slightly higher, gravelly ridges: dominant soils are deep grey-brown cracking clays (Ug5.24, Ug5.25), with lesser (Ug5.16), often with quartz gravel on the surface. Associated are various gravelly-surfaced loamy duplex soils (Dr2.13), (Dr3.12), and (Dr3.13), with (Dy) and (Db) equivalents; sometimes these soils overlie a band of large waterworn quartz gravels at 20-30 in. On the higher ridges extremely gravelly loams (Um4.2) and (Um5.51), red earths (Gn2.12), and yellow earths (Gn2.22) occur; some earths have ironstone nodules in the profile and massive nodular laterite at shallow depths. Adjacent to streams are small areas of loamy red earths (Gn2.12, Gn2.13). Occurs on sheet(s): 7"
"CC70"
"Gently undulating plains: chief soils are deep grey-brown or brown cracking clays (Ug5.24, Ug5.25, Ug5.28) and (Ug5.34 and Ug5.35), varying locally in dominance. Adjacent to smaller stream channels and on levees are loamy red earths (Gn2.11, Gn2.12, and Gn2.13) or brown earths (Gn2.43) . Small low rises occur throughout the unit with quartz-gravel-strewn loamy duplex soils (Dr2.13), (Db1.13), (Dr2.12), and (Dy2.12) or earths (Gn2.22, Gn2.23) and (Gn2.12, Gn2.13). Occurs on sheet(s): 7,10"
"CC71"
"Narrow alluvial plains with many braided stream channels: chief soils are deep grey-brown or brown cracking clays (Ug5.25, Ug5.24, Ug5.28) and (Ug5.34, Ug5.35), varying locally in dominance. Associated are deep non-cracking clays (Uf6.33, Uf6.31). Minor associates are loamy duplex soils (Dy2.13) and (Db1.13) which usually have a scalded surface. Occurs on sheet(s): 7,10"
"CC72"
"Alluvial clay plains with small isolated areas of sands and earths of unit AC20: dominant soils are deep grey-brown and grey cracking clays (Ug5.24, Ug5.28), with lesser (Ug5.25). Some areas have a slight gilgai microrelief. Associated are loamy duplex soils (Dy2.13), (Dr2.13), and (Db1.13) and loamy yellow earths (Gn2.21); these often occur as scalded areas on the eastern margin of the unit. Occurs on sheet(s): 7"
"CC73"
"Very gently undulating plains, occasional areas have a slight gilgai microrelief: dominant soils are deep grey-brown cracking clays (Ug5.24), with lesser (Ug5.28). Near the margins of the unit some non-cracking clays (Uf6.33) occur; small scalded areas have loamy duplex soils (Dy2.13) and (Db1.13). Occurs on sheet(s): 7,10"
"CC74"

"Level alluvial plains with slight to moderate gilgai microrelief (12-24 in.): dominant soils are deep grey cracking clays (Ug5.24), with lesser (Ug5.28). Loamy duplex soils (Dy2.43) and (Dy2.33) and (Dy3) equivalents are the chief associated soils. These occur either as the depression soil of the weaker gilgaied areas or on flat, slightly higher, areas. Minor associated soils include loamy earths (Gn2.14) and (Gn2.44) on low stream levees and occasional friable earths (Gn3.53) and (Gn3.83). Occurs on sheet(s): 7"
"CC75"
"Gently undulating plains: dominant soils are deep grey-brown cracking clays (Ug5.24, Ug5.25). Associated are a range of loamy duplex soils (Db1.33), (Db1.13), (Dy2.33), and (Dy2.13), often occurring as scalded areas. At the margins gravelly loamy red duplex soils (Dr2.13) often occur. Old levees and outwash areas have loamy red earths (Gn2.12, Gn2.13), with occasional associated loamy duplex soils (Dy2.13), (Db1.13), and (Dr2.13). Occurs on sheet(s): 7,10"
"CC76"
"Plains with broad shallow depressions, some drainage-ways with narrow levees: chief soils are deep grey and brown clays (Ug5.24, Ug5.25) and (Ug5.34), often in gilgai complex with (Dy2.13, Dy2.12) soils. Other soils may occur. As mapped, small residual islands of unit My128 are included. Occurs on sheet(s): 10"
"CC77"
"Plains with low limestone rises: chief soils are grey and brown clays (Ug5.25, Ug5.24) and (Ug5.34, Ug5.37) with scattered slabs of limestones, but there are also some fairly extensive areas of (Gn3.52) and (Gn2.42) soils, and possibly other soils, especially in the western portions of the unit. Occurs on sheet(s): 10"
"CC78"
"Level or gently undulating plains with occasional very low gravelly rises: dominant soils are deep grey cracking clays (Ug5.24, Ug5.25), with lesser (Ug5.34, Ug5.35) and (Ug5.22). Associated on the small gravelly areas are loamy duplex soils (Dr2.13), (Db1.13), (Dy2.13), (Db1.33), (Dr2.43), and (Db1.43). Occurs on sheet(s): 10"
"CC79"
"Alluvial plains with numerous braided stream channels: dominant soils are deep grey cracking clays (Ug5.24, Ug5.25, and Ug5.28). Associated are loamy duplex soils (Dy2.13), (Dy2.33), (Dy2.43), (Db1 .33), and (Db1.13), often with scalded surfaces. Adjacent to some channels are bleached loamy red duplex soils (Dr2.43) with lesser (Dr2.13). Occurs on sheet(s): 10"
"CC80"
"Alluvial plains with occasional stream channels: dominant soils are deep grey cracking clays (Ug5.24, Ug5.25), with lesser brown clays (Ug5.34, Ug5.35). Gravel-strewn loamy duplex soils (Dr2.13), (Db1.13), (Dy2.13), (Dr2.43), (Db1.43), and (Dy2.43) are commonly associated and may be locally dominant, especially in eroded areas adjacent to small channels. Older stream levees have loamy red duplex soils (Dr2.42, Dr2.43) and (Dr2.13), with lesser (Db1.12), (Dr2.12), (Dy2.13), (Dr1.33), and (Dr1.43) soils; more recent levees have deep loamy or fine sandy red earths (Gn2.13, Gn2.12) and (Gn2.43, Gn2.42), with occasional deep sands (Uc5.21). Occurs on sheet(s): 10"
"CC81"
"As for unit CC80 but there are only occasional small areas of gravel-strewn loamy duplex soils. Occurs on sheet(s): 10"
"CC82"
"Gently undulating alluvial plains with occasional small low gravelly rises: dominant soils are deep grey cracking clays (Ug5.24, Ug5.25), with lesser brown clays (Ug5.34, Ug5.35). Associated are a range of loamy duplex soils (Dy2.13), (Dy2.33), (Dy2.43), (Db1.13), (Db1.33), and (Dr2.13) which may have gravelstrewn surfaces. On low rises are very gravelly loams (Um5.51) and (K-Um5.51), gravelly red earths (Gn2.11, Gn2.12) and (K-Gn2.11, K-Gn2.12), and occasionally very gravelly-surfaced red duplex soils (Dr2.43) and (Dr2.13). Loamy red earths (Gn2.12) occur on stream levees. Data are limited. Occurs on sheet(s): 10"
"CC83"
"Gently undulating plains: dominant soils are deep grey or grey-brown cracking clays, chiefly (Ug5.24), but with (Ug5.25, Ug5.27) and lesser brown clays (Ug5.34, Ug5.38). Associated soils are similar uniform clays (Uf6.31, Uf6.33, and Uf6.34) with a prominent surface mantle of coarse siliceous and ironstone gravels. These areas are often scalded and the soils have a thin surface crust. In areas where the surface is thicker there are loamy red or brown duplex soils (Dr2.13), (Dr2.33), (Db1.33), and similar (Dr1) and (Db0) soils. In some areas the unit may also include small areas of unit MM5. Occurs on sheet(s): 10"
"CC84"
"As for unit MM40 but deep grey cracking clays (Ug5.24) are greatly dominant over brown clays (Ug5.34). Occurs on sheet(s): 10"
"CC85"
"As for unit MM41 but grey clays (Ug5.24) occur throughout the unit and there are few, if any, gravel-strewn areas. Occurs on sheet(s): 10"
"CC86"

"Clay plains broken by low flat-topped sandy rises and occasional small sand dunes: chief soils are grey clays (Ug5.24). Associated are sandy neutral red earths (Gn2.12) on the low rises, possibly with some (Uc5.21) soils, and (Uc1.2) soils on the dunes. Occurs on sheet(s): 10"
"CC87"
"Flood-plains of major rivers consisting of numerous braided stream channels that are seasonally flooded, and slightly higher areas raised between the channels: chief soils are grey clays (Ug5.24) but other cracking clays such as (Ug5.34) and (Ug5.25) may occur. Occurs on sheet(s): 10"
"CC88"
"Clay plains marginal to major rivers and not channelled to the same extent as unit CC87; subject to seasonal inundation for the greater part; some sand dune and sand-hill areas: chief soils are grey clays (Ug5.24) but brown clays (Ug5.3) may occur also. There are (Uc1.2) soils on dunes and sand-hills, while other soils (undescribed) may occur on the flanks of the sandy areas. Occurs on sheet(s): 10"
"CC89"
"Older alluvial flood-plains of major rivers that are only rarely flooded and have low sandy rises and high sand dunes: chief soils are grey clays (Ug5.24) but some brown clays (Ug5.3) occur also. Associated are (Gn2.12) soils on the sandy rises and (Uc1.23) sands, and possibly other sands such as (Uc5.1), on the dunes. Other soils (undescribed) may occur on the flanks of the sandy areas and dunes. Occurs on sheet(s): 10"
"CC90"
"Clay plains with sand dunes and low broad sandy rises: chief soils are grey and brown clays (Ug5.24) and (Ug5.34, Ug5.38). Associated are (Gn2.12) and (Uc5.21) soils on the sandy rises and (Uc1.23) and (Uc5.21) soils on the dune areas. Other soils may occur. Occurs on sheet(s): 10"
"CC91"
"Clay plains broken by low sandy and/or gravelly rises and occasional sand dunes: chief soils are grey and brown clays (Ug5.2), (Ug5.5), and (Ug5.3); the (Ug5.5) clays are common on clay pans. Associated are (Gn2.12) soils on the low rises, (Uc1.23) sands on the dunes, and various (largely undescribed) soils on intermediate landscape positions. Occurs on sheet(s): 10"
"CC92"
"Clay plains generally similar to unit CC91 but with numerous longitudinal sand dunes largely of (Uc1.23) sands, but other soils may be present also. Occurs on sheet(s): 10"
"CC93"
"Older alluvial flood-plains of major rivers that are not frequently flooded: chief soils are grey clays (Ug5.24). Associated are probably some brown clays (Ug5.3), and there are some areas of (Dr1.33) soils covered with gravels and stones. Other soils may occur. Occurs on sheet(s): 10"
"CC94"
"Flood-plains with a moderate number of stream channels and broken by sand dunes: chief soils are grey and brown clays (Ug5.24) and (Ug5.34). Associated are the (Uc1.23) soils of the dunes; calcareous pans are exposed near the base of some dunes. Other soils are likely. Occurs on sheet(s): 10"
"CC95"
"Clay plains subject to seasonal inundation: chief soils are grey clays (Ug5.24). Associated are small areas of the soils of unit MM59. Occurs on sheet(s): 10"
"CC96"
"Flood-plains subject to inundation but with a low to moderate frequency of stream channels; some sand dunes: chief soils are grey clays (Ug5.24). Associated are brown clays (Ug5.34) on scalded areas: (Dr2.33) and (Dr1.33) soils on banks and also slopes from dunes; and (Uc1.2) sands on dunes. Other soils, including (Gn2.1), may occur and there are sandy and stony deposits in places. Occurs on sheet(s): 10"
"CC97"
"Clay plains with seasonally flooded channel areas: chief soils are grey clays (Ug5.24) in the channel zones with brown clays (Ug5.34) on the slightly raised portions of the plain. Associated are (Dr) and (Db) soils, such as (Dr2.33); and there are some relatively higher areas of (Gn2.12) soils underlain by red-brown hardpan in places. Occurs on sheet(s): 10"
"CC98"
"Clay plains with numerous small clay pans, low dunes and possibly lunettes, and some low sandy rises: chief soils are grey clays (Ug5.2) and (Ug5.5). The latter occur mainly in clay pans. Associated are some (Ug5.3) clays, (Uc1.2) sands on the dunes and lunettes, and (Gn2.12) and (Uc5.21) soils on the low rises. Other soils may occur. Occurs on sheet(s): 10"
"CC99"
"Flood-plains subject to seasonal inundation with some stream channels and swamps: chief soils are grey clays, probably (Ug5.24, Ug5.28). Associated are some sand dunes (Uc1.2) and some small areas similar to unit My149. Data are limited. Occurs on sheet(s): 10"
"CC100"

"Flood-plains subject to seasonal inundation, some channel areas; some lakes and clay pans; some longitudinal sand dunes: chief soils are grey clays (Ug5.2) and probably (Ug5.5) in clay pans. Other soils may occur and include the (Uc1.2) sands of the dunes. Occurs on sheet(s): 10"
"CC101"
"Plains that are only rarely flooded; some sand dunes: chief soils are grey and brown clays (Ug5.2) and (Ug5.3). Other soils include the siliceous sands (Uc1.22, Uc1.21, and Uc1.23) of the dunes. Some (Dr1.32, Dr1.33) soils may occur locally. Occurs on sheet(s): 10"
"CC102"
"Flood-plains with some distributary channels and areas subject to seasonal flooding; many shallow sand drifts and some sand dunes: chief soils are grey clays (Ug5.2) but brown clays (Ug5.3) may occur; they may be quite saline in places. Associated are (Uc1.2) sands on the dunes. Occurs on sheet(s): 10"
"CC103"
"Clay plains with more or less widely spaced longitudinal sand dunes and some clay pans; some areas may be flooded on occasions: chief soils are grey clays (Ug5.2), some of which may be quite saline. Associated are (Ug5.5) clays in the clay pans and (Uc1.21, Uc1.22, and Uc1.23) sands on the dunes. Other soils may occur, especially on dune flanks. Occurs on sheet(s): 10"
"CC104"
"Clay plains with widely spaced longitudinal dunes: chief soils are grey and brown clays (Ug5.2) and (Ug5.3). Associated are the (Uc1.21, Uc1.22, and Uc1.23) sands of the dunes. Other soils may occur, especially on dune flanks. Occurs on sheet(s): 10"
"CC105"
"Small clay plains variably subject to inundation: chief soils are grey and brown clays (Ug5.2) and (Ug5.3), either of which may be dominant locally. Other soils may occur. Occurs on sheet(s): 10"
"CC106"
"Clay plains with some distributary channels; subject to variable flooding: chief soils are grey clays (Ug5.2) and (Ug5.5). Other soils may occur. Occurs on sheet(s): 10"
"CC107"
"Clay plains with distributary channels and subject to some seasonal inundation: chief soils are grey clays (Ug5.2) with a very weak gilgai microrelief. Other soils may occur, especially (Ug5.5) clays. Small sand dunes and sand drifts are included locally. Occurs on sheet(s): 10"
"CC108"
"Similar to, and flanking, unit CC107 but traversed by longitudinal dunes of siliceous sands (Uc1.2). Other soils may occur on the flanks of the dunes. Occurs on sheet(s): 10"
"CC109"
"Flood-plains subject to seasonal inundation; some distributary channels; some sand drifts and sand dunes: chief soils are probably grey clays (Ug5.2). Associated are a variety of soils (mostly undescribed), including (Uc1.2) soils on the sandy areas. Occurs on sheet(s): 10"
"CC110"
"Flood-plains: soils are very variable but chief soils are probably grey and brown clays (Ug5.2) and (Ug5.3). Associated are (Dr1.33) and similar soils, and sandy (Uc) and loamy (Um) alluvial soils. Data are very limited. Occurs on sheet(s): 10"
"CC111"
"Flood-out area: plains of cracking clays, chiefly (Ug5.2) and (Ug5.5), but other soils may be present also. Occurs on sheet(s): 10"
"CC112"
"Narrow valley plains, commonly with many distributary channels; some clay pans and flood-out areas: chief soils are probably grey clays (Ug5.2). Associated are small areas of many other soils (undescribed). Occurs on sheet(s): 10"
"CC113"
"Plains with many distributary channels; clay pans; some sand dunes: chief soils are grey and brown clays (Ug5.2) and (Ug5.3). Associated are (Ug5.5) clays in clay pans and (Uc1.2) sands on dunes. Other soils may occur. Occurs on sheet(s): 10"
"CC114"
"Plains--flood-out areas subject to periodic inundation: chief soils are grey clays (Ug5.2). Other soils are likely to occur also. Occurs on sheet(s): 10"
"CC115"
"Plains--flood-out areas with distributary channels: chief soils are grey and brown clays (Ug5.2) and (Ug5.3). Other soils may occur. Occurs on sheet(s): 10"
"CC116"

"Flood-plains subject to inundation with sandy rises and dunes: chief soils are grey and brown clays (Ug5.24) and (Ug5.34). Associated are the (Gn2.12, Gn2.13) soils of the sandy rises and the (Uc1.23) sands of the dunes. Other soils may occur. Occurs on sheet(s): 10"
"CC117"
"Plains: chief soils are grey clays (Ug5.2). Associated are brown clays (Ug5.3). Other soils may occur. Occurs on sheet(s): 10"
"CC118"
"Plains with some low ridges; some tracts of low dunes; and saline, normally dry lakes: soils are very variable, but chief soils are probably cracking clays (Ug5.2), (Ug5.3), and (Ug5.5). Associated are (Dr1.33) and (Dr1.43) soils on ridges and their slopes, (Gc) soils on the plains, and (Uc1.2) soils on dunes. Other soils may occur. Occurs on sheet(s): 10"
"CC119"
"Flood-plain, only small areas of which are subject to seasonal inundation: chief soils are probably cracking clays (Ug5.2), (Ug5.3), and (Ug5.5). Associated are a wide range of soils, largely undescribed. Occurs on sheet(s): 10"
"CC120"
"Basin plain: chief soils are cracking clays (Ug5.2), (Ug5.3), and (Ug5.5). Occurs on sheet(s): 10"
"CC121"
"Valley plains with sand-hills and mound springs: chief soils are probably cracking clays (Ug5.2) and (Ug5.5) but there are large areas of (Uc) sands. There is also a sand cover over the clays in some areas. Occurs on sheet(s): 10"
"CC122"
"Clay plains and clay pans: chief soils are cracking clays (Ug5.2) and (Ug5.5). Other soils may occur. Occurs on sheet(s): 10"
"CM1"
"Gently undulating to undulating plains: dominant soils are loamy nodular grey earths (Gn2.82, Gn2.81) which are often mottled. Associated are various earths (Gn2.61), (Gn2.62), (Gn2.42), (Gn2.22), (Gn2.15), and (Gn2.12). Loamy duplex soils (Dy2.1), (Dy3.1), and (Db1.1) occur at the margins of the unit, and in some depressions are deep grey-brown cracking clays (Ug5.24, Ug5.25) and (Ug5.34). Occurs on sheet(s): 7"
"CM2"
"Gently undulating stream flood-plains cut by many old channels: dominant soils are loamy grey earths (Gn2.82), with lesser (Gn2.83) and (Gn2.41, Gn2.43). Associated are loams (Um5.52) and sands (Uc5.21) on the infilled channels. Also occurring are moderately deep-surfaced (6 10 in.) loamy bleached alkaline duplex soils such as (Dy2.43), and lower areas of grey cracking clays (Ug5.5) and (Ug5.24) of unit 009. Occurs on sheet(s): 7"
"Ca1"
"Dune formations: leached sands (Uc2.21) with areas of exposed sheet limestone; lesser areas of shallow red-brown sandy soils (Uc6.13) on limestone and of sandy alkaline yellow mottled soils (Dy5.43). Occurs on sheet(s): 1"
"Ca2"
"Sandhills and small plains: leached sands (Uc2.21) on jumble sandhills and teardrop sand-ridges; small intervening plains of sandy neutral or sandy alkaline yellow mottled soils (Dy5.42 and Dy5.43); occasional flats of hard alkaline dark soils (Dd1.23). Area has clay substrata. Occurs on sheet(s): 1"
"Ca3"
"Undulating land with dunes and sandhills: leached sands (Uc2.21) on sandhills and dunes with other leached sands (Uc2.11) overlying limestone on dunes and sandy alkaline yellow mottled soils (Dy5.43 and Dy5.83) on the undulating land; lesser areas of exposed limestone and shallow red-brown sandy soils (Uc6.13); hard alkaline red soils (Dr2.23) and cracking grey clays (Ug5.2) in small basin plains; saline soils (unclassified) in depressions, swamps, and around lakes. Area has limestone substrata. Occurs on sheet(s): 1"
"Ca4"
"Low coastal hills: irregular low hills of leached sands including (Uc2.21 and Uc2.22) and (Uc2.33 and Uc2.36) with small basin plains of sandy yellow mottled soils (Dy5.4 and Dy5.8) and some swampy areas of undescribed soils. Occurs on sheet(s): 2"
"Ca5"
"Dunes of leached sands (Uc2.21) adjoining calcareous dunes of dark, shallow, porous loamy soils (Um6.21), dark crumbly clays (Uf6.11), and shallow sand soils (Uc4.1), with other soils such us (Dy5.2) and (Db1.1) in junction areas between the two dune systems, some layering of soil materials is evident; some undulating areas of siliceous sands (Uc1.21) occur between the dunes. Occurs on sheet(s): 2"
"Ca6"
"Dunes of leached sands (Uc2.2) with some areas of (Uc2.3) soils in low-lying situations, also (Dy5.41) soils in some localities, and flanked by some dunes of calcareous sands (Uc1.11) along the coast. Occurs on sheet(s): 2,3"
"Ca7"

"Old sand dune and swamp system of gently undulating dune-swale succession: dunes of leached sands (Uc2.21 and Uc2.22) with extensive undulating areas of leached sands, such as (Uc2.2), (Uc3.2), and (Uc2.3). Associated are swamplands of (Uc2.2) sands with variable peaty and/or clayey layers on the surface, some acid peats (O) and plastic clays (Uf6.61) also with variable peaty surfaces in the lower-lying portions. As mapped, small areas of neighbouring units are included. Often this unit is separated from unit A9 by an elongate swamp. Occurs on sheet(s): 3"
"Ca8"
"Rounded hills and spurs with gentle slopes and some knolls of lateritized rock: chief soils are leached sands (Uc2.22), with (Dy5.41) and (Gn2.8) soils. Associated are such soils as (Dy3.43), (Dg2.82), and (Dd1.43) on lower slopes and in the narrow valleys, where (Gn2.61) soils may be present also; and small to moderate areas of unit Fz3 on some flat-topped hills. Occurs on sheet(s): 4"
"Ca9"
"Mature coastal sand plain with low dunes approx.25 ft above sea level: chief soils on the broad low sandy banks (dunes) are deep leached sands (Uc2.2), together with (Uc2.33) and (Uc2.31) sands on the slopes and flatter positions. Associated are: (Dg2.41), (Dg2.81), and (Dg2.82) soils in the broader depressions; organic loamy soils (Dy4.13) in former tidal inlets, now slight depressions; and (Dg4.81) soils in some inland depressions. As mapped, small areas of adjoining units, notably narrow strips of the modern beach dunes, unit A10, and in places (inland) unit MT1 are included. Occurs on sheet(s): 4"
"Ca10"
"Undulating to rolling, roughly parallel old dune systems, also with some higher "hilly"dune features but with some present fore-dunes where this unit includes the coastline: chief soils are deep leached sands (Uc2.2). Associated are (Uc2.3) soils in some interdune areas and small sand plains, and (Uc1.22) soils on the present fore-dunes. Other soils may include some acid peats (O), (Gn2.94), (Dg4.81), and (Dg2.63) soils in low-lying situations. As mapped, small areas of units Cb33 and Bl 8 are included. Occurs on sheet(s): 4"
"Ca11"
"Old dune system parallel to the present coastline with low broad dunes less than 25 ft above sea level; some swampy swales: chief soils are deep leached sands (Uc2.2) with a water-table often between 5 and 9 ft in depth. Associated are (Uc2.33) soils in swales and on lower dune slopes. Other soils include acid peats (O) in swampy swales, (Uc2.20) soils on dune side slopes, and (Dg4.81) soils in swales. Occurs on sheet(s): 4"
"Ca12"
"Coastal plain: chief soils are deep leached sands (Uc2.2) and (Uc2.33) soils, some have a peaty surface in treeless areas where acid peats (O) may occur also. Small areas of other soils occur. Data are very limited. As mapped, areas of unit Mb10 are included. Occurs on sheet(s): 4"
"Ca13"
"Small low dunes less than 25 ft above sea level; modern coastal dunes with swampy depressions behind them: chief soils are leached sands (Uc2.21) on dune crests and (Uc2.22) in swales. Associated are (Uc1.21) soils on the coastal dunes, and (Uc2.33) soils on included old dunes. Other soils include deep (Uc2) on old dunes, acid peats (O) in swamps, and (Dg4.81) in swampy depressions. Occurs on sheet(s): 4"
"Ca14"
"Porphyry--steep hilly to mountainous--steep to very steep side slopes to narrow valleys, much bare rock in places: chief soils are leached sands (Uc2.21) with a notably organic surface soil. Associated are shallow (Uc2.12) sand soils. Other soils include (Gn3.11) on basic dykes and (Gn3.71), (Gn3.54), (Um4.1), and (Dr2.21) on phyllitic hills. Occurs on sheet(s): 4"
"Ca15"
"Moderately hilly granitic country with short steep slopes down from plateau scarps at 1200 ft above sea level to low hilly areas at 400 ft or less with smooth crests and gentle slopes: chief soils are leached sands (Uc2.21), with (Uc4.1) and (Uc4.2) on all higher slopes and crests, sometimes stony. Associated are (Dr4.41), (Dr4.21), and (Dr4.61) soils on mid to lower slopes. Minor soil occurrences include (Dy2.41) and (Gn2.11) on lower slopes. Occurs on sheet(s): 4"
"Ca16"
"Strongly undulating or low hilly lands with some granite tor outcrop: dominant soils are shallow to moderately deep, often stony, gritty bleached sands (Uc2.21) and (Uc2.12); other sands (Uc4.1) and (Uc4.2) also occur. Common associated soils are gritty sandy or loamy red duplex soils (Dr2.61) and (Dr2.22), with lesser yellow duplex soils (Dy3.42) and (Dy2.22) on some lower slopes. On some outwash fans gritty red earths (Gn2.14, Gn2.15) may occur. Data are fairly limited. Occurs on sheet(s): 4,7"
"Ca17"
"Undulating outwash fans with occasional low stony granite hills: dominant soils are shallow to moderately deep (20 40 in.) gritty bleached sands (Uc2.21). Other sand soils are (Uc4.32) and (Uc2.12). Adjacent to most drainage lines are sandy or loamy duplex soils (Dy3.41, Dy3.42). The stony hills mostly have shallow (Uc2.12) soils with much rock outcrop. Data are fairly limited. Occurs on sheet(s): 4,7"

"Ca18"
"Coastal plain of flats and broad low sandy banks along shallow swampy depressions; also low dune systems: chief soils are leached sands (Uc2.21). Associated are (Gn3.94) soils over calcareous clay D horizons in the lower-lying areas, and (Gn2.9) and/or (Dg4.8) soils in the swampy depressions. The whole area is traversed by low coastal dunes with (Uc4.2) soils on crests and slopes, (Uc2.21) soils in swales, and (Dy5.51) soils in swampy depressions. The dunes are parallel to the present coastline. Occurs on sheet(s): 4"
"Ca19"
"Low-lying poorly drained plains: chief soils are leached sands (Uc2.2 and Uc2.3) the latter more common in the flatter, wetter sites and the former in the better-drained marginal areas. Associated are a variety of soils in shallow depressions and swampy drainage-ways, including acid peats (O); (Dy5.41) and (Uc2.12) soils overlying block laterite. Occurs on sheet(s): 5"
"Ca20"
"Coastal dunes and plains: chief soils are leached sands (Uc2.21) of the inland dunes where there are swampy interdune flats of leached sands (Uc2.34). Associated are unconsolidated dunes of calcareous sands (Uc1.11) and a plain also of calcareous sands (Uc1.11) with small freshwater swamps fronting the coast. The dunes of leached sands are underlain by calcareous sandy materials at depths of 3-7 ft. Occurs on sheet(s): 5"
"Ca21"
"Stream valleys--broken terrain with deep sand deposits and rock outcrops: chief soils are leached sands (Uc2.21) and (Uc2.3). Associated are a variety of soils as for unit Ub94. Occurs on sheet(s): 5"
"Ca22"
"Dune and swale formations along stream valleys: chief soils are leached sands (Uc2.21) on the dunes with sandy and/or hard neutral and alkaline yellow mottled soils (Dy5.42 and Dy5.43) and (Dy3.42 and Dy3.43) in the swales. Associated are: some plain areas of unit Va64; some lateritic mesas of (Dy3.8) and other soils; and small areas of other undescribed soils seem likely. Occurs on sheet(s): 5"
"Ca23"
"Undulating plain or plateau at low elevation, having a pronounced ridge and depression sequence, some flats, swamps, and lakes: chief soils seem to be leached sands (Uc2.2 and Uc2.3), which occur (i) on upland areas where they have developed in the A horizons of (Dy5) soils where these are deep, or on sand deposits overlying boulder laterite, and (ii) on slopes and in depressions where the (Uc2.33) soils, some of which have peaty surfaces, dominate. Associated are: ironstone gravelly ridges with a variety of (Dy) soils, such as (Dy5.81), (Dy3.8), and (Dr5.84), all containing ironstone gravel or laterite layers; areas of boulder laterite on ridges; (Uc2.21) soils on dunes adjacent to lakes and swamps; and flats and swamps of (Dy5.42) soils which, however, are not extensive. There are strong similarities with units Cb42 and Wd7. Occurs on sheet(s): 5"
"Ca24"
"Gently undulating plain with some small swampy areas: chief soils seem to be shallow leached sands such as (Uc2.21) and (Uc2.32) on boulder laterite layers with (KS-Uc2.12) gravels on indurated and mottled layers, and (Dy5.81) with ironstone gravel and (Dy5.84) soils in rapid succession on the gently undulating slopes of the plain. Associated soils are not known but could be similar to those for unit Wd7 with which it merges. Occurs on sheet(s): 5"
"Ca25"
"Gently undulating plain with very low dunes, salt lakes, some small flats, and seasonal swamps: chief soils are leached sands (Uc2.22) and possibly (Uc2.21) underlain by yellow-brown clays at about 3 ft, and below which mottled-zone materials occur at about 5 ft. Associated are small areas of (Dy) and (Dg) soils possibly similar to those for unit Xd1 in the flats and swamps. Data are limited. Occurs on sheet(s): 5"
"Ca26"
"Hills, small ranges of hills, headlands and off-shore islands, bare rock walls: granitic bosses and tors with shallow leached sands (Uc2.22). Associated are small areas of other soils (undescribed). Coastal occurrences may also have dunes of (Uc2.2) and/or (Uc1) sands piled up against the rocks. Occurs on sheet(s): 5"
"Ca27"
"Sandy plains with occasional pockets of sand dunes, a few small swamps, and stream courses: chief soils are leached sands (Uc2.21), often with a sandy clay substrate between 3 and 6 ft in depth. Associated are (Dy5.61) and gravelly (Dy5.81) soils with (Uc1.22) soils on the dunes. Occurs on sheet(s): 5"
"Ca28"
"Gently undulating sand plain with occasional low lateritic residuals: chief soils are leached sands (Uc2.21) and yellow siliceous sands (Uc1.22). Occurs on sheet(s): 5,6"
"Ca29"
"Gently undulating alluvial plains: dominant soils are deep nodular bleached sands (Uc2.21) occurring on stream levees. Associated are deep loamy earths (Gn2.41) and (Gn2.81) and sandy earths (Gn2.91, Gn2.94). Marginal to the unit and in lower sites are loamy duplex soils (Dy2.33), (Dy2.13), and (Dy3.33), and massive cracking clays (Ug5.5). Occurs on sheet(s): 7"

"Ca30"
"Undulating to moderately undulating lands with occasional low granite hills: dominant soils are moderately deep to deep coarse bleached sands (Uc2.21), with lesser (Uc4.22, Uc4.21); the latter may occasionally be locally dominant. Minor associated soils include sandy red or yellow earths (Gn2.15) and (Gn2.25), and loamy duplex soils (Dy3.42, Dy3.41) and (Dy2.42) that occur in the floors of the major drainage lines. Occurs on sheet(s): 7"
"Ca31"
"High hilly to mountainous lands with very steep slopes and much granite or other acid igneous rock outcrop: dominant soils are moderately deep to deep strongly bleached yellowy sands (Uc2.21), with other bleached sands (Uc2.12) and (Uc3.21) closely associated. Also common are other uniform sands (Uc4.2), sandy red earths (Gn2.17), and similar red earths with a conspicuous bleach. Sandy or loamy duplex soils (Dy3.42), (Dr2.22), and (Dy2.22) occur on some lower slopes and in drainage lines. Data are limited. Occurs on sheet(s): 7"
"Ca32"
"Gently undulating outwash plains with some isolated low hills near the margins of the unit: dominant soils are moderately deep to deep bleached sands (Uc2.22), with similar sands (Uc2.12) and (Uc4.22, Uc4.21) closely associated. Included in the unit are small areas of shallow loamy duplex soils (Dy3.43), (Dy3.33), and dark cracking clays (Ug5.14, Ug5.13). Occurs on sheet(s): 7"
"Ca33"
"Gently undulating to undulating lands with occasional low rocky hills; some granite tor outcrop also occurs on areas of lesser relief: dominant soils are moderately deep bleached sands, chiefly (Uc2.22) but with large areas of (Uc2.21) and lesser (Uc2.12) soils. Other shallow to moderately deep sands (Uc4.12) and (Uc4.21, Uc4.22) occur on higher slopes and adjacent to rock outcrop. A range of loamy duplex soils (Dr2.81), (Dr2.41), (Dr3.31), (Dr3.41), (Dy3.32), and (Dy3.43) occur on lower slopes. Included are small areas of loamy red or yellow earths of unit Mw46, chiefly (Gn2.14), with lesser (Gn2.15) and (Gn2.24). Occurs on sheet(s): 7"
"Ca34"
"Strongly undulating lands with many low stony rises; granite tor outcrop is very common: dominant soils are shallow to moderately deep gritty bleached sands; (Uc2.22) is probably most common but (Uc2.21) and (Uc2.12) also occur widely. Other shallow sands (Uc4.21), (Uc4.11), and (Uc4.12) occur on the stony rises and adjacent to rock outcrop. Occurs on sheet(s): 7"
"Ca35"
"Hilly or high hilly lands with many sandstone mesas bounded by steep scarps; the area is often dissected by streams to form narrow steep-sided ravines and deep valleys; massive sandstone outcrop is often prominent: dominant soils are shallow to moderately deep gravelly bleached sands (Uc2.21), often with red subsoils. On more gentle dip slopes or more extensive plateau surfaces, sandy red earths (Gn2.14, Gn2.15, and Gn2.11) are common, with lesser sandy yellow earths (Gn2.24), (Gn2.34), and (Gn2.74). Duplex soils occur on some steeper slopes, particularly associated with shale outcrops, the chief forms being (Dy3.41), (Dy5.41), and (Dr2.41). Around the dissected margins of the unit there may be small eroded exposures of unit Fu25. Data are fairly limited. Occurs on sheet(s): 7"
"Ca36"
"Moderately or occasionally gently undulating lands with some low eroded sandstone mesas: dominant soils are deep bleached sands (Uc2.21). with associated leached sands (Uc4.22, Uc4.21). Shallower sands (Uc2.21) and (Uc2.12) occur on the eroded sandstone mesas. On broad ridge crests are areas of deep sandy red earths (Gn2.14), with sandy bleached mottled yellow earths (Gn2.74) usually associated downslope. In better-defined drainage depressions grey duplex soils (Dy3.42, Dy3.43) occur, also similar (Dy2) soils. Data are fairly limited. Occurs on sheet(s): 7"
"Ca37"
"Strongly undulating lands with some low sandstone hills and dissected mesas: dominant and associated soils are as for unit Ca36, but with a greater proportion of shallow to moderately deep bleached sands (Uc2.21). Data are very limited. Occurs on sheet(s): 7"
"Ca38"
"Sandy infilled old stream channels and levees with some shallow functional streams: dominant soils are deep bleached sands (Uc2.21), with some deep sandy duplex soils (Dy3.81), and (Dy3.41, Dy3.42) and bleached sandy yellow or grey earths (Gn2.34), (Gn2.74), and (Gn2.94, Gn2.95) occurring on the broader levees and small flood-plains. Data are limited. Occurs on sheet(s): 7"
"Ca39"
"Undulating to gently undulating plains with prominent shallow drainage depressions: dominant soils are deep mottled bleached sands (Uc2.22), with other deep sands (Uc2.21), (Uc5.22), and (Uc4.21) also occurring. Associated are deep sandy yellow earths (Gn2.74), (Gn2.34), and (Gn2.24). Sandy or loamy bleached grey earths (Gn2.95, Gn2.94), and loamy mottled duplex soils (Dy3.43, Dy3.42) occur in the shallow drainage depressions. Data are fairly limited. Occurs on sheet(s): 7"
"Ca40"

"Gently undulating plains with shallow well-defined drainage depressions: dominant soils are deep bleached sands (Uc2.21), with occasional (Uc2.12); quartz gravel may be prominent at depth in some profiles. Associated are some deep sandy bleached grey earths (Gn2.94), with very occasionally some sandy bleached yellow earths (Gn2.34) and (Gn2.74), or, on higher broad ridge crests, sandy red earths (Gn2.14). The drainage depressions have sandy or loamy bleached duplex soils (Dy3.42, Dy3.41, or Dy3.43), and occasionally similar (Dy2) soils. Occurs on sheet(s): 7"
"Ca41"
"Undulating to moderately undulating lands with occasional granite tor outcrop: dominant soils are deep bleached sands (Uc2.21), with (Uc2.23) often associated. Near granite outcrop shallow to moderately deep bleached sands (Uc2.12) are common, with occasional (Uc4.11), (Dr2.81), (Dy3.81), (Dy2.81), and (Gn2.34). On some higher broad ridge crests deep sandy red earths (Gn2.14) or bleached earths (Gn2.74) and (Gn2.94) occur. In shallow drainage depressions are sandy or loamy duplex soils (Dy3.42) and (Dy2.42) or occasionally bleached grey earths (Gn2.94, Gn2.95). Occurs on sheet(s): 7"
"Ca42"
"Gently undulating to undulating plains and outwash fans from the granite hills of units JJ48, JK35, and WM1; shallow well-defined drainage depressions are common: dominant soils are deep bleached sands, chiefly (Uc2.21), occasionally (Uc2.23) and (Uc2.33). On higher ridge crests there may be small areas of deep sandy red earths (Gn2.14), with other deep sandy earths (Gn2.74) and (Gn2.94) associated. The shallow drainage depressions have sandy or loamy duplex soils (Dy3.42, Dy3.43), or occasionally bleached grey earths (Gn2.94, Gn2.95). Where the unit adjoins the granite hills relief is stronger and there may be some granite outcrop on higher ridges with shallow bleached sands (Uc2.12), shallow stony duplex soils (Dy3.41), (Dy3.81), (Dy3.21), and (Dy2.21), and shallow gravelly grey earths (Gn2.94) and (Gn2.84). Occurs on sheet(s): 7"
"Ca43"
"Level or very gently undulating sandy plains, mostly fringing drainage lines. Free water is often present either at the surface or at shallow depths for long periods of the year; small swamps are common in some localities: dominant soils are deep bleached sands (Uc2.21), less commonly (Uc2.23). A weak organic B horizon may be present in some soils (Uc2.33, Uc2.31). Other sands (Uc1.21) and (Uc4.21) also occasionally occur. On slightly higher sites and marginal low rises there are deep sandy earths (Gn2.64) and (Gn2.74), and, as mapped, the unit may include small undulating areas of red or yellowish red earths of units Mw56 and Mr21. Where the unit is adjacent to unit B36 there may be included small vegetated remnant low sand dunes with (Uc1.21) soils. Small areas of salt pans and mangrove swamps occur where the unit is adjacent to the coast. Occurs on sheet(s): 7"
"Cb1"
"Hilly with a few swampy areas: leached sands (Uc2.31 and Uc2.32) on the hills with some (Uc2.33) at lower levels; small areas of shallow hard alkaline red soils (Dr2.23) and shallow red-brown sandy soils (Uc6.13) on limestone with very localized occurrences of friable neutral red soils (Dr4.12) and brown friable earths (Gn3.22) in the vicinity of old volcanic cones. Occurs on sheet(s): 1"
"Cb2"
"Plains, tracts of dunes, and low limestone ridges: dunes of leached sands (Uc2.31 and Uc2.32) and shallow red soils on limestone (Uc6.13), (Um6.24), and (Dr4.53) plains of (Uc2.3), and sandy alkaline yellow mottled soils (Dy5.43 and Dy5.83 (.82) with smaller areas of shallow dark cracking clays (Ug5.11) and other cracking clay soils (Ug5) in lower-lying situations. Occurs on sheet(s): 1"
"Cb3"
"Dune and swale: dunes of leached sands (Uc2.3) and (Uc2.2) which increases in area in the northern portion of the unit, shallow red-brown sandy soils (Uc6.13), and exposed limestone; swales of sandy alkaline yellow mottled soils (Dy5.43 (2) and Dy5.83 (2) and lesser areas of hard alkaline red soils (Dr2.23) and hard alkaline yellow soils (Dy2.23). Swamps in low-lying situations. This unit gradually merges into Cb4. Occurs on sheet(s): 1"
"Cb4"
"Dune and swale: dunes of leached sands (Uc2.31 and Uc2.32) and swales of leached sand with coffee rock (Uc2.33); small areas of sandy yelloW mottled soils (Dy5.4 and Dy5.8). Swamps in low-lying situations. Occurs on sheet(s): 1"
"Cb5"
"Plains and swamps with some dunes: leached sands with coffee rock (Uc2.33) on plains and variations of these soils with highly organic surface soils in the wetter situations; small areas of sandy yellow mottled soils (Dy5.4 and Dy5.8); leached sands (Uc2.3) on dunes. Swamps in low-lying situations. Occurs on sheet(s): 1"
"Cb6"
"Hilly with small wet valleys: hills and hillocks of various kinds of leached sands (Uc2.3) with small areas of red and yellow earths (Gn2.1 and Gn2.2) on slopes and spurs; hard acid brown soils (Db1.21) and possibly similar yellow soils on flat-topped ridges; leached sands (Uc2.33) with highly organic surfaces (fibrous peat 12-18 in. thick) in the small wet valleys. Occurs on sheet(s): 1"
"Cb7"

"Dissected tableland with dunes and swamps: leached sands (Uc2.3 and Uc2.2) on dunes with leached sands containing coffee rock (Uc2.33) and sandy yellow mottled soils (Dy5.8 and Dy5.4) which may be locally dominant on the flatter areas. Swamps in low-lying situations. Occurs on sheet(s): 1"
"Cb8"
"Undulating land: leached sands (Uc2.3 including Uc2.33) in association with hard acidic yellow mottled soils (Dy3.61), some of which contain ironstone gravel, and sandy neutral yellow mottled soils (Dy5.82); small areas of shallow sand soils (Uc4.11) and shallow grey-brown sandy soils (Uc6.11) on ridge and hilltops. Occurs on sheet(s): 1"
"Cb9"
"Coastal lowlands: undulating area of various leached sands (Uc2.3) including (Uc2.33) with a clay D horizon, other undescribed soils especially in the low-lying swampy areas. Occurs on sheet(s): 2"
"Cb10"
"Hilly: moderate to steep slopes of various leached sands (Uc2.3) some with clay D horizons, also other soils such as (Um2.3), some with clay D horizons, and with narrow incised drainageways of various hard yellow mottled soils (Dy3). Occurs on sheet(s): 2"
"Cb11"
"Undulating to low hilly: undulating to broken hilly terrain of leached sands (Uc2.3) with undescribed soils in the low-lying swampy situations; some small areas of red, porous, friable earths (Gn4.11) on low hills and hill slopes. Occurs on sheet(s): 2"
"Cb12"
"Coastal plains: swampy plains of leached sands (Uc2.3) and other undescribed soils, including saline kinds. Occurs on sheet(s): 2"
"Cb13"
"Low coastal hills: low hills of leached sands (Uc2.32) and other (Uc2.3) soils with small plains of hard neutral yellow mottled soils (Dy3.42), and some swampy areas of undescribed soils. Occurs on sheet(s): 2"
"Cb14"
"Coastal lowlands: irregular hilly dunes of leached sands (Uc2.33) with swampy areas of acid peats (O) and also other undescribed soils between the dunes. Occurs on sheet(s): 2"
"Cb15"
"Coastal plain: plain and very low dunes of leached sands (Uc2.33) with other undescribed soils especially in the lower-lying swampy areas, aud towards the coast. Occurs on sheet(s): 2"
"Cb16"
"Coastal dunes and flats: dunes of leached sands (Uc2.33 and Uc4.33) and minor areas (Uc2.21) parallel with the coast; and near the coast some areas of deep calcareous sands (Uc1.11), also lowlying flats with sand-spits and salt marshes of variable undescribed soils. Occurs on sheet(s): 2"
"Cb17"
"Coastal dunes and plains: partially drifting dunes of deep calcareous sands (Uc1.11) adjacent to the coast and passing inland to stabilized dunes of leached sands (Uc2.21) and thence to plains of leached sands (Uc2.33) with smaller areas of (Uc4.33, Uc3.33, and Uc2.22) and yellow leached earths (Gn3.84); occasional rock outcrops and low-lying swampy areas of varied soils including (Dd3.11), (Dd3.51), and acid peaty (O) soils. Occurs on sheet(s): 2"
"Cb18"
"Coastal plains: poorly drained low-lying coastal plains of leached sands (Uc2.33) with minor areas of sandy yellow mottled soils (Dy5.81); higher dissected coastal plains of leached sands (Uc2.33); both traversed by streams with terrace remnants of (Um6.32) and (Gn4) soils, alluvial fans and narrow floodplains of (U) soils; also narrow marine benches of (Dy5) and (Dy3) soils, occasional coastal dunes of (Uc2.2) and (Uc1.11) and swamps of (O). Occurs on sheet(s): 2"
"Cb19"
"Coastal plains dunes and hills: similar to Cb18 with hard yellow mottled soils (Dy3.4 and Dy3.6) on terraces and plains; also with some dunes similar to A8 and some hilly areas similar to Wd3 or Qa1. Occurs on sheet(s): 2"
"Cb20"
"Plains with some dunes and knolls: flat to undulating areas of leached sands (Uc2.33 and Uc2.32) some of which have clay D horizons; dunes of (Uc2.22 and Uc2.33); a few knolls of (Uc4.11) and (Dd1.21) soils also small areas similar to unit S2; swamps of (Um) and neutral peaty (O) soils. Occurs on sheet(s): 2"
"Cb21"
"Plains with some dunes; flat to undulating areas of leached sands (Uc2.33) with dunes of (Uc2.21) and (Uc2.33) and with swamps of (Um?6.11) and acid peaty (O) soils; traversed by streams with terraces and floodplains of (Uf) and (Um) soils; broken by a few low hills of (Uc4.11) soils. Occurs on sheet(s): 2"
"Cb22"

"Dunes and intervening lagoons with an ENE.-WSW. orientation: stabilized dunes of leached sands (Uc2.33, Uc2.36, and Uc4.33) and swamps and lagoons of (Dd3.13 and Dd4.63) soils with neutral peaty (O) soils. Occurs on sheet(s): 2"
"Cb23"
"Coastal plains: plains of leached sands (Uc2.33) and other (Uc2.3) soils in association with sandy acidic yellow mottled soils (Dy5.41 and Dy5.81) and small areas of (Dy3.4) soils with dunes of leached sands, (Uc2.2) on dune crests. and (Uc2.3) on dune slopes; and with small swampy areas and possibly some lunettes both with undescribed soils. Occurs on sheet(s): 2"
"Cb24"
"Stony hills with rock outcrops: moderate to steep hill slopes with shallow leached sands (Uc2.34) in association with shallow sand soils (Uc4.11); other (Uc2.3) soils in flatter situations; minor areas of yellow leached earths (Gn3.54 and Gn3.84). Occurs on sheet(s): 2"
"Cb25"
"Rugged mountain terrain mostly at moderate to high elevation: ridges and slopes of leached sands (Uc2.3) in association with shallow sand soils (Uc4.11)--both these have highly organic (peaty) surface horizons, and with yellow leached earths (Gn3.5, Gn3.6, Gn3.7, and Gn3.8); dissected by streams with valley plains of acid peaty (O) soils and some gorges, numerous rock outcrops. Occurs on sheet(s): 2"
"Cb26"
"Low coastal hills: low hills of leached sands (Uc2.36) with clay D horizons, also other (Uc2.3) soils with clay D horizons, enclosing swampy basins of acid peats (O) and other undescribed soils. Occurs on sheet(s): 2"
"Cb27"
"Coastal sand plains and dunes, lagoons, and swampy areas: chief soils are leached sands (Uc2.3 and Uc2.2). Associated are dunes of siliceous sands (Uc1.2) and/or calcareous sands (Uc1.1) fringing the coastline; and swampy areas of (Uf6) soils and (Uc1.2) soils with peaty surfaces. Unit Cb27 has similarities with units Cb28 and Ca6. Occurs on sheet(s): 3"
"Cb28"
"Undulating coastal plains (ridge and swale sand plains with swampy hollows), tracts of dunes: chief soils are various leached sands (Uc2.3) including (Uc2.33). Associated are tracts of relatively stable dunes of leached sand (Uc2.2); swampy hollows of various acid peats (O) and (Uc2) soils with peaty surfaces; and relatively unstable dunes of calcareous sands (Uc1.1) and/or siliceous sands (Uc1.2) bordering the coast. Compare unit A9. As mapped, low hills of undescribed soils projecting through the sand plain, e.g. Nelson's Bay area, and some coastal swampy areas are included. Occurs on sheet(s): 3"
"Cb29"
"Gently undulating sandy plateau with shallow swamps: chief soils are deep leached sands (Uc2.33) and other (Uc2) soils, sandy acidic yellow mottled soils (Dy5.81), and possibly some acid peats (O). Associated are soils of unit Mb2 into which this unit grades. Data are limited. Occurs on sheet(s): 3"
"Cb30"
"Rugged granitic areas with rock walls and tors: chief soils are leached sands (Uc2.3), notably (Uc2.34) and (Uc2.31) with various shallow sand soils such as (Uc4.1) and (Uc1.21). Associated are soils common to unit Wa10 especially in areas of more subdued relief; (Dy3) soils, such as (Dy3.62), often with large amounts of ironstone gravel, especially on undulating ridge tops (?plateau remnants); (Dr2.21) soils on areas of dark intrusive rocks; occasionally soils of unit Rh5; and some of the wetter portions which may approach unit Mw4 in character. Occurs on sheet(s): 3"
"Cb31"
"Coastal plain with low sandy banks and weakly defined drainage lines--elevation 25-50 ft above sea level: chief soils are leached sands (Uc2.33, Uc2.32, and Uc2.34), with (Uc2.2) soils on banks, some of which are underlain by clay D horizons. Associated are: (Dg2.81) and (Dg4.81) soils along depressional flats; (Gn2.94) and (Dy3.41) soils in flats; (Uc2.21) and (Uc1.23) soils on low coastal dunes; and (Dg2.63) soils in saline marshes. Occurs on sheet(s): 4"
"Cb32"
"Weakly dissected coastal plain less than 50 ft above sea level, consisting of sand plains, low sand dunes, and low rounded sandstone rises: chief soils are the leached sands (Uc2.33 and Uc2.34) of the sand plain in association with yellow earths (Gn2.24) and (Gn2.74) on the gently undulating sandstone rises. Other soils are: (Uc2.31) on old fore-dunes; (Uc1.22) on present fore-dunes; (Dy2.31) and (Dy3.31) on lower slopes of the gently undulating sandstone rises and on some creek flats; (Dg4.81) in depressions of the undulating plain; and (Gn3.95) along the larger stream flats. Occurs on sheet(s): 4"
"Cb33"
"Sand plain with some dunes, swampy areas, and some included beach dunes: chief soils are leached sands (Uc2.3) on the sand plain and lower dune slopes. Associated are some deep (Uc2.2) soils on dunes Other soils include acid

peats (O) in swamps and depressions, (Uc1.22) on beach dunes, and possibly other soils. As mapped, some high dunes of unit B16 may be included and also areas of unit Ca10. Occurs on sheet(s): 4"
"Cb34"
"Flat to very gently undulating coastal plain less than 25 ft above sea level: chief soils are leached sands (Uc2.35) on low heath plains with (Uc2.33) on low broad sandy rises. Associated are (Dg4.81) and (Dg2.31) soils in swampy flats, and probably (Gn2.94) soils on flats and drainage-ways. Other soils include (Dy3.41) on some flats, (Dy5.41) on sandstone rises, (Dy5.11) along stream flats, and small areas of soils of adjoining units. Occurs on sheet(s): 4"
"Cb35"
"Flat to very gently undulating coastal plain as for unit Cb34, together with moderate areas of units Ca13, NX1, and Wa17. The leached sands (Uc2.35 and Uc2.33) of unit Cb34 are dominant. Occurs on sheet(s): 4"
"Cb36"
"Flat to very gently undulating coastal plain less than 25 ft above sea level: chief soils seem to be leached sands (Uc2.35) on the heath plains. Associated are probably (Dg4.41) and (Dg4.81) soils marginal to the heath flats. Other soils include (Dy5.41) and (Gn2.84) over clay D horizons on low sandy banks; (Gn3.94) along local creek flats; and (Uc1.21) on present beach dunes. Occurs on sheet(s): 4"
"Cb37"
"Old low coastal dunes parallel to the present coastline: chief soils are leached sands (Uc2.3) with some (Uc2.2) soils. Minor soil occurrences include peats (O) and gleys (Dg4.81) in the depressions. Occurs on sheet(s): 4"
"Cb38"
"Sandy dunes with intervening sandy and clayey swamp flats: chief soils are leached sands (Uc2.33) and (Uc2.21), sometimes with a clay D horizon below 5 ft, on the dunes and sandy swamps. Associated are various soils in the clayey swamps, such as (Ug6.4) and some (Dy) and (Dg) soils. Occurs on sheet(s): 5"
"Cb39"
"Subdued dune-swale terrain: chief soils are leached sands (Uc2.33) with (Uc2.22) and (Uc2.21) on the low dunes. Associated are small areas of other sand soils (Uc). Occurs on sheet(s): 5"
"Cb40"
"Swampy plains: chief soils are leached sands (Uc2.33), some of which have a thin peaty surface horizon. Associated are small hummocks of leached sands (Uc1.21). Occurs on sheet(s): 5"
"Cb41"
"Low-lying wet plains with swamps and lakes, some estuarine areas: chief soils are leached sands (Uc2.33), some of which have thin peaty surface horizons. Associated are a variety of peat (O) and other soils in the swamps and depressions; some other leached sands such as (Uc2.32) on slopes; diatomaceous earths (unclassified); some granitic tors on slopes; and other undescribed soils. As mapped, areas of the ironstone gravelly soils of the adjacent units are included. Occurs on sheet(s): 5"
"Cb42"
"Plains with a succession of swampy flats broken by low sandy, or ironstone gravelly, knolls and hillocks: chief soils are leached sands (Uc2.33), some of which have thin peaty surface horizons. Associated are leached sands (Uc2.2 and Uc2.3) on sandy knolls; soils of units Tf6 and Cd22 on ironstone gravelly knolls and hillocks; and some acid peats (O) in lower-lying sites. This unit merges along its northern boundaries with unit Cd22. Occurs on sheet(s): 5"
"Cb43"
"Plains--swampy flats with shallow swamps and lakes, some lunettes: chief soils are various leached sands, especially (Uc2.33) which may have thin peaty surface horizons and (Uc2.35) with various (Dg) and (Dy) soils such as (Dg4.13), (Dy5.82), and (Dy5.42). Associated are lunettes of (Uc1.2) soils and other (Uc) soils, some with ironstone gravels, in colluvial sites. As mapped, areas of units Cd22 and Tf6 are included. Occurs on sheet(s): 5"
"Cb44"
"The Collie basin area, generally flat to strongly undulating land with many sandy flats and swamps: chief soils seem to be leached sands (Uc2.33) in the lower and more swampy sites and (Uc2.21), often containing ironstone gravels, on flat to gently sloping areas. Associated are (Dy3.61 and Dy3.62), (Dy3.8), and (Dy5.8) soils all containing ironstone gravels on the undulating areas. As mapped, areas of the adjoining units may be included. Occurs on sheet(s): 5"
"Cb45"
"Level or very gently undulating plains: dominant soils are moderately deep to deep bleached sands which are usually underlain by a cemented pan at depths ranging from 20 to 60 in. The chief soil is probably (Uc2.34) but also occurring are deep (Uc2.21) soils with a pan at depth. Other associated soils are sandy bleached earths (Gn2.94), (Gn2.74), and (Gn2.34), with sandy or loamy bleached duplex soils (Dy3.43, Dy3.42) and (Dy2.82, Dy2.83) common on lower sites. Data are fairly limited. Occurs on sheet(s): 7"
"Cd1"

"Steep ranges with tors: chief soils on the flatter areas are leached sands (Uc2.12) with mottled weathered granite below the bleached A2. Associated are (Dy3.4) soils. Occurs on sheet(s): 3"
"Cd2"
"Moderate to strongly undulating lands: dominant soils occurring on upper and mid slopes are moderately deep leached sands (Uc2.12) and (Uc3.12). Lower slopes have deep sands (Uc1.21, Uc1.23) and some areas of deep-surfaced sandy duplex soils (Dy5.41) and (Dy5.81). Valley floors have sandy or loamy-surfaced duplex soils (Dy2.43) and (Dd1.43) with some areas of earths (Gn2.91). On some higher ridges there are red duplex soils (Dr2.12) or sandy red earths (Gn2.12). Occurs on sheet(s): 4"
"Cd3"
"Steep hilly to mountainous land: chief soils seem to be leached sands (Uc2.12) and siliceous sands (Uc1.21 and Uc1.22) on sandstones; grey cracking clays (Ug5.23) on shales; and shallow red clays (Uf6.12) on basalt. Associated are hard acid red and yellow soils (Dr2.41) and (Dy3.41), with red earths (Gn2.11 and Gn2.14) on platforms between the 800 and 1400 ft contours. Small areas of other soils such as (Uc4.2), (Um4.31), (Um6.21), (Ug6.5), (Dr2.43), (Dr2.81), (Dy4.13), and (Dy5.11) have been recorded. There are also similarities with unit Rh9, and some of the soils recorded therein are also likely to be present in this extremely complex area. Occurs on sheet(s): 4"
"Cd4"
"Mountainous land on granites and associated acid to intermediate plutonic rocks: chief soils are gritty leached sands (Uc2.12) and (Uc4.1). Associated soils on lower slopes are (Dr4.42), (Dy4.42), (Dr5.42), and (Dy5.42), and small areas of (Gn3.11) soils on basaltic materials. Small valleys of unit MM9 are included in places. Occurs on sheet(s): 4"
"Cd5"
"Granite--steep hilly land with some low hilly areas--many steep slopes with much bare rock: chief soils are leached sands (Uc2.12) with some (Uc4.1) soils. Other soils are (Dy5.81) on slopes, (Dy3.81) and (Dy3.41) on foothill slopes and narrow valley floors, and (Gn3.11) and (Gn2.14) on small areas in some localities. Occurs on sheet(s): 4"
"Cd6"
"Granite--steep hilly to mountainous land, many steep slopes with bare rock, some trachyte peaks to 1400 ft: chief soils are leached sands (Uc2.12) with some (Uc4.1) soils. Other soils are: (Gn3.11) on some phyllitic rocks and basalts; (Gn3.41) on basaltic remnants; (Gn2.14) and (Uc2.21) on some fans; (Dy5.81) and (Dy3.81) on foothill slopes; and possibly local areas of a variety of other soils. Occurs on sheet(s): 4"
"Cd7"
"Hilly to steep hilly land on coarse siliceous sandstones, rock outcrops, narrow valleys: chief soils are leached sands (Uc2.12) and siliceous sands (Uc1.21) on crests and slopes. Associated are (Gn2.74) soils on lower slopes. Other soils include (Dr3.41) and (Gn2.14) on slopes and probably (Gn2.94) and (Dy3.81) on stream flats. Occurs on sheet(s): 4"
"Cd8"
"Generally low hilly land on siliceous sandstones with gentle to moderate slopes to fairly broad stream flats: chief soils are leached sands (Uc2.12) on crests and upper slopes. Associated are (Dy3.41) and (Dy5.81) soils on lower and middle slopes with (Gn2.34) and (Gn2.74) soils on upper middle slopes. Minor soils include (Dr3.41) and (Dd1.41) on hill slopes and fair areas of (Gn3.92) and (Dy2.12) on stream flats. Occurs on sheet(s): 4"
"Cd9"
"Hilly to low hilly terrain on granitic rocks with moderate slopes and open valleys with narrow creek flats: chief soils are leached sands (Uc2.12) on hill crests and slopes. Associated are (Dy3.81) and (Dy5.81) soils on mid hill slopes. Other soils encountered are: (Dy3.41) on lower hill slopes and flats; (Gn2.14) on isolated flat tops more than 400 ft above sea level; (Dr3.81) on some slopes; (Uf6.31) and (Uf6.32) on basic dykes; and (Uc4.1) soils on hill crests and slopes. Occurs on sheet(s): 4"
"Cd10"
"Steep hilly sandstone country with very steep slopes and much rock outcrop: chief soils are leached sands (Uc2.12) on crests and slopes. Other soils include (Uc4.1) and (Uc1.21) on slopes, (Gn2.14) and (Gn2.74) on some platforms and foothills, and (Dr3.41) and (Dy3.41) on some foothill slopes. As mapped, small areas of mountainous basaltic country with (Gn3.41), (Uf6.32), (Um6.21), and (Gn3 .11) soils are included. Occurs on sheet(s): 4"
"Cd11"
"Moderate to steep hilly granitic country with rough stony slopes and crests, much rock outcrop; occasional flat-topped plateau remnants: chief soils are shallow stony sands (Uc2.12) on crests and steep slopes. Associated are stony and gravelly (Um2.12), and (Um4.1) with (Dy3.41) soils. Some (Dy3.42) and (Dy3.43) soils occur on colluvial slopes in minor valleys, while (Gn2.11) and (Dr2.41) soils occur on plateau remnants. Occurs on sheet(s): 4"
"Cd12"

"Moderate to steep hilly granitic country of unit Cd11 with moderately hilly "valleys"of unit Ub76. Occurs on sheet(s): 4"
"Cd13"
"Hilly or very strongly undulating lands with coarse gritty shallow sands: dominant are leached sands (Uc2.12), with associated (Uc2.21) and (Uc1.23). Also commonly associated are sandy red earths (Gn2.14) and shallow stony duplex soils (Dy2.21) and (Dr2.21). On lower flatter areas deeper sandy or loamy duplex soils (Dy3.42) occur. Data are limited. Occurs on sheet(s): 4"
"Cd14"
"Low hilly to strongly undulating elevated lands with some steeper high hilly areas; rock outcrop is very common throughout: dominant soils are very shallow (6-18 in.) stony gritty leached sands or sandy loams (Uc2.12). Less common are similar stony loams (Um2.12) and (Um4.1). On some slopes shallow stony duplex soils occur, chiefly (Dy3.41), (Dy3.42), and similar (Dy2) soils. Throughout this unit there may be small remnants of unit Tb119. Occurs on sheet(s): 4"
"Cd15"
"High, steep-sided, sandstone hills and strike ridges with narrow intervening valleys; massive rock outcrop is very common on hills and high ridges: dominant soils of higher landscape sites are shallow leached sands (Uc2.12), with associated (Uc4.11), (Uc1.21), and less commonly (Um1.41) and (Um2.12). In the valleys sandy or loamy duplex soils occur, chiefly (Dy2.42), (Dy2.43), (Dy3.42), (Dy3.43), and (Dy5.41). Data are limited. Occurs on sheet(s): 4"
"Cd16"
"High hills or mountains with steep slopes and much granite outcrop: dominant soils are very shallow mostly stony leached coarse sands (Uc2.12) with lesser (Uc2.21). Other sand soils also probably occur, together with some shallow stony duplex soils (Dr2.22) and (Dr2.61). Data are very limited. Occurs on sheet(s): 4"
"Cd17"
"Strong undulating or low hilly lands, mostly with short slopes; granite tor outcrop is occasionally prominent: dominant soils of the higher or steeper landscape sites are shallow gritty leached sands (Uc2.12), together with other shallow sands (Uc4.11); rock outcrop is common. On lower slopes and valley floors sandy or loamy duplex soils are common, chiefly (Dy3.42), (Dy2.42), (Dy2.43), (Dy3.21), and (Dr3.22). Gritty grey earths (Gn2.82) and (Gn2.95) may also occur. Throughout the unit the dominance of (Uc2) or duplex soils (D) may vary locally. Occurs on sheet(s): 4,7"
"Cd18"
"Low hilly or strongly undulating lands consisting of small sandstone mesas and their strongly dissected remnants; low steep scarps are common: dominant soils are probably shallow stony leached sands (Uc2.12) and (Uc2.21), with similar loamy soils (Um2.12), (Um4.1), and (Um1.43) associated. On more extensive mesas loamy yellow or red earths (Gn2.22 and Gn2.12) occur; deeper sands (Uc4.2) occur on some dissected slopes. Adjacent to drainage lines are small areas of sandy or loamy duplex soils (Dy3.42). Data are limited. Occurs on sheet(s): 4"
"Cd19"
"Steep hilly to mountainous granitic country with flanking areas of rolling to low hilly terrain; much rock outcrop: chief soils are leached sands (Uc2.12) on the steeper slopes with (Uc2.21) on areas of gentler topography. Associated are (Uc4.11) soils on slopes, (Dy5.81) soils on fans and flats, and (Dg4.81) soils on flats. Minor soil occurrences include (Gn2.94) on basal hill slopes, (Gn2.14) on debris slopes and fans, (Uc3.2) on creek flats, and (Uc4.2) with (Gn2.24) on some fans. The steeper portions of this unit are similar to unit Cd5. Occurs on sheet(s): 4"
"Cd20"
"Steep hilly to mountainous country on granites or quartz porphyry--narrow crests and steep-sided V-valleys; much bare rock outcrop and boulders: chief soils are leached sands (Uc2.12); associated are (Uc4.11) and (Uc2.21) soils. Minor soil occurrences include (Dy3.41) and others. Small areas of unit Tb1 30 are included. Occurs on sheet(s): 4"
"Cd21"
"Low tor-covered hills on grey granitic rock: the dominant soils occupying the crests and upper slopes are leached sands (Uc2.12). Associated are (Dy3.41) and lesser (Dr2.81) soils on mid slopes. Minor soil occurrences include (Dy5.41), (Dr2.61), (Dr2.41), and (Dy3.43). As mapped, small inclusions of units MW29, Tb129, and Va61 occur. Occurs on sheet(s): 4"
"Cd22"
"Flat to gently undulating portions of lateritic plateau at moderate elevation, occasional low hills, some tors: chief soils are leached sands (Uc2.12) and (Uc2.21), some only 6 in. thick, underlain by thick ironstone gravel and boulder layers and mottled kaolinitic clays at depths below 2-5 ft. Associated are: (Dy5.81) soils containing ironstone gravels and other soils of unit Tf6 on slopes; flats of leached sands (Uc2.33), some small areas of yellow (Gn2) soils containing ironstone gravel; small swampy areas of unit Cb43 soils; and minor areas of unit Ta9 soils

where dissection is incised below the laterite. This unit merges along its southern boundaries with unit Cb42. Occurs on sheet(s): 5"
"Cd23"
"Gently undulating sandy lateritic country of broad low rises and shallow valleys; block laterite outcrops in many places and especially on dissection slopes; occasionally sandstone ridges outcrop: chief soils are shallow leached sands (Uc2.12) overlying block laterite or large amounts of ironstone gravel at depths of 18 to 30 in. Associated are other sand soils (Uc2.22) and (Uc1.22) either overlying or containing large amounts of ironstone gravel. Other soil occurrences are (Uc5.22 and Uc5.21) and possibly some sandy (Gn2.1) soils on flat areas; (Dy3.41) or (Dy3.81) soils on some stream flats and shallow depressions; (Uc1.23) soils on stream levees; and possibly some (Gn2.6) soils on flats along streams. Some areas are probably similar to unit AC19. Occurs on sheet(s): 8"
"Cd24"
"Dissected sandy lateritic country with broad flat to gently undulating uplands, stony hills and narrow drainage-ways; block laterite common; rock outcrops occur on the hills: chief soils on the areas of gentle relief seem to be shallow leached sands (Uc2.12) overlying block laterite or large amounts of ironstone gravel with (Uc5.21 and Uc5.22) earthy sands commonly present, and some (Gn2.12) soils also. Broken to a varying degree by hilly areas of the shallow (U) soils of unit JJ34; traversed in part by narrow shallow valleys of (Ug5) soils and block laterite, and in part by larger streams flanked by levees of (Uc1.43) soils and plains of (Gn2.6) soils. Occurs on sheet(s): 8"
"Cd25"
"Remnants of flat to gently undulating sandy laterite country; block laterite outcrops in places: chief soils may be shallow leached sands (Uc2.12) overlying block laterite or large amounts of ironstone gravel but there will be some variation from area to area with other (Uc) soils, especially (Uc5.22) and (Uc5.21), prominent also. Occurs on sheet(s): 8"
"Cd26"
"Gently undulating sandy lateritic country with low north-west-trending sand dunes: chief soils are probably shallow leached sands (Uc2.12) overlying block laterite or large amounts of ironstone gravel at depths of 18 to 30 in. Associated are the soils of unit Cd23 and the (Uc) sands of the dune formations. Occurs on sheet(s): 8"
"Cd27"
"Undulating lands with some areas of sandstone outcrop: dominant soils are shallow bleached gravelly sands (Uc2.12), which may have ironstone nodules or quartz gravel throughout the profile. Very shallow gritty sands (Uc1.21) occur adjacent to sandstone outcrops. Associated on longer slopes are moderately deep sandy grey earths (Gn2.81) and yellow earths (Gn2.21) with a prominent ironstone nodule horizon. Deep fine sandy loams (Uc5.21) occur on stream levees. Occurs on sheet(s): 7"
"Cd28"
"Very gently undulating plains; nearly all soils are normally underlain by a massive nodular laterite horizon at shallow to moderate depths (12-30 in.): dominant soils are bleached sands (Uc2.12), but other sands (Uc5.22, Uc5.23) are commonly associated. Also occurring are sandy earths (Gn2.81) and (Gn2.21), which, although mostly strongly nodular at depth (30-40 in.), do not normally have a massive laterite horizon; small areas of sandy red earths (Gn2.11) are also included. Where low scarped margins occur, particularly adjacent to deeper drainage lines, massive nodular laterite is usually exposed. Occurs on sheet(s): 7"
"Cd29"
"Level to very gently undulating plains: dominant soils are shallow to moderately deep bleached sands (Uc2.12) overlying massive laterite at 18-36 in. Associated soils include loamy red earths (Gn2.14) on the higher landscape sites and sandy yellow earths (Gn2.24), with lesser (Gn2.34), on lower slopes. Deep loamy duplex soils (Dy2.23), (Dy2.43), and (Dy3.43) occur in the broad concave drainage lines. Occurs on sheet(s): 7"
"Cd30"
"Moderately to strongly undulating lands with some low hilly areas; rock outcrop is common: dominant soils are shallow gravelly bleached sands or sandy loams (Uc2.12) with less commonly bleached loams (Um2.12). Chief associated soils are similar bleached sands and loams (Uc2.21), (Um2.2), (Um4.21), and (Um4.12). Small areas of sandy or loamy duplex soils of unit Va79 are included. Occurs on sheet(s): 7"
"Cd31"
"Hilly to high hilly lands with some limited mountainous areas; acid volcanic rock outcrop is common: dominant soils are very shallow gravelly bleached sands (Uc2.12), with lesser similar loams (Um2.12). Shallow to moderately deep loamy duplex soils (Dy3.41, Dy3.42) and (Dy2.42) are minor associated soils occurring on lower slopes and in drainage lines. Data are limited. Occurs on sheet(s): 7"
"Cd32"
"Undulating lands with some low rocky hills; acid igneous rock outcrop is fairly common: dominant soils are shallow to moderately deep strongly bleached sands (Uc2.12). Minor associated soils include other shallow sands (Uc4.2), (Uc4.12), and (Uc2.22), occasional loamy yellow earths (Gn2.24), and shallow loamy duplex soils (Dy3.43, Dy3.42) on lower slopes. Some shallow loamy red duplex soils (Dr2.22) and (Dr2.12) occur on more basic rocks. Occurs on sheet(s): 7"

"Cd33"
"High hills and mountains with very steep scarped margins; large granite tor outcrop occupies a considerable part of the unit: dominant soils are probably shallow bleached sands (Uc2.12) but other sand soils such as (Uc4.1), (Uc4.2), and sandy grey earths (Gn2.84) also probably occur. Around the steep margins very shallow sands (Uc1.21) occur. Data are extremely limited. Occurs on sheet(s): 7"
"Cd34"
"Strongly undulating lands with some low hilly areas; granite tor outcrop is common: dominant soils are shallow to moderately deep bleached sands (Uc2.12), with lesser (Uc2.21, Uc2.23). Also occurring are other gritty sands (Uc4.11), gritty bleached duplex soils (Dr2.81), (Dy2.81), and (Dy3.81), and gritty grey earths (Gn2.84, Gn2.85, and Gn2.82). On some broad ridge crests there may be small areas of deep sandy red earths (Gn2.14), and on lower slopes and adjacent to drainage lines there are small areas of bleached duplex soils (Dy3.41, Dy3.42). Occurs on sheet(s): 7"
"Cd35"
"Moderately to strongly undulating lands with high sandstone ridges and dissected low scarps: dominant soils on higher sites are probably shallow to moderately deep gravelly bleached sands (Uc2.12), with (Uc2.21) common where the sands are deeper. On lower and more gentle slopes loamy nodular bleached grey earths (Gn2.94) occur, and on some broad ridges there are areas of sandy yellow (Gn2.74) and (Gn2.24) or red earths (Gn2.14). Data are limited. Occurs on sheet(s): 7"
"Cz1"
"Gently undulating plain, or plateau at low elevation, with some lakes, swamps, and saline flats: chief soils are ironstone gravels (KS-Uc2.2) with shallow leached sands (Uc2.21 and Uc2.22), below which layers of boulder laterite or large amounts of ironstone gravel occur. Associated are (Dy5.82) soils containing ironstone gravels. This unit grades into unit Xd1, but generally, indurated lateritic substrata are more common in this unit than in unit Xd1. Occurs on sheet(s): 5"
"D1"
"Hilly and steep hilly areas: outcropping rocks and areas of shallow grey-brown sandy soils (Uc6.11) with smaller areas of hard neutral yellow mottled soils (Dy3.22). Occurs on sheet(s): 1"
"D2"
"Hilly and steep hilly areas with some tableland remnants: as for D1 with small areas of hard acidic yellow mottled soils some containing ironstone gravel (Dy3.41 and Dy3.61). Occurs on sheet(s): 1"
"D3"
"Hills or rugged hilly ranges rock outcrops and shallow grey-brown sandy soils (Uc6.11) with leached sands (Uc2.2 and Uc2.3) on alluvial slopes of the hills or ranges for at least the two southernmost areas of D3. Occurs on sheet(s): 1"
"D4"
"Hilly to mountainous: rock outcrops and shallow grey-brown sandy soils (Uc6.11) with leached sands (Uc2.2 and Uc2.3) on alluvial slopes, in basin plains and gullies; occasional basin plains of button-grass peats (O) surrounded by wet earths (Gn2.81). In the wetter portions (e.g. Halls Gap Mt. Victory), yellow leached earths (Gn2.74 and Gn2.34) occur on valley slopes, red earths (Gn2.1) on upper hill slopes, and hard, acid or neutral, red soils (Dr2.21 and Dr2.22) in intermediate positions. There is considerable change in soil with altitude. Soils other than those recorded here probably occur also. Occurs on sheet(s): 1"
"D5"
"Rugged hills at low elevation: rugged steep hilly areas of shallow grey-brown sandy soils (Uc6.11) with many rock outcrops, in association with shallow forms of hard red soils (Dr2.2) and shallow forms of hard yellow mottled soils (Dy3.2); dissected by deeply incised stream valleys of undescribed soils. Occurs on sheet(s): 2"
"D6"
"Undulating to rolling aeolianite dunes with small flats and valleys: chief soils are shallow grey-brown sandy soils (Uc6.11) from 12 to 36 in. deep and underlain by aeolianite which is exposed in places. Associated are small flats of (Dr4.12) soils and small valleys of (Ug5.2) soils. As mapped, small areas of units A13 and B26 may be included. Occurs on sheet(s): 5"
"DD1"
"Dune formations with relatively small plains between: dunes of brown calcareous earths, (Gc1.12) and (Gc1.22) in particular, and (Gn1.13) soils with small areas of brown sands (Uc5.1); plains of brown calcareous earths (Gc1.12) and (Gc1.22) and (Gn1.13) soils, with crusty loamy soils (Dr1.33) and (Dr1.43) in lower-lying portions. The (Gn1.13) soils may be dominant locally and are more common in some DD1 areas than was recorded previously. Areas of other soils, such as (Um5.5) and (Uc1.23), are likely. There are small inclusions of adjoining units. This description is amended from that given in Sheet 1. Occurs on sheet(s): 1,10"
"DD2"
"Plains with more or less isolated tracts of dunes: broad plains of brown calcareous earths (especially Gc1.12) with areas of exposed caliche and crusty loamy soils (Dr1.33 and Dr1.13) with claypans, saline soils (unclassified),

swamps, and intermittent lakes in the lower-lying portions; dunes of brown sands (Uc5.1) and brown calcareous earths (Gc1.22). Small areas of alluvial soils (unclassified) and hard alkaline red soils (Dr2.33) on outwash adjacent to Mt. Lofty range. Incomplete data. Occurs on sheet(s): 1,10"
"DD3"
"Plains with melon-hole microrelief in places, tracts of dunes, box flats: plains and dunes of brown calcareous earths (Gc1.12), (Gc1.22), (Gc2.12). Associated are: small areas of low dunes with sandy earths (Gn1.13) and possibly other (Gn1) soils; lower-lying situations generally with crusty loamy soils (Dr1.33); some pronounced dunes of brown sands (Uc5.1); and box flats with undescribed soils. The clay substrata below these soils generally occur at shallow depths towards the northern portion of the unit, which is extremely complex, and could be subdivided if more data were available. See sheet 1 also. Occurs on sheet(s): 1,3,10"
"DD4"
"Plains: piedmont alluvial plains of brown calcareous earths (Gc1.12 and Gc1.22) many of which have a stony pavement; sandy alluvial soils (unclassified) in the stream valleys. Occurs on sheet(s): 1,10"
"DD5"
"Plain with low dunes: brown calcareous earths (Gc1.12 and Gc1.22) with sandy earths (Gn1.13) in association with crusty loamy soils (Dr1.33) which are often eroded and scalded, and small areas of cracking grey clays (Ug5.2). Occurs on sheet(s): 1,3"
"DD6"
"Plains and dunes: plains of highly calcareous loamy earths (Gc1) and crusty loamy soils (Dr1.33), some small areas of cracking grey clays (Ug5.2), and with east west dunes of brown calcareous earths (Gc1.12 and Gc1.22) and brown sands (Uc5.1). Swamps and lunettes (soils unclassified). Occurs on sheet(s): 1"
"DD7"
"Plains, old lake basins (swamps), and lunettes: highly salinized variations of brown calcareous earths (Gc) and crusty loamy soils (Dr1); gypsum accumulations; some soils from neighbouring map units; other saline soils (undescribed). Incomplete data. Occurs on sheet(s): 1"
"DD8"
"Dunes and small plains: brown calcareous earths (Gc) and saline amorphous loamy soils (Um5.12), some contain siliceous pans. Incomplete data. Occurs on sheet(s): 1"
"DD9"
"Gently undulating slopes: chief soils are brown and grey-brown calcareous earths (Gc1.12) and (Gc1.22), some low gilgai microrelief in places. Acid clays may occur at depth. As mapped, small areas of units Oc31, Sl28, and Va66 are included. Occurs on sheet(s): 5"
"DD10"
"Plains with some clay pans and small salt lakes, dunes, and lunettes: chief soils are brown and grey-brown calcareous earths (Gc1.12) and (Gc1.22). All the soils of unit Ya28 are associated, the proportions of each vary greatly within short distances. There are similarities with units Lb1O and DD11 of Sheet 5. As mapped, areas of adjacent units are included. Occurs on sheet(s): 5,10"
"DD11"
"Very gently undulating plains sloping upwards from the eastern sides of saline valleys: chief soils are brown and grey-brown calcareous earths (Gc1.12), (Gc1.22), and (Gc2.12). Associated are various (Dy) soils, such as (Dy5.43), which may be very prominent locally and may form complexes with the (Gc) soils; and lesser areas of (Dr2.33) soils. There are similarities with units DD9, Lb1O, and DD12. As mapped, small areas of units JJ16, X17, and Sl29 are included. Occurs on sheet(s): 5"
"DD12"
"Gently undulating plains with gilgais, slightly raised above the surrounding land; calcrete (kunkar) underlies the soils in places and acid clays commonly occur below depths of 3-6 ft: chief soils are brown and grey-brown calcareous earths (Gc1.22 and Gc2.22) with grey-brown highly calcareous earths (Gc1.12) on the gilgai plains. Associated are hard and sandy alkaline yellow and yellow mottled soils (Dy2.43, Dy2.83, Dy3.43, Dy3.83, Dy4.43, Dy4.83, Dy5.43, and Dy5.83); smaller areas of hard alkaline red soils (Dr2.33); and possibly some minor areas of cracking clays such as (Ug5.3). As mapped, areas of units Lb1O and JY1 and also some stony and sandy soils associated with granitic outcrops are included. Occurs on sheet(s): 5"
"DD13"
"Gently undulating plains with some gilgai areas, occasionally broken by stony ridges and hills: chief soils seem to be brown and grey-brown calcareous earths (Gc1.12) and (Gc1.22) on the local rises and crusty loamy soils (Dr1.43), (Dr1.33), and (Dr1.83) in the intervening flats. Associated are soils of unit BB5 on the stony ridges and hills; and areas of other soils, such as (Gn2.12) with ironstone gravels, and (Dy) soils similar to those of unit Ya28, are likely. Weathering greenstones are common below the (Gc) soils at depths of 3-5 ft. Occurs on sheet(s): 5,10"
"DD14"
"Flat to undulating land with small valleys occasionally broken by low narrow rocky hills and ridges, or tors and bosses; some block silcrete and silcrete fragments recorded in the area of Sheet 10; some clay pans and salt lakes

with dunes and lunettes; some small dune tracts in the area of Sheet 10: chief soils are brown and grey-brown calcareous earths (Gc1.12) and (Gc1.22), mostly with loamy surface soils, but there are some areas with sandy surface soils and some (Gc2.22) soils and gilgais. Associated are various (Dr) soils such as (Dr1.73, Dr1.83) in valleys and flats; shallow red earths (Gn2.12) often with rock at 3 ft; siliceous sands (Uc1.2) on dunes and lunettes; and areas of undescribed soils. Country rock is present in some areas at depths of 3-5 ft, while in other sites non-calcareous clays occur at similar depths. Occurs on sheet(s): 5,10"
"DD15"
"Undulating plains with some low dunes, seasonal lakes, and clay pans: chief soils seem to be brown and greybrown calcareous earths (Gc 1.12) and (Gc 1.22). Associated are flats of (Gn2.13) soils; rises of (Gn2.12) soils containing ironstone gravel; and areas of (Dr2.33) soils with (Ug5.3) soils and some small gilgais. Small areas of adjoining units may be included. Occurs on sheet(s): 5"
"DD16"
"Plains with some small lakes and lunettes: chief soils are brown calcareous earths (Gc1.22) in association with (Gn2.13) and (Dy3.4) soils. Occurs on sheet(s): 5"
"DD17"
"Undulating land: chief soils are brown calcareous earths (Gc1.12) and (Gc1.22) with some low gilgais, and loamy red and yellow earths (Gn2.12) and (Gn2.2) with soil dominance varying locally between the (Gc) and (Gn) soils. Associated are flats of (Gn2.13) soils and small areas of the soils of adjoining units. Occurs on sheet(s): 5"
"DD18"
"Plains with some limestone ridges and flats: chief soils are brown calcareous earths (Gc1.22) and (Gc2.21) with shallow loamy (Um1.3) soils on limestone. There are areas of red earthy sands (Uc5.21) and sandy red earths (Gn2.13), particularly at the junction with unit Mx13 to the south. Occurs on sheet(s): 6"
"DD19"
"Slightly dissected pediplains formed on travertine limestone, with some valley plains and minor areas of red sand dunes: chief soils are brown calcareous earths (Gc1) where limestone is shallow, with (Gn2.13) overlying limestone at depth. Valley plains are largely of hard red soils (Dr2.33), and red sands (Uc5.21). There are minor areas of (Uc5.11) and (Uc1) on the dunes. Occurs on sheet(s): 6"
"DD20"
"Low plains with residuals of Tertiary limestone forming hills and mesas to 50 ft high: chief soils of the plains are brown calcareous earths (Gc1.21 and Gc1.22) with shallow calcareous loams (Um1.3) on limestone. Soils of the residual ridges are probably calcareous loams (Um1.3). Occurs on sheet(s): 6"
"DD21"
"Gently dissected plains on limestone: chief soils are calcareous earths (Gc1.21, Gc1.22) overlying limestone, and there are some shallow (Uc) sands on limestone and in dunes marginal to unit AA13. Occurs on sheet(s): 6"
"DD22"
"Plains dissected by through drainage-ways flanked by their flood-plains: generally similar to unit DD2 but the plains of brown calcareous earths (Gc1.12) are traversed by flood-plains with (Dr4.73, Dr4.72) soils. Other soils may occur. Occurs on sheet(s): 10"
"DD23"
"Plains with many clay pans or flats: generally similar to unit DD2 but there are (Ug5.2), (Ug5.3), and (Ug5.5) clays in the clay pans and flats. Other soils may occur. Occurs on sheet(s): 10"
"DD24"
"Plains with some through drainage-ways: chief soils are brown calcareous earths, especially (Gc1.22), with some irregular shallow depression-type gilgais probably associated with occurrences of (Dr1.33) and (Ug5.3) soils. There are (Ug5.3) and (Ug5.2) soils along the drainage-ways and in clay pans and flats. Occurs on sheet(s): 10"
"DD25"
"Plains with irregular sandy areas; some clay pans and flats; some through drainage-ways; and some dunes: chief soils are brown calcareous earths (Gc1.12) and (Gc1.22). Associated are a variety of soils including (Gn1.19, Gn1.13) in irregular and uneven sandy rise areas; (Gn1.13) on flat areas; (Uc5.11, Uc5.12) on dunes; (Gn2.13) on sandy plains, especially marginal to unit Mx38; and clays (Ug5.2), (Ug5.3), and (Ug5.5) in clay pans, flats, and along drainage-ways. Occurs on sheet(s): 10"
"DD26"
"Plains with sand dunes: chief soils are brown calcareous earths (Gc1.12) and (Gc1.22). Associated are (Uc5.1) sands. Other soils may occur also. Occurs on sheet(s): 10"
"DD27"
"Plains with tracts of sand dunes; clay pans and seasonal lakes: chief soils on the plains and in dune areas are brown calcareous earths (Gc1.12) and (Gc1.22). Associated soils include (Uc5.1) and possibly (Uc1.2) sands on the sand dunes; (Dr1.33) and (Dr1.13) on stony plains; and various (Dy) soils, including shallow (Dy1.43) on shales, marginal to Lake Eyre. Occurs on sheet(s): 10"
"DD28"

"Undulating terrain with mesas and buttes; some saline seasonally swampy areas with gypseous lunettes: chief soils are brown calcareous earths (Gc1.12) and (Gc1.22). Associated are shallow calcareous loams (Um5.11) and crusty loamy soils (Dr1.33) and (Dr1.43). There is a variable stone and gravel mantle. Occurs on sheet(s): 10"
"DD29"
"Plains broken by hills and ridges; some dune tracts; saline flats; clay pans; seasonal swamps and lakes: chief soils are brown calcareous earths (Gc1.12) and (Gc1.22), with shallow calcareous loams (Um5.11). Associated are dunes of (Uc5.1) and (Gc) soils and also (Uc1.23) and (Gn1.13) soils, particularly in the north of the area; hills and ridges with rock outcrops, (Um5.11), and other shallow (Um) and (Uc) soils; and valley plains in the north of the area with (Gn1.13), (Gn2.13), (Uc1.4), and (Uc1.2) soils. This is a broad complex unit which could be subdivided when more data are available. Occurs on sheet(s): 10"
"DD30"
"Plains with some low scarp features; a few sand dunes: chief soils are brown calcareous earths (Gc1.22) and (Gc1.12). Associated are areas of shallow (Uc5.21), (Uc1.43), and (Uc1.23) soils on the plains. Deep (Uc1.23) sands occur on the dunes. Occurs on sheet(s): 10"
"DD31"
"Uneven plain with low calcrete (kunkar) rises and tracts of dunes: a variable unit; chief soils are probably brown calcareous earths (Gc1.12) and (Gc1.22); but there are extensive areas of shallow (Uc1.43) sands on calcrete rises alternating with shallow (Uc5.21) sands between the rises. (Uc1.23) and (Uc5.1) sands occur on the sand dunes and (Uc5.21) in interdune areas. Data are limited. Occurs on sheet(s): 10"
"DD32"
"Undulating terrain with some sand dunes: chief soils are brown calcareous earths (Gc1.12) and (Gc1.22) with shallow calcareous loams (Um5.11), and (Uc5.1) sands on the dunes. Other soils may occur. Data are limited. Occurs on sheet(s): 10"
"DD33"
"Undulating plains with some low dunes, seasonal lakes, and clay pans: chief soils seem to be brown and greybrown calcareous earths (Gc1.12) and (Gc1.22) together with sandy red earths (Gn2.13, Gn2.12). Other soils include various (Uc) sands, some of which are underlain by red-brown hardpan. Small areas of the soils of adjoining units probably occur also. Occurs on sheet(s): 10"
"DD34"
"Very gently to gently undulating plains with broad flats and low broad rises, the former being the prominent feature: chief soils are brown calcareous earths (Gc1.12) and (Gc1.22) with calcareous loams (Um5.11) on the low rises. There are only small areas of calcrete (kunkar) outcropping in this unit, but it usually occurs at depth. Occurs on sheet(s): 10"
"DD35"
"Plains on limestone and calcrete (kunkar); some small clay pans: chief soils are probably brown calcareous earths (Gc1.12) and (Gc1.22) and shallow calcareous loams (Um5.11). Other soils may occur. Data are very limited. Occurs on sheet(s): 10"
"E1"
"Dunes and plains: limestone dunes of shallow red-brown sandy soils (Uc6.13) and exposed sheet limestone and plains of shallow cracking dark clays (Ug5.11), peaty soils (O), deep sands (Uc1.22), and some soils containing flints (unclassified). Occurs on sheet(s): 1"
"E2"
"Dunes and small basin plains: limestone dunes of shallow red-brown sandy soils (Uc6.13) and small basin plains of peaty soils (O) and shallow cracking dark clays (Ug5.11). Occurs on sheet(s): 1"
"E3"
"Plain: shallow red-brown sandy soils (Uc6.13) containing flints below the very thin surface soil. Occurs on sheet(s): 1"
"E4"
"Undulating plain: shallow red-brown sandy soils (Uc6.13) and siliceous sands (Uc1.21) with lesser areas of dark shallow porous soils (Um6.21); sandy alkaline yellow mottled soils (Dy5.43) and hard alkaline red soils (Dr2.23). Area has limestone substrata. Occurs on sheet(s): 1"
"E5"
"Limestone hills: outcropping limestone with shallow red-brown sandy soils (Uc6.13) and shallow dark sandy soils (Uc6.12); small and very local occurrences of brown calcareous earths (Gc). Occurs on sheet(s): 1"
"E6"
"Limestone plain: soils as for E5 plus very small areas of brown sands (Uc5.11) and shallow variants of hard alkaline red soils (Dr2.23). Occurs on sheet(s): 1"
"E7"

"Plain: shallow red-brown sandy soils (Uc6.13), outcropping limestones, sandy alkaline yellow mottled soils (Dy5.43 and Dy5.83), leached sands (Uc2.2), and very local occurrences of hard alkaline red soils (Dr2.33). Occurs on sheet(s): 1"
"E8"
"Plain: soils as for E7 plus saline soils (unclassified) in the drainage-ways. Occurs on sheet(s): 1"
"E9"
"Plain: shallow red-brown sandy soils (Uc6.13) with outcropping limestone and brown calcareous earths (Gc 1.12). Occurs on sheet(s): 1"
"E10"
"Undulating--old dune formations, largely stripped of sands: mainly exposed limestones with small areas of shallow red-brown sandy soils (Uc6.13); also small areas of soil materials derived from adjacent soil formations (map units) and overlying the limestone. Occurs on sheet(s): 1"
"E11"
"Coastal dunes and plains: Coastal dunes of calcareous sands (Uc1.11); plains and E.-W. calcareous dunes of shallow red-brown sandy soils (Uc6.13) in association with brown, shallow, porous loamy soils (Um6.23) and others such as (Uc5.3) and (Dr4.13 and Dr4.53); many small areas of other soils are included also. Occurs on sheet(s): 2"
"EE1"
"Hills and hill slopes: yellow leached earths with whole-coloured subsoils (Gn2.34) and mottled subsoils (Gn2.74) in association with leached sands (Uc2.2 and Uc2.3); minor areas of other soils common to adjacent map units. Occurs on sheet(s): 1"
"EE2"
"Hilly: yellow leached earths with whole-coloured subsoils (Gn2.34) and mottled subsoils (Gn2.74); small areas of leached sands (Uc2.2 and Uc2.3); cracking dark clays (Ug5.12 and Ug5.13); friable neutral and alkaline dark soils (Dd3.12 and Dd3.13); minor areas of other soils (unclassified) associated with Miocene limestone. Occurs on sheet(s): 1"
"F1"
"Hilly and steep hilly areas: outcropping rocks and shallow dense loamy soils (Um5.41) with small areas shallow hard alkaline red soils (Dr2.23). Occurs on sheet(s): 1"
"F2"
"Hilly to steep hilly region: outcropping rocks and shallow dense loamy soils (Um5.41), also small areas various friable loamy soils (Um6); shallow hard red soils (both Dr2.22 and Dr2.23); and with various alluvial and colluvial soils (unclassified) in the small valleys. Occurs on sheet(s): 1"
"F3"
"Hills and ranges with intervening plains: hills and ranges of rock outcrops, shallow dense loamy soils (Um5.41), and shallow calcareous loamy soils (Um5.11) with plains of crusty loamy soils (Dr1.33) and brown calcareous earths (Gc); coarse sandy alluvial soils and saline soils (unclassified) in the lower-lying situations. Occurs on sheet(s): 1,10"
"F4"
"Rounded hills with small intervening basin plains: shallow dense loamy soils (Um5.41) covered by stones, on the hills; plains of brown calcareous earths (Gc) and some dunes of brown sands (Uc5.11 and Uc5.12); saline soils (unclassified) around seasonal lakes. Occurs on sheet(s): 1,10"
"F5"
"Hilly with small valley plains: shallow dense loamy soils (Um5.41); shallow calcareous loamy soils (Um5.11); and shallow loams (Um1.43) and sands (Uc1.43) occur on the hills. Associated are crusty loamy soils (Dr1.13) and (Dr1.33) and highly calcareous loamy earths (Gc1.12) on pediments, slopes, and in the small valleys. This description is expanded slightly from that given in Sheet 1. Occurs on sheet(s): 1,10"
"F6"
"Hills and ranges of hills of shallow dense loamy soils (Um5.41) and rock outcrops. Occurs on sheet(s): 1"
"F7"
"Hilly to submountainous: hill crests and upper slopes of shallow loamy soils with weak horizon development (Um5.41) and (Um5.51) often containing rock chips, possibly other (Um) soils also. Associated are shallow forms of (Dy3.41) and (Dr2.21) soils on middle and lower slopes, small valley plains of undescribed soils along the streams, and minor areas of other soils including shallow forms of dark friable loamy soils (Um6) on specific rock types such as hornfels and limestones. The (D) soils may be more common than the present limited data suggest. Occurs on sheet(s): 3,4"
"F8"
"Gently undulating to low hilly areas with gneissic rock outcrops; some low dunes: chief soils seem to be shallow loams (Um5.41), (Um5.51), and (Um1.43). Associated are shallow (Uc5.22) and (Gn2.12) soils with a redbrown hardpan at shallow depths. Occurs on sheet(s): 5,6"

"F9"
"Mountains--rocky ridges of metamorphic rocks (phyllites, schists, and gneisses): the main surface is outcropping rock with virtually no soil or some shallow dense loamy soils (Um5.41). Included valley plains have hard neutral red soils (Dr2.42) and (Dr2.32) with some mixed alluvia along streamlines. Small areas of other soils such as (Um2.12) may occur on slopes. Occurs on sheet(s): 5,8,9"
"F10"
"Rounded hills with piedmont alluvial plains: chief soils are shallow dense loamy soils (Um5.41) and possibly other shallow (Um) and (Uc) soils. Associated are the (Dr1.33) and (Dr1.43) soils of the plains. Occurs on sheet(s): 10"
"FF1"
"Volcanic cone and surrounding apron plain: dark friable earths (Gn4.42) and other similar soils (unclassified); possibly some (Gn3.22). Occurs on sheet(s): 1"
"FM1"
"Moderately hilly with "lumpy"dissection slopes, many landslips, narrow terraces in strongly sloping valleys; basement rocks are ochrous shales and clays: chief soils are alkaline grey friable earths (Gn3.93). Associated are: grey clays (Ug5.24) on terraces with slight gilgai microrelief; (Ug5.14 and Ug5.16) clays in valleys; (Gn3.43) soils on some crests and upper slopes; and (Dy2.43) soils on slopes marginal to sandstone areas. Minor inclusions of soils of unit Mz9. Occurs on sheet(s): 4"
"FM2"
"Low hilly lands on mudstones, some sandstones, conglomerates, and limestones; broad rounded crests and long slopes but relief increasing in places to moderately hilly: chief soils are alkaline grey friable earths (Gn3.93), with some strongly acid forms (Gn3.90), and brown friable earths (Gn3.22 and Gn3.23). Associated are: (Dr4.22), (Dy4.22), and (Dy4.23) soils on slopes and crests; (Dy3.43) and (Dy5.43) soils on mid and lower slopes; and (Um6.22) soils on some crests. Occurs on sheet(s): 4"
"FV1"
"Low hilly lands on metasediments of low gravelly ridges with convex crests and gentle to moderate side slopes; gravelly fans; narrow creek flats: chief soils are shallow gravelly leached loams (Um2.21). Associated are (Uc2.21) soils on fans. Minor soil occurrences include (Um2.12) on ridge crests and (Dy3.42) and (Dy5.81) on local flats. Small areas of unit J4 are included where this unit joins the coast. Occurs on sheet(s): 4"
"Fa1"
"Broken, undulating to hilly area with large rock outcrops: gentle to moderate slopes of loamy soils (Um5.5) in association with various earthy soils (Gn2), such as (Gn2.82); soils are not well known. Occurs on sheet(s): 2"
"Fa2"
"Steep hilly areas: moderate to steep hill slopes of vesicular loamy soils (Um5.51), loamy soils having an A2 horizon (Um4.2), and possibly other soils, such as (Gn2) soils, and rock outcrops; and in association with hard acidic red soils (Dr2.21 and Dr2.61) and hard acidic yellow mottled soils (Dy3.21 and Dy3.61) on mid and lower slopes with rock outcrops; small incised valley plains of various unclassified soils. The (D) soils may be very common locally and their variety could be greater than stated. As mapped, areas of unit Mw13 may be included. Occurs on sheet(s): 2,3"
"Fa3"
"Mountainous: moderate to very steep hill slopes of vesicular loamy soils (Um5.51) in association with loamy soils having an A2 horizon (Um4.2), dense loamy soils (Um5.41), shallow grey-brown sandy soils (Uc6.11), (Uc4.11), and (Um4.1), areas of yellow-brown earths (Gn2.44) and red earths (Gn2.1), also (Dy3.2 and Dy3.4) and (Dr2.2) soils and rock outcrops; some small areas of (Um7.11) or soils grading to this at the higher altitudes; some small open flats and valley plains of dark cracking clays (Ug5.1) often with peaty surfaces, also other soils not described; some deeply incised stream valleys with undescribed soils. The (D) soils may be very common locally and their variety could be greater than that stated. Occurs on sheet(s): 2,3"
"Fa4"
"Ranges with numerous rock outcrops containing basic igneous rocks (greenstones): chief soils seem to be shallow loams (Um5.51). Occurs on sheet(s): 5,6,10"
"Fa5"
"Ranges in areas of shales and greywacke along with some dolomites and volcanic rocks; there may be some narrow valley plains and steep dissected pediments: stony shallow earthy loams (Um5.51) are dominant but there are extensive areas without soil cover; (Dr2.33) and (Dr2.43) soils are also important on the pediments and (Um5.5) soils on the narrow gravel-covered valley plains. Occurs on sheet(s): 6"
"Fa6"
"Low ranges and stony hills often capped by red-brown hardpan and fringed by breakaways and dissected pediments; dominant soils are shallow stony earthy loams (Um5.51), but (Dr2.33) are nearly as important; (Um5.3) soils occur on the red-brown hardpan capping. Occurs on sheet(s): 6"
"Fa7"

"Greenstone hills and low ranges with some slate and basalt: dominant soils are shallow stony earthy loams (Um5.51) on the steep slopes while (Um5.3) and (Uc5.21) overlying red-brown hardpan occur on the stony pediments. Occurs on sheet(s): 6,10"
"Fa8"
"Steep ranges comprising fine-grained sedimentary rocks along with basic dykes; extensive portions of this unit are without soil cover: chief soils are shallow stony earthy loams (Um5.51) on the steep slopes while shallow stony (Uc1.43) and (Uc5.11) soils occur in similar situations. Associated are a variety of soils including (Dr2.32 and Dr2.33) on dissected pediments and small areas of shallow (Um5.3) soils on narrow valley plains within this unit. Occurs on sheet(s): 6,10"
"Fa9"
"Stony hills with some steeply dissected pediments on fine-grained sedimentary rocks and basic dykes; some small valley plains may occur: shallow stony earthy loams (Um5.51) dominate along with small areas of shallow stony (Uc1.43) soils on steeper slopes. There is a greater proportion of (Dr2.32 and Dr2.33) soils than in unit Fa8. Shallow (Um5.3) soils occur on small valley plains. Occurs on sheet(s): 6,10"
"Fa10"
"Steep ranges comprising sandstones, conglomerates, and quartzites intruded by basic dykes; some small valley plains may occur; extensive portions of this unit are without soil cover: chief soils appear to be shallow stony earthy loams (Um5.51) along with extensive areas of shallow stony (Uc1.43) and (Uc5.11) soils. Small areas of (Dr2.32 and Dr2.33) soils are present on dissected pediments; and (Uc5.21), (Um5.3), and (Gn2.11) soils occur on the small valley plains. Occurs on sheet(s): 6"
"Fa11"
"Stony hills with some steeply dissected pediments on sandstones, conglomerates, and quartzites intruded by basic dykes; some small valley plains may occur: shallow stony earthy loams (Um5.51) dominate along with areas of (Uc1.43) and (Uc5.11) soils on steeper slopes; (Dr2.32 and Dr2.33) soils are quite extensive; and (Uc5.4), (Um5.3), and (Gn2.11) soils occur on the small valley plains. Occurs on sheet(s): 6"
"Fa12"
"Gently undulating plain with frequent low granite tors and coalescing pediplain: chief soils are earthy loams (Um5.51), and coarse sands (Uc5.21) overlying granite within 3 ft. There are considerable areas of red earths (Gn2.12), which may assume dominance in some places; some hard red soils (Dr2) together with coarse (Uc1) soils along creek lines; and minor areas of calcareous loams (Um1) associated with calcrete (kunkar). Occurs on sheet(s): 6,10"
"Fa13"
"Ranges of banded jaspilite and chert along with shales, dolomites, and iron ore formations; some areas of ferruginous duricrust as well as occasional narrow winding valley plains and steeply dissected pediments. This unit is largely associated with the Hamersley and Ophthalmia Ranges. The soils are frequently stony and shallow and there are extensive areas without soil cover: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5.11) soils on the steeper slopes. Associated are (Dr2.33 and Dr2.32) soils on the limited areas of dissected pediments, while (Um5.52) and (Uf6.71) soils occur on the valley plains. Occurs on sheet(s): 6,10"
"Fa14"
"Steep hills and steeply dissected pediments on areas of banded jaspilite and chert along with shales, dolomite, and iron ore formations; some narrow winding valley plains: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5.11) soils on the steeper slopes. (Dr2.33 and Dr2.32) soils which occur on the pediments are more extensive than in unit Fa13. (Um5.52) and (Uf6.71) soils occur on the valley plains. Occurs on sheet(s): 6,10"
"Fa15"
"Ranges of basalt along with shale, chert, jaspilite, and dolomite; some narrow winding valley plains. The soils are frequently shallow and there are extensive areas without soil cover: chief soils are shallow stony loams (Um5.51) along with (Um6.23) soils. (Dr2.33) soils occur on lower slopes extending onto the narrow valley plains where they are associated with (Uf6.71) and (Um5.52) soils. Occurs on sheet(s): 6"
"Fa16"
"Hills and steep dissected pediments in areas of basalt, shale, chert, jaspilite, and dolomite; some narrow valley plains: chief soils are shallow stony loams (Um5.51) along with appreciable areas of (Dr2.33) soils. There may also be small areas of (Um6.23) soils on the slopes, and (Uf6.71) and (Um5.52) soils occur on the valley plains. Occurs on sheet(s): 6"
"Fa17"
"Ranges comprising basic intrusive rocks, conglomerates, and other sediments including dolomite; some valley plains. Soils are frequently shallow and stony and there are areas without soil cover: chief soils are stony shallow earthy loams (Um5.51) along with some (Um6.23) soils. (Um5.52), (Gn2.13), and (Dr2.33) soils occur on the valley plains with (Um5.11) soils on calcrete (kunkar) along the creek lines. The (Um5.11) soils may be associated also with stony (Gc1.12) soils on exposures of dolomite. Occurs on sheet(s): 6"
"Fa18"

"Low stony hills and steeply dissected pediments on areas of basic intrusive rocks, conglomerate, and other sedimentary rocks including dolomite: chief soils are shallow stony earthy loams (Um5.51) along with some (Dr2.32 and Dr2.33) and (Uf6.23) soils. (Um5.11) and stony (Gc1.12) soils occur on exposures of dolomite as well as calcrete (kunkar). Occurs on sheet(s): 6"
"Fa19"
"Steep stony hills and ranges on metamorphosed basic and ultrabasic rocks, with some iron ore formations. There may also be small areas of granite. Limited areas of steep dissected pediments and valley plains are included. The soils are generally shallow and stony and there are extensive areas without soil cover: chief soils are shallow stony earthy loams (Um5.51) along with (Um6.23) soils. (Dr2.33) soils occur on the pediments; (Uf6.71) and (Ug5.37) soils occur on the plains. Occurs on sheet(s): 6"
"Fa20"
"Undulating to strongly undulating lands with rock outcrop on crests and slopes: dominant soils are shallow gravelly loams (Um5.51) and (Um4.21), with (Um1.43) occurring on ridge crests. Loamy red duplex soils (Dr2.13) and red earths (Gn2.12, Gn2.13, and Gn2.16) are important associated soils on lower slopes and in valleys. Occurs on sheet(s): 7,10"
"Fa21"
"Undulating to moderately undulating lands with rock outcrop and gravel-strewn crests and slopes: dominant soils are very gravelly shallow loams (Um5.51), (Um4.1), and (Um4.21); associated soils on slopes are gravel-strewn loamy red earths (Gn2.15, Gn2.12, Gn2.13, and Gn2.16), which in some areas may be locally dominant. Loamy red duplex soils (Dr2.13, Dr2.12) occur in lower sites together with occasional small areas of cracking clays (Ug5.22, Ug5.24). Occurs on sheet(s): 7,10"
"Fa22"
"Gently undulating to undulating plains with extremely gravelly ridge crests: dominant soils are shallow gravelly loams (Um5.51), (Um4.22), (Um2.12), (K-Um5.51), and (K-Um4.2). Associated are loamy grey earths (Gn2.82, Gn2.83, and Gn2.81), red earths (Gn2.14, Gn2.11), yellow earths (Gn2.21, Gn2.22), and brown earths (Gn2.42); these earths usually have quartz gravel on the surface and may be locally dominant. Areas of moderately deep grey-brown cracking clays (Ug5.22) occur in lower sites, and also associated are gravel-strewn red friable earths (Gn3.13) and loamy duplex soils (Dr2.13), (Dy2.13), (Dr2.12), and (Dy2.12). Occurs on sheet(s): 7"
"Fa23"
"Undulating lands with broad crests and long slopes: dominant soils are very gravelly shallow loams (Um5.5 1) and (Um4.2), sometimes with ironstone nodules in the profile. Gravelly red earths (Gn2.12, Gn2.11) and yellow earths (Gn2.22) are common associated soils. In lower sites are various gravel-strewn loamy duplex soils, chiefly (Dr2.13), (Dr3.12), and (Dr2.12), with similar (Dy) and (Db) soils; layers of quartz gravel may occur between 20 and 30 in. Small areas of deep cracking clays (Ug5.24, Ug5.25) of unit CC69 occur throughout. Occurs on sheet(s): 7"
"Fa24"
"Gently undulating to undulating plains with massive nodular laterite often outcropping; occasional short steep rock-strewn scarps: dominant soils are shallow, extremely nodular, loams, chiefly (Um5.51), with associated (Um2.12), (Um4.1), (Um4.22), and (Um1.43). In lower areas are very nodular loamy earths (Gn2.61), (Gn2.81), (Gn2.82), (Gn2.42), (Gn2.21), (Gn2.14), (Gn2.11), and (Gn2.12). On lower scarp slopes are loamy duplex soils (Dr2.12), (Dr2.13), (Dr3.42), (Db1.12), (Dy2.13), and (Dy2.12). In depressions and drainage lines there are small areas of grey-brown cracking clays (Ug5.22, Ug5.24). Stream levees have loamy red earths (Gn2.12, Gn2.11). Occurs on sheet(s): 7"
"Fa25"
"Moderately undulating lands with much rock outcrop and quartz gravels: dominant soils are shallow gravelstrewn loams (Um5.51), with lesser (Um1.43), (Um4.1), (Um4.21), and shallow gravelly bleached loams (Um2.12). On lesser slopes are gravelly-surfaced shallow to moderately deep loamy red duplex soils (Dr2.12, Dr2.13), with lesser (Db1.13). Some low areas have bleached loamy duplex soils (Dy2.4) and (Dy3.4). In isolated areas on lower slopes, loamy red or yellow earths (Gn2.12) and (Gn2.22) occur. Occurs on sheet(s): 7,10"
"Fa26"
"Strongly undulating lands with short steep slopes and much rock outcrop; some undulating outwash slopes: dominant soils are shallow stony red loams (Um5.51), with lesser (Um4.1) and (Um4.2). Associated soils on lower slopes are gravelly-surfaced moderately deep red duplex soils (Dr2.21); on stream levees are sandy red earths (Gn2.15) and lesser sandy yellow earths (Gn2.25). Occurs on sheet(s): 7"
"Fa27"
"Undulating or occasionally strongly undulating lands: dominant soils are shallow stony red loams (Um5.51). Moderately deep loamy red duplex soils (Dr2.23) and (Dr2.13) are common on the more gently sloping country. Many of the gentle outwash slopes have moderate to strong linear gilgai; the soils are dominantly deep cracking clays (Ug5.16), (Ug5.25), (Ug5.12), and (Ug5.37), with loamy duplex soils (Dy3.13), (Dd1.13), and (Db1.13) also associated. Occurs on sheet(s): 7"

"Fa28"
"Steep hills and low ranges associated with various rocks including dolomite and some chert breccia; exposures of rock are extensive and soils are shallow and stony: chief soils are shallow stony earthy loams (Um5.51). Other soils include shallow stony forms of (Dr2.32). Occurs on sheet(s): 10"
"Fa29"
"Steep stony hills and low ranges on highly folded quartzites, shales, and slates with extensive areas of rock exposures; small valley plains are included; soils are generally stony and shallow: chief soils are shallow stony earthy loams (Um5.51). Other soils include (Dr2.32), (Gn2.1), and (Uc5.11). Occurs on sheet(s): 10"
"Fa30"
"Ranges on metamorphosed sandstones, dolomites, jaspilites, and lavas with extensive rock exposures; soils are shallow and stony: chief soils are shallow stony earthy loams (Um5.51) together with some (Uc5.11) soils. Occurs on sheet(s): 10"
"Fa31"
"Rugged ranges with extensive areas of bare rock largely on metamorphics and granites but with some inclusions of sandstones and conglomerates: chief soils are shallow stony earthy loams (Um5.51) together with other shallow (Um) and (Uc) soils. Small areas of other soils are likely. Occurs on sheet(s): 10"
"Fa32"
"Low ranges and hills largely on metamorphics and granites but with some inclusions of sandstones and conglomerates; extensive areas of bare rock; transgressed by dunes in places and flanked by small plains: chief soils are probably shallow stony earthy loams (Um5.51) of the hill slopes with other shallow (Um) and (Uc) soils, but (Uc5.2) soils are likely to be common on flanking plains, probably with some (Gn2.1) soils, while (Uc1.23) soils occur on the dunes. Occurs on sheet(s): 10"
"Fa33"
"Rugged undulating to hilly areas on sedimentary and volcanic rocks with dissected rock mesas, pediments, and small valleys with dunes; much bare rock: chief soils are probably shallow stony earthy loams (Um5.51). Other soils probably include (Uc1.43), (Um1.43), and (Um5.3), with (Uc5.2) in sandy areas and (Uc1.23) on dunes. Occurs on sheet(s): 10"
"Fa34"
"Steep hills and ranges on basic rocks; rock outcrop common; some gorges; small pediments and plains: chief soils are probably shallow stony earthy loams (Um5.51) and other loamy soils (Um1.43) on the steeper slopes generally, with red earths (Gn2.12), often with a gravel pavement, on areas of gentler topography. Small areas of unit MM27 are included. Occurs on sheet(s): 10"
"Fa36"
"Undulating to moderately undulating lands with rock outcrop common: dominant soils are very gravelly shallow loams (Um5.51) and (K-Um5.51), with occasional (Um1.43) and (K-Um1.43). Associated are gravelly loamy red earths (Gn2.11, Gn2.12) and very gravelly red duplex soils (Dr2.13), (Dr2.43), and (Dr2.23). Relatively stone-free loamy red earths (Gn2.1) occur on small stream levees. Data are limited. Occurs on sheet(s): 10"
"Fa37"
"Undulating lands with occasional steep stony rises: dominant soils are very gravelly shallow loams (Um5.51) and (K-Um5.51). Associated are gravelly moderately deep to deep red earths (Gn2.11, Gn2.12). Other soils include very gravelly shallow loams (Um1.43), (K-Um1.43), (Um1.42), and (K-Um1.42), and shallow gravelly red duplex soils (Dr2.4) and (Dr2.1) may occur in lower slope positions. Data are limited. Occurs on sheet(s): 10"
"Fa38"
"Moderately to strongly undulating lands with occasional low hills and much rock outcrop: dominant soils are shallow very gravelly loams (Um5.51) and (Um1.43) and similar (K-Um) soils. Associated are other shallow gravelly loams (Um5.41), (Um4.21), (Um4.1), and calcareous loams (Um1.3). Gravelly-surfaced shallow red duplex soils (Dr2.12, Dr2.13) and lesser red friable earths (Gn3.12) are common on slopes and in valleys. Loamy red earths (Gn2.12) occur on stream levees and outwash fans. Occurs on sheet(s): 10"
"Fa39"
"Undulating to moderately undulating lands with much rock outcrop: dominant and associated soils are as for unit Fa38. Occurs on sheet(s): 10"
"Fa40"
"Gently undulating to undulating lands with occasional low mesas; rock outcrop is common: dominant soils are shallow very gravelly loams (Um5.51) and (Um5.41). Associated in lower sites are gravelly loamy red earths (Gn2.13, Gn2.12) and gravel-strewn loamy red duplex soils (Dr2.13, Dr2.12) and (Dr2.43). Near outcrops and on the mesas are shallow gravelly loams (Um1.3), (Um1.43), and (K-Um1.43), with occasional (Um6.22). Small areas of cracking clays (Ug5.24) and (Ug5.34) may be included. Occurs on sheet(s): 10"
"Fa41"
"Undulating to moderately undulating with some strongly undulating areas; rock outcrop is common: dominant soils are very shallow gravelly loams (Um5.51), with (Um1.43) and (K-Um1.43) more common on phosphatic rock

outcrops. Associated are other shallow gravelly loams (Um5.2), (Um1.41), (Um1.3), and lesser (Um5.11). On some outwash slopes are calcareous earths (Gc2.22) and gravel-free red earths (Gn2.13). Occurs on sheet(s): 10"
"Fa42"
"Level to gently undulating lateritic plateau remnants with scarped margins: dominant soils are shallow to moderately deep gravelly loams (Um5.51), with lesser (K-Um5.51), (Um1.43), (K-Um1.43), and (Um1.42). Associated in lower sites are shallow gravelly loamy duplex soils, mainly (Dr2.32) but also (Dy2.32) and (Dy3.32). On some of the more extensive plateau remnants there are fairly large areas of moderately deep to deep loamy red earths (Gn2.11, Gn2.12). Data are limited. Occurs on sheet(s): 10"
"Fa43"
"Gently undulating to undulating dissected lateritic plateau with many dissected low mesas: chief soils are shallow gravelly loams, (Um5.51) is probably dominant but areas of (Um1.43) with lesser (Um1.41, Um1.42) also occur. Associated soils include shallow to moderately deep gravelly-surfaced loamy red duplex soils (Dr2.32) and (Dr2.42) and shallow gravelly loamy red earths (Gn2.12, Gn2.11). The small mesas are outliers of unit Fa42. Deep cracking clays (Ug5.34), (Ug5.24), and (Ug5.38) occur in the small drainage lines included in the unit; these clays usually have a scalded surface. Occurs on sheet(s): 10"
"Fa45"
"Dissected undulating plateau areas of slopes and plains; some scarp zones with mottled and pallid rock material exposed; some mesas and buttes; silcrete boulders are common: dominant soils are shallow loams (Um5.51) and red earths (Gn2.12). Associated are small areas of a variety of soils, including (Um1.43) on scarps; (Dr2.12) on stony ridge tops; (Ug5.2) and (Ug5.3) with (Dr2.33) at the base of scarps. Red-brown hardpan may occur, especially in the western areas of the unit. Occurs on sheet(s): 10"
"Fa46"
"Gently undulating and sloping plains with silcrete stones and boulders: chief soils are shallow loams (Um5.51), 3-18in. deep, with variable areas of red earths (Gn2.12, Gn2.11, and Gn2.13). Associated are (Dr2.33), sometimes (Dr1.33), with (Ug5.3) soils in flats and depressions generally, and the soils of unit Oc86 in the small drainage-ways. As mapped, areas of unit My142 may be included. Red-brown hardpan may occur, especially in the western areas of the unit. Occurs on sheet(s): 10"
"Fa47"
"Undulating to low hilly terrain with gravel-strewn surfaces: chief soils are probably shallow loams (Um5.51) on mottled rock, with (Um5.3) and (Gn2.12) soils on red-brown hardpan. Associated are probably (Dr1.32, Dr1.33) soils with (Ug5.3) clays in microassociation. Data are very limited. Occurs on sheet(s): 10"
"Fa48"
"Dissected plateau remnants as mesas, ridges, and buttes often strewn with silcrete boulders, stones, and gravels: chief soils are shallow loams (Um5.51) and (Um1.43). Associated are shallow (Gn2.12) soils. Pockets of dark red-brown pedal clays occur in places below the soils and boulders. Occurs on sheet(s): 10"
"Fb1"
"Alluvial flood-plains dissected by present and prior drainage lines and their associated small levees: dominant soils of the level areas are uniform earthy loams (Um5.52) that are usually stratified at depth. The soils of the small levees are deep sands (Uc5.11) and (Uc5.21). In shallow depressions or near the margins of the unit loamy duplex soils (Dy2.43) and (Dr2.33) occur. Also occurring in the unit are small areas of red and yellow earths (Gn2.12) and (Gn2.22). Occurs on sheet(s): 4"
"Fb2"
"Narrow outwash plains flanking ranges of sedimentary rocks: dominant soils are deep earthy loams (Um5 .52) but large areas of (Dr2.33) soils are also present. Occurs on sheet(s): 6"
"Fb3"
"High-level valley plains set in extensive areas of unit Fa13. There are extensive areas of pisolitic limonite deposits: principal soils are deep earthy loams (Um5.52) along with small areas of (Gn2.12) soils. Occurs on sheet(s): 6,10"
"Fb4"
"Alluvial plains associated with major streams: dominant soils are uniform loams (Um5.52) which may be stratified at depth. More recent levees have deep earthy sands (Uc5.2). Older levees and infilled stream channels have sandy or loamy red earths (Gn2.14, Gn2.15). Small areas of loamy duplex soils (Dy2.33) and (Db1.33) may occur in lower sites. Data are very limited. Occurs on sheet(s): 7"
"Fb5"
"Stream levees and numerous old stream channels: dominant soils are deep earthy loams (Um5.52) that are usually stratified at depth. Associated on back slopes are brown earths (Gn2.41, Gn2.43) and (Gn2.53) and occasionally sandy red earths (Gn2.14). Away from the channels on the margins of the unit are some loamy grey duplex soils (Dy2.33) of unit Si12. More recent levees and terraces have deep sands (Uc5.22, Uc5.21) and (Uc4.31). Occurs on sheet(s): 7"
"Fb6"

"Low delta plains merging into marine plains, salt pans, and mangroves: dominant soils are deep uniform loams (Um5.52), but large areas of dark loamy duplex soils (Dd1.33) and (Dd1.43) occur in swampy areas and on small included areas of marine plain. Brown earths (Gn2.43) and deep sands (Uc1.22) occur on more prominent levees, and saline clays (Uf6.62) occur on small areas of salt pans. Occurs on sheet(s): 7"
"Fb7"
"Delta plains dissected by numerous present and prior drainage lines and their associated levees: dominant soils are deep uniform loams (Um5.52), with lesser (Um5.42); both soils are usually stratified at depth. Levee soils are dominantly brown earths (Gn2.43), with sands (Uc1.22, Uc1.23) occurring on the higher levees and stranded beach ridges. Some areas of dark loamy duplex soils (Dd1.13) and (Dd1.33) occur in depressions and swampy areas. Occurs on sheet(s): 7"
"Fb8"
"Plains: chief soils are deep earthy loams (Um5.52) together with some areas of clay soils (Uf6.71) and (Ug5.37). Occurs on sheet(s): 10"
"Fc1"
"Low plateaux on sandstone, siltstone, and chalcedony with some lateritic duricrust: chief soils are shallow gravelly loams and sands (K-Um5.51), (K-Um1.43), (K-Uc1.43), and (KS-Uc5.21). Small areas of other soils including some (Gn2.1) soils are likely; (Uc1.23) sands occur on occasional dunes. As mapped, small plains of unit AB31 may be included. Occurs on sheet(s): 10"
"Fc2"
"Undulating or strongly undulating gravelly ridges, usually with rounded crests; in some areas low stony hills occur: dominant soils are shallow very gravelly red loams (K-Um5.51), with other shallow gravelly loams (K-Um1.43), (Um5.51), and (Um1.43) associated. On flatter sites gravelly red earths (Gn2.12, Gn2.11) occur, and on lower slopes there are small areas of loamy duplex soils (Dr2.32, Dr2.33). Occurs on sheet(s): 10"
"Fd1"
"Undulating limestone ridges, usually with broad crests and long gentle slopes; in some areas low benched scarps occur; outcrop is common: dominant soils are shallow gravelly calcareous loams (Um5.61), with other similar shallow gravelly calcareous loams (Um1.3), (Um5.11), and (Um6.22, Um6.23) associated. In lower sites shallow to moderately deep loamy calcareous earths (Gc1.12), (Gc1.22), and (Gc2.22, Gc2.21) are common. Occurs on sheet(s): 10"
"Fd2"
"As for unit Fd1 but there are important areas of loamy red earths (Gn2.13, Gn2.12) on flatter sites, and occasional low stony hills or high ridges of units Fz46 and Fc2. Data are very limited. Occurs on sheet(s): 10"
"Fp1"
"Flood-plains adjacent to stream lines, often dissected by present or prior drainage channels; shallow swamp and lagoonal depressions occur and parts of the area are subject to flooding: dominant soils are uniform loamy soils (Um5.42) that are occasionally earthy (Um5.5) or structured (Um6.11) and (Um6.14) and are underlain by deep alluvial deposits. Slightly higher levee soils are sandy, chiefly (Uc5.11) with lesser (Uc1.21), while in lower sites uniform silty soils (Uf6.32 and Uf6.33) are common, with less often loamy duplex soils (Db1.13), (Dd1.13), and (Dd1.12). Occurs on sheet(s): 4"
"Fq1"
"Alluvial fan plain dissected by numerous active and prior stream channels: soils are extremely variable over short lateral distances but all have uniform or weakly gradational texture profiles. The dominant soil of the inter-channel areas is a uniform silt loam (Um3.2), often with older buried soils at shallow depths. Other soils commonly occurring include (Um5.5), (Um2.2), (Gn2.55), (Gn2.83), and smaller areas of (Uf6.5) soils. Many of these soils have bare eroded surfaces. Small areas of loamy duplex soils (Dr2.43), (Dr2.33), and (Dy2.43) also occur. Old sand-filled channels and levees have deep sandy soils (Uc1.21 and Uc1.23), (Uc5.21 and Uc5.23); included in the unit, as mapped, are small areas of loamy and sandy red earths (Gn2.12). Occurs on sheet(s): 4"
"Fu1"
"Hilly to steep hilly terrain: chief soils seem to be leached loams (Um2.12) on the crests and upper slopes with (Dy2.41) and (Dy3.41) soils on mid and lower slopes. Data are very limited. Occurs on sheet(s): 4"
"Fu2"
"Hilly to steep hilly areas of metasediments and phyllites, traversed by narrow valley plains along the streams: chief soils are shallow and stony leached loams (Um2.12) and also (Um5.2) loams. Associated are: (Gn3.11), (Gn3.14), and (Gn3.91) soils on upper to mid-slope positions; (Dy2.11) and (Dr2.11) soils on mid to lower-slope positions; small areas of other soils including (Uc6.11), (Dr2.22), (Dr3.11), and (Dr4.41). As mapped, areas of adjoining units may be included. Occurs on sheet(s): 4"
"Fu3"
"Steep hilly to mountainous terrain on metasediments and phyllites rising to 2800 ft above sea level: chief soils on the slopes are shallow and stony leached loams (Um2.1), and also (Um5.2) loams. Associated are: (Dr2.11) and (Dy2.11) soils in less elevated sites; (Uc6.11) sands with some (Dr5.81) and (Dy5.81) soils on included granites;

and (Gn3.11) soils on small basaltic residuals. As mapped, narrow terraced valleys of unit MM9 are included in some localities. Occurs on sheet(s): 4"
"Fu4"
"Steep hilly terrain on phyllites--steep side slopes to narrow valleys; some small sloping fan development: chief soils are leached loams (Um2.12) and loamy soils having an A2 horizon (Um4.1) on hill crests and slopes. Associated are shallow forms of (Dr2.31), (Dr3.31), and related soils (similar to the chief soils of unit Pc2) on all slopes. Other soils encountered are (Dy3.31) on hill slopes, (Gn3.71) and (Gn3.41) on fans, and (Gn2.94) and (Gn3.74) along stream valleys. Occurs on sheet(s): 4"
"Fu5"
"Steep hilly to mountainous land on shales and phyllites, with narrow crests and steep to very steep slopes to narrow valleys: chief soils are leached loams (Um2.12) on crests and slopes. Associated are (Um4.1), (Uc2.12), (Uc4.1), and (Dy3.41) on slopes. Other soils include (Dr3.41) on slopes and (Gn3.12) and (Gn3.42) on dyke rocks. Occurs on sheet(s): 4"
"Fu6"
"Hilly to steep hilly land on shales and cherts; narrow ridge crests with moderate to steep side slopes; narrow valleys; and shallow gravelly soils: chief soils are leached loams (Um2.12) on crests and slopes. Associated are (Um4.1), (Uc2.12), and shallow (Dy3.41) and (Dr3.41) soils. Small areas of many other soils, especially those of unit Fu8, occur throughout. As mapped, there are inclusions of units Mm8 and X13. Occurs on sheet(s): 4"
"Fu7"
"Mountainous land on shales and cherts; steep to very steep slopes with narrow valleys; some rock outcrops: chief soils are leached loams (Um2.12) with (Uc2.12) on crests and slopes. Associated are (Um4.1) soils. Small areas of other soils, especially those of unit Fu8, may occur. Occurs on sheet(s): 4"
"Fu8"
"Generally low hilly terrain on shales with gentle to moderate side slopes to open shallow valleys: chief soils are leached loams (Um2.12) on crests and upper slopes and hard acid red mottled soils (Dr3.41) on upper and middle slopes. Associated are (Dy3.41) soils on lower slopes of shale hills and (Db1.12), (Dy3.42), and (Gn3.42) on the slopes of andesitic and tuff hills. Minor soils are: (Dr2.43), (Dy3.42), (Db1.43), (Gn3.12), and (Gn3.13) on limestones; (Um6.22), (Dr5.21), and (Dr5.41) on shales associated with limestones; (Uc1.23) and (Um1.43) on young river terraces; (Gn2.22) on high river terraces; (Gn3.92) and (Gn2.94) on stream flats; and (Gn3.91) on slope fans. Small inclusions of unit Mm8 occur in some localities. Occurs on sheet(s): 4"
"Fu9"
"Steep hilly to mountainous terrain with some rocky hills and knolls and some rounded crests: chief soils are leached loams (Um2.12) of a very fine sandy nature on hill crests and slopes of tuff and trachyte with (Dy2.41) soils on andesite. Associated are (Dr3.41) and (Um4.1) soils on shales. Other soils include: (Db1.41), (Db1.42), and (Gn3.12) on andesitic hill slopes; (Dg1.41) on steep slopes of tuff; (Dy3.41) soils on creek flats; and (Ug5.1) soils around outcrops of basic rocks. Occurs on sheet(s): 4"
"Fu10"
"Steep hilly to mountainous land derived from silicified shales, slates, and cherty materials with some basic dyke rocks forming cliff scarps--very steep slopes, V-valleys, much rock outcrop: chief soils are leached loams (Um2.12) and related shallow stony soils (Um4.1). Associated are (Dr4.21), (Dr4.41), (Dy4.42), and (Dy2.42) soils on the steep slopes. Minor soil occurrences include (Dr2.43), (Dr2.23), and (Dy2.43) on fans and (Dr2.12) on basic dykes. Occurs on sheet(s): 4"
"Fu11"
"Steep hilly lands on metasediments with narrow ridge crests, steep side slopes, and V-valleys: chief soils are shallow gravelly leached loams (Um2.12) with shallow gravelly (Um2.21) soils on lower slopes and fans. Associated are shallow gravelly (Dy3.41) soils on lower slopes and saddles and (Um4.1) soils on crests. Minor soil occurrences include (Um6), (Uc2.12), and (Dy3.42). Occurs on sheet(s): 4"
"Fu12"
"Steep hilly lands as for unit Fu11, flanked by low hilly ridges of unit Fv1. Occurs on sheet(s): 4"
"Fu13"
"Hilly to steep hilly lands on metamorphic rocks: chief soils are leached loams (Um2.12) and sands (Uc2.12). Associated are (Uc4.1) and (Um4.1) soils on crests, with (Dy3.41) and (Dy2.41) soils on slopes. Minor areas of other soils such as (Dr2.42) may occur. Occurs on sheet(s): 4"
"Fu14"
"Steep hilly to mountainous scarp country with plateau remnants at high level: chief soils are probably leached loams (Um2.12) with (Um4.1). Associated are: (Um6.21) and other (Um6) soils, and shallow (Gn3.12) soils on more basic rocks; and (Gn2.11) and/or (Gn2.14) soils on the plateau remnants of unit Mz20. Minor soils include (Dy), (Dr), and (Ug) forms. As mapped, small areas of units CC23 and CC43 are included. Occurs on sheet(s): 4"
"Fu15"

"High hilly or mountainous areas with some marginal strongly undulating slopes: dominant soils are shallow stony loams (Um2.12), with lesser (Um4.1), (Um1.42), and (Um1.43). On lower flatter slopes shallow stony loamy duplex soils occur, chiefly (Dy3.42 and Dy3.41) and similar (Dy2) soils. In some steep-sided stream valleys friable earths may occur, chiefly (Gn3.12), (Gn3.14), and (Gn3.32), together with lesser areas of (Dr2.12) soils. Occurs on sheet(s): 4"
"Fu16"
"Moderate to strongly undulating lands with occasional low hills: dominant soils are shallow stony leached loams (Um2.12), with lesser (Um4.1). Closely associated in lower-slope sites are shallow stony loamy duplex soils (Dy2.43) and (Dy3.43), with smaller areas of (Dr2.33). Data are limited. Occurs on sheet(s): 4"
"Fu17"
"Low hilly to hilly lands with steep slopes: dominant soils are shallow extremely stony leached loams (Um2.12), with (Um4.1) closely associated, and with lesser areas of (Um2.2) and (Uc2.21) soils. On lower slopes shallow stony duplex soils occur, chiefly (Dy2.43), (Dy3.43), (Dr2.33), and (Dr2.12). Data are limited. Occurs on sheet(s): 4"
"Fu18"
"Moderate to strongly undulating lands with occasional low hills: dominant soils are shallow stony bleached loams (Um2.12), with lesser (Um4.1); the soils often have a quartz-gravel-strewn surface. Associated on some slopes are gravelly red duplex soils (Dr2.33), (Dr2.22), and (Dr2.43). In broad valley floors stone-free loamy red earths (Gn2.12, Gn2.11) occur, with lesser loamy yellow earths (Gn2.21, Gn2.22). In some areas on basic rocks there are small inclusions of the (Gn3.12) soils of unit Mo29. Occurs on sheet(s): 7"
"Fu19"
"Low hilly to strongly undulating lands with rock outcrop throughout: dominant soils are very shallow stony bleached loams (Um2.12), with other shallow stony loams (Um4.11) and (Um5.41) associated. Occurring in some areas on basic rock outcrops are small areas of red friable earths (Gn3.12) of unit Mo29. In marginal flatter sites there are small areas of loamy yellow or red earths (Gn2.21) and (Gn2.11); some valley floors have neutral red earths (Gn2.12). Occurs on sheet(s): 7"
"Fu20"
"Low hilly to hilly ranges, mostly with rounded crests; massive rock outcrop is very common. All soils are very shallow and usually stony. Bleached loams (Um2.12) are dominant but other shallow loams (Um4.2) also occur with, less commonly, shallow bleached sands (Uc2.12). Occurs on sheet(s): 7"
"Fu21"
"Low hilly or strongly undulating lands, usually with numerous dissected mesas and steep scarps: dominant soils of the dissected mesas are shallow stony bleached loams (Um2.12) and bleached sands (Uc2.12). Massive sandstone outcrop is common. Similar (Um4.1) and (Uc4.12) soils also occur. Outwash slopes have deep sands (Uc4.22) and (Uc2.21). Smaller areas of yellow earths (Gn2.21), bleached grey earths (Gn2.94), and occasional red earths (Gn2.14) occur on areas of lesser relief. Small areas of loamy duplex soils (Dy2.42, Dy2.43) occur in some valley floors. Data are limited. Occurs on sheet(s): 7"
"Fu22"
"Hilly to high hilly lands with very steep slopes and much acid volcanic rock outcrop: dominant soils are shallow to moderately deep bleached loams (Um2.12), but the unit also includes areas of moderately deep to deep friable earths, mainly (Gn3.74), but with (Gn3.84), (Gn3.94), and (Gn3.04) on the wetter eastern margins. Loamy duplex soils (Dy3.43, Dy3.41) occur on some lower slopes and in drainage lines. Occurs on sheet(s): 7"
"Fu23"
"High hilly lands with some marginal strongly undulating to low hilly areas; slopes are fairly steep with much acid volcanic rock outcrop: dominant soils are shallow gravelly loams (Um2.12), with lesser (Um4.2) and (Um4.1). The latter are common on the very steep slopes. Some moderately deep to deep loams (Um2.21, Um2.22) and similar sands (Uc2.21, Uc2.22) occur on lower colluvial slopes. Moderately deep to deep loamy yellow duplex soils (Dy3.43) and (Dy2.43) occur on the valley floors and basal slopes. Areas of loamy red duplex soils (Dr2.22), (Dr2.42), and (Dr3.42) occur on some of the basic rocks. Occurs on sheet(s): 7"
"Fu24"
"Strongly undulating to low hilly lands with occasional steep scarps and much massive acid volcanic rock outcrop: dominant and associated soils are similar to those of unit Fu23. Occurs on sheet(s): 7"
"Fu25"
"Low hilly to hilly lands closely dissected by numerous small streams; undulating areas occur marginally and there are some areas of high hills with very steep slopes; rock outcrop is common: dominant soils are very shallow gravelly bleached loams (Um2.12), with lesser areas of similar loams (Um2.21), (Um4.1), and (Um4.21). Smaller areas of similar sandy loams (Uc2) and (Uc4) occur locally. Associated throughout the unit are areas of shallow gravelly duplex soils, particularly on lesser slopes. The chief forms are (Dy3.41), (Dr2.41), and (Dr3.41); in some valley floors there are small areas of (Dy3.43) soils. Small areas of basic volcanic rocks in the unit have deeper red

friable clays (Uf6.31). At the northern margin, the unit may be capped by small sandstone mesas of unit Ca35. Occurs on sheet(s): 7"
"Fu26"
"Strongly undulating to occasionally low hilly lands; this unit has much less relief than unit Fu25 and is less dissected by streams: dominant soils are as for unit Fu25 but there is a greater proportion of shallow gravelly mottled duplex soils (Dy3.41, Dy3.43), which occur on lesser slopes. Small areas of unit Va85 are included. Occurs on sheet(s): 7"
"Fu27"
"High hilly to mountainous lands with very steep slopes; rock outcrop is very prominent. The soils are the same as for unit Fu25. Occurs on sheet(s): 7"
"Fu28"
"Hilly or low hilly lands with much massive igneous rock outcrop: dominant soils on higher landscape sites are shallow stony loams, (Um2.12) and (Um2.21) are probably dominant with lesser (Um4.2). On lower slopes shallow gravelly duplex soils are common, chiefly (Dy3.41) and (Dy2.41); similar deeper loamy duplex soils occur in valley floors. On some densely vegetated hills there are small areas of red friable earths (Gn3.11, Gn3.14). Adjacent to the coast are some areas of small fringing sand dunes with (Uc1.21) and (Uc4.2) soils. Data are limited. Occurs on sheet(s): 7"
"Fx1"
"Low hilly to hilly lands with steep slopes and broad valley floors; much rock outcrop occurs on the slopes and crests. All soils have much angular gravel on the surface and in the profile: dominant are shallow loams (K-Um1.43) and (Um1.43), with other shallow loams (Um4.1) and (Um4.21) associated on the slopes. In the valley floors are gravelly bleached duplex soils (Dy3.42, Dy3.43). Associated soils on carbonate rocks are shallow gravelly-surfaced red duplex soils (Dr2.42), (Dr2.11), and (Dr2.13). Occurs on sheet(s): 7"
"Fy1"
"Steep ranges on dolomites and sandstones, dissected by narrow valley plains and with some stony pediments; rock outcrop frequent: soils are all shallow; chief soils are probably loams (Um1.3, Um1.4) with clays (Uf1.3) and (Ug) on more basic rocks. Some red earths (Gn2) occur in valleys and also recent sands (Uc) along creeks. Restricted areas of hard red soils (Dr2) occur on pediments. Occurs on sheet(s): 6"
"Fy2"
"Rugged limestone ranges, steeply dissected and with cliff faces forming their margins. The area is dominated by bare limestone and there are pockets of shallow calcareous loams (Um1.3). Occurs on sheet(s): 6"
"Fy3"
"Coastal islands formed on hard marine limestones, with small areas of shelly dunes; bare rock areas prominent: chief soils are probably shallow calcareous loams (Um1.3) and (Um5.11). There is a coastal fringe of calcareous sands (Uc1.11). Occurs on sheet(s): 6"
"Fy4"
"Undulating to moderately undulating lands with much limestone outcrop: dominant soils are very shallow gravelly loams (Um1.3), with lesser (Um5.11). Associated soils on lower sites are other shallow loams (Um6.22), red duplex soils (Dr2.13), and loamy red or brown earths (Gn2.13, Gn2.12), and (Gn2.4) on stream levees. Occurs on sheet(s): 7,10"
"Fy5"
"Undulating to strongly undulating lands with low mesas having benched slopes and much limestone outcrop: dominant soils are shallow gravelly calcareous loams (Um1.3), with other loams (Um1.13) and (Um5.11) closely associated. Associated soils on lower slopes are shallow friable loams (Um6.14), which are also often gravelly. Loamy red earths (Gn2.12, Gn2.13) occur on stream levees. Occurs on sheet(s): 7"
"Fz1"
"Hills, ranges of hills, low hilly ridges, or dissected tableland remnants (mesa, butte, or cuesta forms): chief soils are shallow loams (Um1.43) and (Um5.41) usually containing or covered by siliceous gravel, with many rock outcrops and boulders of siliceous or ferruginous materials. Associated soils include shallow sands (Uc1.43), red earths (Gn2.12 and Gn2.13), and less frequently (Dr1) soils such as (Dr1.32). In Queensland occurrences the (Um1) soils are notably dominant whereas the (Um5) soils appear more common in the south. Compare unit F6 of Sheet 1. Occurs on sheet(s): 3,4,10"
"Fz2"
"Low hills and stony ridges, some mesaand butte-like residuals with shallow mostly stony soils: soils of the stony areas are shallow (Um1.43) and (Uf1.43), with (Dd1.22 and Dd1.23) and (Dr2.22 and Dr2.23). Stony (Gn2.12) soils occur on some mesa-like residuals. The pediment slopes have (Dr2.22), (Dr2.23), and (Dr2.32) soils while valley areas often have gravelly (Ug5.37 and Ug5.38) clays and/or (Db1.33) soils. Rock materials are usually of lateritic appearance (mottled-zone materials). Occurs on sheet(s): 3,4"
"Fz3"

"Low hills and dissected low ranges, often with mesaor butte-like remnants: chief soils are shallow stony loamy soils (Um1.43 and Um1.42), with less commonly (Uc1.2), (Uc1.4), or (Uf1.43) soils. A variety of shallow stony (D) soils may also occur locally. The associated valley floors and slopes have mainly loamy to sandy-surfaced (Dy2.33 and Dy2.43) or (Dy3.33 and Dy3.43) soils, with occasional areas of red earths (Gn2.12), sandy-surfaced (Dy5.3) and (Dy5.4) soils, or brown loamy soils (Db1.33) and (Db1.43). Occurs on sheet(s): 3,4"
"Fz4"
"Low flat-topped basaltic ridges, very stony and bouldery: chief soils on the ridges are shallow loams (Um1.43) while some areas of brown cracking clays (Ug5.3) occur on slopes below the scarps. Data are limited. Occurs on sheet(s): 3"
"Fz5"
"Low hills and dissected tableland remnants of butte and mesa-like form; rock outcrops of lateritic materials and siliceous boulders are very common: dominant soils are shallow gravelly loams (Um1.43), with lesser areas of (Um5.41) and small areas of red earths (Gn2.12). Associated soils at the base of scarps include brown and grey clays (Ug5.32) and (Ug5.22) and red loamy duplex soils (Dr1.33) and (Dr2.33). Occurs on sheet(s): 4,10"
"Fz6"
"High hills, strongly dissected low ranges with some mesas: dominant soils are shallow stony loams (Um1.43 and Um1.41) with lesser (Um4.2). Associated are areas of shallow sandy soils (Uc1.21), (Uc3.12), and (Uc5.11). On many slopes duplex soils occur, chiefly (Dr2.41), (Dr3.43), and similar (Db) soils; on flatter valley floors sandy-surfaced duplex soils are common, chiefly (Dy3.42) and (Dy2.42). Occurs on sheet(s): 4"
"Fz7"
"Strongly undulating to low hilly lands: dominant soils are shallow stony loams (Um1.43) and (Um1.41), (Um4.1), and (Um5.5). Associated are shallow sandy soils (Uc2.12), (Uc3.12), and (Uc1.21). On some slopes shallow duplex soils (Dr2.33), (Dr2.32), (Dy3.43), and (Dy3.42) occur; in valley floors deeper sandy soils (Uc1.21 and Uc1.23) and (Uc5.21 and Uc5.22) occur. Small areas of sandy red earths (Gn2.12 and Gn2.11) and yellow earths (Gn2.22 and Gn2.21) are also included in the unit. Occurs on sheet(s): 4"
"Fz8"
"High mountains with precipitous scarps, high plateaux, and deep narrow ravines: dominant soils are shallow stony loams, chiefly (Um1.43 and Um1.41), with numerous rock outcrops. Other (Um) and (Uf) soils are probably present. Data are limited. Occurs on sheet(s): 4"
"Fz9"
"Strongly undulating or low hilly areas, the hills mostly of mesaor cuesta-like form with steep-scarped dissected margins: dominant soils are gravelly mostly shallow loams (Um1.43), (Um4.1), and (Um4.2) with lesser (Um2.12). Shallow sandy soils (Uc1.23), (Uc4.2), and (Uc5.11) are often associated. Steep marginal slopes have gravelly duplex soils, chiefly (Dr2.21 and Dr2.41) and (Dy3.41 and Dy3.42). Flatter areas, especially valley floors, have loamy duplex soils (Dy3.42), (Dy3.43), (Db1.43), (Db1.42), and (Dr2.12). Occurs on sheet(s): 4"
"Fz10"
"Steep hilly to mountainous country with some small plateau remnants; narrow valleys: chief soils are shallow loams (Um1.41) with some (Um1.43), (Um4.1), and (Um2.12), with many rock outcrops. Associated soils are (Dr2.12) on slopes. Minor soil occurrences include (Dy2.4) and (Dy3.4) on slopes and some flat-topped ridges, (Ug5.14) on lower slopes, and (Ug5.34) and (Ug5.15) in the narrow valley floors. Some areas may have similarities to unit Fu14. Data are limited. Occurs on sheet(s): 4"
"Fz11"
"Steep ridges with some flat crests; a dense drainage pattern with moderate areas of low spurs: chief soils are shallow loams (Um1.41 and Um1.43) and possibly (Um4.1) with rock outcrops. Associated are (Dy3.42) soils on lower ridge slopes and (Dr3.41) soils on spurs. Minor soil occurrences include (Dr2.12) on ridge slopes; and on narrow valley plains (Dd1.13), (Dy3.42), and (Gn3.94) soils occur. Occurs on sheet(s): 4"
"Fz12"
"Low hilly or strongly undulating dissected lands with short slopes and a close drainage pattern: dominant soils are shallow extremely gravelly loams (Um1.43); angular quartz gravel is prominent on the surface and throughout the solum. Associated are other shallow stony loams (Um4.1) and (Um2.12), and deeper less gravelly red duplex soils (Dr2.12), (Dr2.13), (Dr2.23), (Dr2.33), (Dr2.43), and (Dy2.43). Also occurring locally are comparatively stone-free areas of red clays and clay loams (Uf6.31) and (Gn2.12 and Gn2.13). Small alluvial stream flood-plains within the unit mostly have loamy duplex soils (Dy2.43) and (Db1.33). Occurs on sheet(s): 4"
"Fz13"
"Low hilly to very strongly undulating lands, much dissected by streams that have only small, or no, flood-plains: chief soils are shallow stony loams (Um1.43) and (Um4.1) with much massive sandstone outcrop. Associated are mainly shallow loamy duplex soils (Dr2.32), (Dy2.32), and (Dy3.32). The (Dy) soils are deeper and stone-free and mostly occur on lower slopes or small valley floors. In some more siliceous sandstone areas shallow stony sands (Uc1.21 and Uc1.23), (Uc4.11), and (Uc4.2) occur. Occurs on sheet(s): 4"
"Fz14"

"Very high hilly or mountainous lands with steep slopes and some abrupt high dissected scarps; flatter lands are very limited and are mostly confined to narrow valley floors; igneous rock outcrop is extensive throughout. Dominant soils are shallow stony loams (Um1.43 and Um1.42), with associated (Um4.1) and (Um2.12), and shallow stony duplex soils (Dr2.12), (Dr2.22), (Dy2.11), (Dy2.12), (Dy2.22), and (Dy2.41). Some less stony areas of deeper soils have friable earths (Gn3.1), (Gn3.15), (Gn3.21), and (Gn3.22). Small alluvial valley floors may have loamy duplex soils (Dy3.42) and (Dy3.32). Occurs on sheet(s): 4"
"Fz15"
"High hilly lands, but with rounded hill crests and only moderately steep slopes; limited flatter areas occur as more mature stream valleys; igneous rock outcrops are almost universal: dominant soils are very shallow stony loams (Um1.43, Um1.42, and Um1.41), with associated (Um4.1), (Um2.12), and (Um5.41). Flatter areas have less stony deeper strongly developed duplex profiles (Dy3.42), (Dy3.22), similar (Dy2) soils, and smaller areas of (Dr2.12) and (Dr2.22). Occurs on sheet(s): 4"
"Fz16"
"Gently undulating plains with some scarped lateritic margins and some low eroded mesa-like hills: dominant soils are very shallow often stony loams (Um1.41, Um1.42, and Um1.43) that overlie a mottled rock pavement; bare rock is often exposed. Associated soils include shallow sandy or loamy red earths (Gn2.12), and small areas of duplex soils (Dr2.13), (Dr2.33), and (Dy2.33), also overlying mottled rock. Occurs on sheet(s): 4"
"Fz17"
"Undulating stony ridges and occasional low mesas with scarped margins; always covered with a mantle of siliceous (billy) boulders (12-24 in.): dominant soils are shallow extremely gravelly loams (Um1.41 and Um1.42); occasional bare stony pavements of mottled rock occur. Flatter areas in the unit have loamy or sandy yellow earths (Gn2.22) or grey earths (Gn2.82), and less often red earths (Gn2.12); these earths often contain a nodular laterite horizon. Adjacent to some drainage lines are shallow loamy duplex soils (Dy2.32) and (Dy3.42). Occurs on sheet(s): 4"
"Fz18"
"Hilly or high hilly lands with much massive volcanic rock outcrop: dominant soils are very shallow mostly stony loams (Um1.41), with lesser areas of (Um4.1) and (Um2.12). Lower flatter slopes have stony loamy duplex soils, chiefly (Dy2.42 and Dy2.43). As mapped, the unit may have marginal inclusions of deep cracking clays (Ug5.24), (Ug5.16), and (Ug5.34). Occurs on sheet(s): 4"
"Fz19"
"Plateau residuals, with shallow loamy soils and much outcropping hard sedimentary rock, flanked by steep breakaway sides: chief soils are probably non-calcareous brown loams (Um 1.43) and (Um1.23) with some brown calcareous loamy soils (Um1.13) and (Um1.3) on fossiliferous limestone. Loam soils with weak pedologic organization (Um5) are probably also present. Occurs on sheet(s): 6"
"Fz20"
"Hilly limestone country of ridges, cuestas, and plateaux; many rock outcrops and boulders: chief soils are shallow loams (Um1.43) with variable areas of (Um6) loamy soils such as (Um6.24). Associated in areas of gentler topography are (Dr2.12) soils in complex with (Ug5.2) soils in narrow depressions. Other soils include (Gn2.15) and (Gn2.12) and some (Gn3.13) on gentler slopes with (Gn2.2) soils in lower-lying sites. Occurs on sheet(s): 8,9"
"Fz21"
"Hilly limestone country with many boulders and outcrops: chief soils are shallow loams (Um1.43) with limestone boulders or outcrops on hills, gently sloping boulder areas, and short steep strike scarps. Smaller areas of (Gn2.12), (Gn2.4), and (Um6) soils occur on gentle slopes; very small areas of (Ug5.2) soils occur on lower gentle slopes; and some (Uc) and (Um) soils border streamlines. Occurs on sheet(s): 8,9"
"Fz22"
"Generally flat to gently undulating country with numerous outcrops of platy limestone: chief soils are shallow loams (Um1.4), possibly with pockets of (Gn3.12) soils. Small areas of cracking clays (Ug5) may be associated. Occurs on sheet(s): 8"
"Fz23"
"Generally hilly terrain of low to prominent roughly rounded or benched hills on basaltic and allied rock types with rocky and stony steep to moderate slopes: chief soils seem to be shallow loams (Um1.43), (K-Um1.4), and (Um4.1) but there may be some similar (Uc) soils such as (Uc4.1 and Uc4.2). Associated are (Gn3.12) and/or (Gn2.12) soils in areas of gentler relief, while patches of block laterite and some (Uc) soils such as (K-Uc1.4) and (Uc2) occur sporadically. Small valley plains with (Gn2.12), (Gn2.6), and (Dy3.4) soils are of limited extent. Some areas of unit JJ34 and adjoining units are included. Occurs on sheet(s): 8"
"Fz24"
"Strongly undulating to low hilly lands on dolomitic sandstones and allied rocks, with some hills having steep slopes and much bare rock outcrop: dominant soils are shallow stony loams (Um1.43), (Um4.1), and (Um4.21), with gravelly-surfaced red duplex soils (Dr2.12) occurring on some slopes. On valley floors are shallow loamy red earths (Gn2.12, Gn2.11). Data are limited. Occurs on sheet(s): 7,8"

"Fz25"
"Low hilly to hilly lands with much rock outcrop and steep gravelly scree slopes: dominant soils are gravelly shallow loams (Um1.43) and (K-Um1.43), with associated (Um4.1) and (Um4.22) on slopes. Small areas of shallow gravelly bleached loams (Um2.12) also occur. Stream levees have red or yellow earths (Gn2.12) and (Gn2.22), or gravelly sands (Uc5.23) and (Uc4.22). Gravelly-surfaced red duplex soils (Dr2.12, Dr2.13) occur on some lower slopes. Occasionally this unit includes small remnant sandstone mesas with sands (Uc5.2) and (Uc1.2) and some red or yellow earths (Gn2.12) and (Gn2.22). Occurs on sheet(s): 7,10"
"Fz26"
"Low hilly to hilly lands with steep scree slopes and rounded crests; rock outcrop is common: dominant soils are gravelly extremely shallow loams (Um1.43), with gravelly loams (Um4.1), (Um4.21), and (Um2.12) also occurring. Associated on the higher slopes are shallow loamy red duplex soils (Dr2.41) and (Dr3.41), and on basal slopes other shallow loamy duplex soils (Dy2.42), (Dy3.42), and (Dy3.12). All duplex soils have very gravelly A horizons. Occurs on sheet(s): 7"
"Fz27"
"Strongly undulating to low hilly lands with much rock and gravel on steep slopes: dominant soils are gravelly shallow loams (Um1.43), with other shallow gravelly loams (Um5.51), (Um4.1), and (Um4.21) occurring on lower slopes. Shallow loamy red duplex soils (Dr2.13, Dr2.12) also occur on lower slopes. Shallow gravelly loams (Um5.51) occur on small basic dykes which may be found throughout the unit. Occurs on sheet(s): 7,10"
"Fz28"
"Undulating lands with rock outcrop, gravel-strewn slopes, and small marginal outwash fans: dominant soils are shallow gravelly loams (Um1.43, Um1.41), with other shallow gravelly loams (Um5.51) and (Um4.1) associated. On outwash fans and lower slopes are shallow gravelly-surfaced bleached duplex soils (Dy2.43) and (Dr2.43). Occurs on sheet(s): 7,10"
"Fz29"
"Low hilly to hilly lands with much rock outcrop, steep slopes, and narrow undulating valleys: dominant soils are very shallow gravelly loams (Um1.43) and (K-Um1.43), with associated (Um5.51) and (K-Um5.51). Some very gravelly red earths (Gn2.11) and (K-Gn2.11) also occur. On the lower slopes, shallow, very gravelly-surfaced, red duplex soils (Dr2.12, Dr2.13) occur, while in the valleys, gravel-strewn loamy red earths (Gn2.11, Gn2.12) are common. Occurs on sheet(s): 7,10"
"Fz30"
"Undulating pediments on sandstone, shale, and dolomite with some dolerite dykes; much rock outcrop; stony and gravelly pavements are common: chief soils are shallow loams and sandy loams (Um1.43) and (Uc1.43). Small areas of many other soils including (Gn2.12), (Um5.3), (Dr2.33), and (Dr1.33) may occur. Occurs on sheet(s): 10"
"Fz31"
"Undulating pediments characterized by silcrete-capped cuestas, and hilly ridges on tillite and shale; much rock outcrop; stony pavements are common: chief soils are shallow loams and sandy loams (Um1.43) and (Uc1.43). Other soils include (Dr2.33) on alluvial fans and valleys and lower slopes where a red-brown hardpan may underlie the soil; and shallow (Um5.3) and (Uc5.21) soils underlain by red-brown hardpans on included plain tracts. Occurs on sheet(s): 10"
"Fz32"
"Undulating pediments and plains on schist and gneiss, but with some basalt; rock outcrops; stony pavements: chief soils on the slopes are shallow loams and sandy loams (Um1.43), (Uc1.43), and (Um5.51). Associated on the plains and lower slopes are shallow (Uc5.21), (Um5.3), and (Gn2.12) soils underlain by red-brown hardpan. As mapped, small areas of adjoining units are included. Occurs on sheet(s): 10"
"Fz33"
"Undulating stony ranges and ridges with some plains: chief soils are probably shallow loams (Um1.43), (K-Um1.43), and (Um5.51) with some rock outcrop. Associated on the lower slopes and plains are (Dr2.33) and possibly (Dr1.33) soils, with smaller areas of (Gn2.12, Gn2.13) soils. Occurs on sheet(s): 10"
"Fz34"
"Low hilly sandstone ranges occurring as steep-scarped dissected cuestas with undulating dip slopes; rock outcrop is very prominent: dominant soils are very shallow stony loams (Um1.43), with associated (Um5.51) and limited occurrences of similar (K-Um) soils. On the undulating slopes stony-surfaced red duplex soils (Dr2.32, Dr2.33) occur, and in some valley floors there are small areas of loamy red earths (Gn2.12, Gn2.13). Data are fairly limited. Occurs on sheet(s): 10"
"Fz35"
"Low hilly lands consisting of numerous dissected lateritic mesas that usually have steep-scarped or benched margins, particularly where the siliceous duricrust capping is still preserved. A complex array of soils are present, depending on landscape position and degree of dissection; nearly all are covered with siliceous or ironstone gravel ranging up to 4 in. diameter, occasionally greater. The soils of the upper slopes probably occupy the greater proportion of the unit: these are usually shallow gravelly loams (Um1.43), (K-Um1.43), but other mostly shallow

gravelly soils (Um4.21), (Uf1.42, Uf1.43), and (Uf6.31) are also common. On lower slopes the above soils again occur but there are also important occurrences of shallow to moderately deep cracking clays (Ug5.32), (Ug5.22), and occasionally loamy red duplex soils. On outwash fans and pediments the soils of unit Oc83 occur. The level surfaces of the larger mesas have loamy red earths (Gn2.12, Gn2.11) or red porous loams (Um5.51). Occurs on sheet(s): 10"
"Fz36"
"Strongly undulating to low hilly lands with many low dissected mesas with scarped margins; much rock outcrop: dominant soils are shallow gravelly loams (Um1.43), with associated (K-Um1.43) and (Um5.51). On more extensive plateau surfaces the soils are deeper loams (Um5.51) or loamy red earths (Gn2.11, Gn2.12). Fringing larger drainage lines are small flood-plains with loamy red duplex soils (Dr2.33). Data are limited. Occurs on sheet(s): 10"
"Fz37"
"Undulating to moderately undulating lands with much rock outcrop: dominant soils are very gravelly shallow loams (Um1.43), with (Um5.51) commonly associated. Very gravelly-surfaced shallow bleached red duplex soils (Dr2.43), (Dr3.42), and (Dr2.42) with some (Dr2.13, Dr2.12) occur on lesser slopes and may be locally dominant. Loamy red earths (Gn2.11, Gn2.12) often occur in lower outwash areas. Occurs on sheet(s): 10"
"Fz38"
"Dissected plateaux with some steep scarps and narrow valleys: dominant soils are shallow gravelly loams (Um1.43) and (K-Um1.43), with lesser (Um5.51) and occasional shallow gravelly sands (Uc1.23), (Uc1.21), and (K-Uc1). Associated are shallow to moderately deep loamy red earths (Gn2.11, Gn2.12), which are often gravelly. In narrow valleys and outwash areas are loamy red earths (Gn2.12) and yellow earths (Gn2.22, Gn2.62) and loamy duplex soils (Dr2.13, Dr2.12), (Dr2.43), and (Dy2.12, Dy2.13). Data are limited. Occurs on sheet(s): 10"
"Fz39"
"Strongly undulating to low hilly lands with much rock outcrop and steep gravelly slopes. Soils are similar to those of unit Fz29. Data are limited. Occurs on sheet(s): 10"
"Fz40"
"Low hilly to hilly lands with steep scree slopes; much rock outcrop: dominant soils are very shallow gravelly loams (Um1.43, Um1.42). Associated are other shallow gravelly loams (Um5.51), (K-Um1.43), (K-Um5.51), and shallow gravelly bleached loams (Um2.12). At the base of slopes and in narrow valleys are very gravelly red earths (Gn2.11, Gn2.12). Occasionally, gravelly-surfaced red duplex soils (Dr2.13, Dr2.43, and Dr2.12) may occur. Data are limited. Occurs on sheet(s): 10"
"Fz41"
"Strongly undulating to low hilly lands with steep gravelly slopes; much rock outcrop: dominant soils are very gravelly shallow loams (Um1.43), (K-Um1.43), (Um5.51), and (K-Um5.51). Associated on lower slopes are very gravelly-surfaced shallow bleached red duplex soils (Dr2.43, Dr2.42), with lesser (Dr2.13, Dr2.12). Occurs on sheet(s): 10"
"Fz42"
"As for Fz29 but with associated shallow gravelly sands (Uc1.23), (K-Uc1.23), (Uc1.21), (K-Uc1.21), (Uc4.12), (Uc4.22), and (Uc4.11). Occurs on sheet(s): 10"
"Fz43"
"Dissected plateaux or mesas with steep scarps and narrow gently undulating valleys; rock outcrop is common: dominant soils are extremely shallow loams, chiefly (Um1.43), but with other loams (Um1.3), (Um1.13), and (Um2.12) associated. Some small areas of shallow red earths (Gn2.1) or yellow earths (Gn2.2) may also occur. Very gravelly shallow loams (Um5.51) and (Um4.21) occur on higher positions of the scarps, while loamy red duplex soils (Dr2.13), (Dr3.13), and (Dr2.12) occasionally occupy lower sites. Sandy or loamy earths (Gn2.41), (Gn2.54), with associated (Gn2.11) and (Gn2.21), occur in narrow valley floors. Data are limited. Occurs on sheet(s): 10"
"Fz44"
"Strongly undulating lands with narrow gently undulating valleys and occasional low hills; rock outcrop is very common: dominant soils are very shallow gravelly loams (Um1.43), with lesser (Um5.51), (Um4.21), and similar (K-Um) soils. In valley floors are loamy or sandy earths (Gn2.41), (Gn2.54), (Gn2.74), and (Gn2.12) and occasional loamy duplex soils (Dr2.12), (Db1.12), and (Dr2.42). Occurs on sheet(s): 10"
"Fz45"
"Gently undulating to undulating eroded lateritic plateau with some low lateritic scarps and dissected mesas: a range of soils occur in the unit but shallow gravelly loams are probably dominant, chiefly (Um1.43), but (Um1.41, Um1.42), (K-Um1.43), and (Um5.51) also occur widely. Associated are a range of shallow to moderately deep loamy duplex soils (Dr3.32), (Dr2.32), (Dy3.32), (Dy2.32), (Dy1.32), and (Db2.32). In some areas loamy red duplex soils (Dr2.32) or porous loams (Um5.51) may be locally dominant. Shallow to moderately deep loamy red earths (Gn2.11) and lesser yellow earths (Gn2.21) occur on the mesa remnants. Occurs on sheet(s): 10"
"Fz46"

"Strongly undulating or occasionally low hilly lands, usually with rounded ridge crests and moderate slopes; silicified rock outcrop is common: dominant soils are shallow to very shallow gravelly loams (Um1.43), (K-Um1.43), with other similar loams (Um5.51), (K-Um5.51) often associated. On lesser slopes deeper loams (Um5.51) and loamy red earths (Gn2.11, Gn2.12) occur. On lower slopes and adjacent to drainage lines are small areas of loamy red duplex soils (Dr2.32, Dr2.33). Occurs on sheet(s): 10"
"Fz47"
"Dissected low plateaux with scarps, mesas, and buttes; some gently undulating plateau crests; mottled and pallid rock and silcrete boulders are common: dominant soils are shallow stony loams (Um1.43) on scarps and areas of steeper relief generally, with porous loamy soils (Um5.51) on areas of gentler relief. Associated are (Gn2.12) soils on areas of gentler relief, and (Dr2.33) and (Ug5.2) and (Ug5.3) soils at the base of scarps in small variable areas. Occurs on sheet(s): 10"
"Fz48"
"Pronounced scarp ridges with mesas and buttes, and covered with gravels and stones of silicified sandstone; leached and ferruginized rock is often exposed on scarp slopes: chief soils are probably shallow stony loams (Um1.43) but the soils of unit Nd6 are closely associated, particularly on the remnants of the plateau crests and on some pediments. Occurs on sheet(s): 10"
"Fz49"
"Similar to unit Fz47 but the soils of unit BE14 are associated in areas of gentler relief. Occurs on sheet(s): 10"
"Fz50"
"Dissected tableland partly of cuesta form; pronounced scarp ridges with mesas and buttes; there is a siliceous stone and gravel mantle: chief soils are probably shallow stony loams (Um1.43), but the (Dr1.33-Ug5.3) gilgai complex of unit Nb26 is well represented on summits. Occurs on sheet(s): 10"
"Fz51"
"Rugged hilly terrain with numerous rock outcrops; pediments and terrace remnants are all covered with gravels and stones; soils are typically shallow: chief soils are shallow stony loams (Um1.43) and sandy loams (Uc1.43). Associated soils include (Um5.3), shallow (Dr1.33), shallow (Ug5.3), and shallow (Gn2.1) with some red-brown hardpan. Other soils may occur. Occurs on sheet(s): 10"
"G1"
"Stony rises: slabs or boulders of basalt with dark shallow porous loamy soils (Um6.21), dark shallow loamy soils (Um6.41), and red shallow porous loamy soils (Um6.24); with red deep porous loamy soils (Um6.13) in dry hollows between stony rises, and deep cracking dark clays (Ug5.13) in wet hollows between stony rises; smaller areas of friable earths (Gn3.42), hard alkaline dark mottled soils (Dd2.33), and hard alkaline red soils (Dr2.13) in association with cracking grey clays (Ug5.2) on flat areas between stony rises. Each area of stony rise has some feature particular to itself. Occurs on sheet(s): 1,2"
"G2"
"River terraces and floodplains liable to flooding: soils variable and generally not described but are likely to include various loamy soils (Um6), earths (Gn2.51 and Gn2.8), and plastic clay soils (Uf6). Occurs on sheet(s): 2"
"G3"
"River floodplains: floodplains of friable loamy soils (Um6) including (Um6.11), and others including probably (Uc) and (Um5) soils on the better drained portions, with other soils probably including plastic clay soils (Uf6) and cracking clays (Ug6) on the poorly drained portions. Occurs on sheet(s): 2"
"G4"
"Plains: floodplains and low terraces of various friable loamy soils (Um6), friable earths (Gn4), and other soils including (Dd) and (Dy); area has a relatively high water-table. Remnants of higher terraces of hard alkaline red soils (Dr2.23) occur also. Occurs on sheet(s): 2"
"GG1"
"Plains with swamps, lakes, and their lunettes; volcanic cones and stony rises: friable earths (Gn3.43, Gn3.42, Gn3.11) on lunettes, in the vicinity of some volcanic cones, between stony rises, and on some undulating portions of the plain; friable loamy soils (Um6.12 and Um6.33) on and near stony rises: friable red soils (Dr4.1, Dr4.2), friable dark soils (Dd4.13, Dd3.11), and structured red clays (Uf6.31) on and near some volcanic cones; hard alkaline yellow mottled soils (Dy3.43) with hard neutral dark soils (Dd2.32) on the plains; dark cracking clays (Ug5.15 and Ug5.16) along some creek valleys Note.--Even the "hard"soils of the plain areas included here have darker (more friable?) surface horizons than do their close relatives in adjacent units, e.g. than (Dy3.43) in unit Va2. Occurs on sheet(s): 1"
"Gb1"
"Undulating: dark deep porous loamy soils (Um6.12) and dark shallow porous loamy soils (Um6.21) with small areas of brown friable earth (Gn3.22) and coherent sandy soils (Uc6.14) especially around the outer portions of the area. Occurs on sheet(s): 1"
"Gb2"

"Mountainous: moderate to steep hill slopes of red deep porous, loamy soils (Um6.13) in association with dark porous loamy soils (Um6.11 and Um6.12). Occurs on sheet(s): 2"
"Gb3"
"Hilly with some steep slopes: hill slopes of deep, porous, loamy soils (Um6.14) in association with shallow loam soils (Um4.1) and small areas of friable, porous earths (Gn4.3 and Gn4.5), particularly in the eastern portion of the unit, and hard acidic yellow mottled soils (Dy3.21), particularly in the western portion of the unit; minor areas of red, friable, porous earths (Gn4.1) on some hill tops; small incised stream valleys of undescribed soils. Occurs on sheet(s): 2"
"Gb4"
"River terraces: (1) lower of dark, porous, loamy soils (Um6.11), (2) middle of (Gn2.2 and Gn2.4), (3) upper of (Dy2.41 or Dy3.41 or Dy5.41), and (4) present floodplains of various (Uc1 and Um1) soils.. Occurs on sheet(s): 2,3"
"Gb5"
"River terraces and flood-plains with lagoons and swamps, well drained to poorly drained, some areas subject to periodic inundation: chief soils are probably dark porous loamy soils (Um6.11) on terraces and levee formations with various (Uc) and (Um) soils on present flood-plains. Associated are variable areas of the soils recorded for unit Va15 on terrace remnants and adjoining slopes. Data are limited. As mapped, areas of soils of the adjoining units may be included. Occurs on sheet(s): 3"
"Gb6"
"Younger river terraces, present flood-plain, and swamps: chief soils are dark friable loamy soils (Um6.11), possibly with some (Gn2.8) soils on the terraces. Associated are various (Um) and (Uc) soils on the flood-plains and swamps. Area is subject to periodic inundation. As mapped, areas of units X9, Mb2, and Sp1 are included. Occurs on sheet(s): 3"
"Gb7"
"River terraces and flood-plains: chief soils are dark porous loamy soils (Um6.11) with terrace remnants of (Gn2.15), (Dr2.42), and other soils such as (Dd1.43). Data are limited. Occurs on sheet(s): 3"
"Gb8"
"River terraces and flood-plains: chief soils are dark porous loamy soils (Um6.11) with (Ug5.1) and (Dr2) soils. As mapped, areas of units Mu8 and Od2 are included. Occurs on sheet(s): 3"
"Gb9"
"River terraces and flood-plains: chief soils are dark friable loamy soils (Um6.11) locally underlain by either sandy or clayey substrata, and occurring on the middle river terraces. Associated are hard alkaline dark soils (Dd1.33 and Dd1.43), and/or friable dark soils (Dd3.12), and/or hard alkaline brown soils (Db1.33) on terrace remnants flanking the valley slopes; siliceous sands (Uc1.23) on low terraces adjoining the river; and local areas of various soils including (Ug5.15), (Ug5.16) and possibly (Ug5.4), (Db1), and (Dy) soils. Locally the (Ug5) soils may form soil complexes with the (Dd) and (Db) soils. Occurs on sheet(s): 3"
"Gb10"
"River terraces, levees, flood-plains, coastal swamps, and tidal flats: this unit contains the same land forms and soils as unit Gb9, but in addition has (i) swamps and levees of the lower river flood-plain of (Uf6.6), (Ug5), and other undescribed soils; (ii) estuarine flats of peaty or organic soils over acid clays; and (iii) tidal mud flats. The soils of these areas are not well known but probably have similarities with the soils of units J3, Mc4, NY1, and NN1. The smaller areas mapped as unit Gb10 consist mainly of areas of (i) and/or (iii) above. Occurs on sheet(s): 3"
"Gb11"
"River terraces and flood-plains: chief soils are dark porous loamy soils (Um6.11) and, less commonly, cracking clays (Ug5.16) on the younger terraces, with various (Um) and (Uc) soils on the flood-plains. Associated are higher terrace remnants with a variety of soils including (Dr2.22), (Dr3.43), (Dy3.4), (Gn3 .12), and (Gn2.15) soils. Data are limited. Occurs on sheet(s): 3"
"Gb12"
"River flood-plains, terraces, and levees: chief soils are probably dark porous loamy soils (Um6.11 and Um6.12) with other (Um) and (Uc) soils. Associated are, locally, fairly large areas of dark cracking clays such as (Ug5.16); areas of (Dy3.4) soils; and sometimes areas of gravelly (Gn2) soils. Soils data are limited. Occurs on sheet(s): 3"
"Gb13"
"Dissected river terraces: chief soils are dark porous loamy soils (Um6.11 and Um6.12) or middle terraces; associated are younger terraces of various (Uc) and (Um) soils and older terrace remnants of hard acidic yellow mottled soils (Dy3.41) often with some ironstone gravels. Other soils are likely. Occurs on sheet(s): 3"
"Gb14"
"River flood-plains and swamps: chief soils are dark porous loamy soils (Um6.11 and Um6.12), generally as: broad gently sloping levees of (Um6.11) and (Um6.12) soils under which clay D horizons may occur at shallow depths especially on back slopes; ridge and depression areas of (Um6.11) and (Um6.12) soils with sandy D horizons on

the ridges and clay D horizons in the depressions where (Uf6) soils may occur too; low-lying swamp lands of plastic clays (Uf6.61) often saline at the surface and underlain by very acid clays at depth; and smaller areas close to river channels of gently undulating country with (Uc) and (Um) soils. Occurs on sheet(s): 3"
"Gb15"
"Delta plains with small prior stream channels and associated levees: dominant are friable uniform-textured soils (Um6.11) with a very dark organic silt loam surface changing to earthy loamy material at depth. D horizons or other layered materials are frequently present at shallow depths. Some similar (Um4.2) and (Um5.5) soils also occur, and on the levee crests there are uniform sandy soils (Uc5.11) and (Uc1.21). Occurs on sheet(s): 4,7"
"Gb16"
"Alluvial fans: chief soils are dark porous loamy soils (Um6.11). Associated are other (Um) and possibly (Uf) soils. Buried profiles of older soils occur at shallow depths. Occurs on sheet(s): 5"
"Gd1"
"Subcoastal plain: dark shallow porous loamy soils (Um6.21) with some areas of red shallow porous loamy soils (Um6.24) and possibly small areas of dark friable earths (Gn4.4). Occurs on sheet(s): 1"
"Gd2"
"Subcoastal plain: dark shallow porous loamy soils (Um6.21) on shell beds. Occurs on sheet(s): 1"
"Gd3"
"Hilly to steep hilly, occasionally with rock walls: chief soils are dark shallow porous loamy soils (Um6.21) and similar soils (not described). Associated are a variety of soils including (Dy3.4) and (Ug5.1) but generally descriptions are lacking. As mapped, soils of unit Mg19 and of all adjoining units are included. This unit has some features similar to units Me3 and Kb2. Occurs on sheet(s): 3"
"Gd4"
"Steep hilly to submountainous basaltic uplands: crests and steep slopes of flat-topped and also rounded hills, with dark shallow porous loamy soils (Um6.21), shallow friable clays (Uf6.11), shallow cracking dark clays (Ug5.12), and red friable earths (Gn3.12), all often very stony. Both (Gn3.41) and (Dr4.11) soils are present on some steep eastern slopes in the Sheet 4 occurrences of this unit. Unit Gd4 grades into: soils of unit Kb6 at lower levels and in the drier portions of the area; and soils of unit Mp3 at higher levels in the wetter portions of the area. Minor areas of other undescribed soils are likely. Occurs on sheet(s): 3,4"
"Gd5"
"Steep hilly to mountainous land on andesite with many rock outcrops: chief soils are probably dark shallow often gravelly porous loamy soils (Um6.21) with other shallow often gravelly loamy soils (Um4.1) on the steep slopes. Associated are: small areas of other soils including (Gn3.12), (Dr2.12), (Db3.12), and (Gn3.42) on flatter sites; (Dd1.42) and (Db1.12) soils on some of the included low hills; (Gn3.72) and (Gn3.91) on lower slopes; and (Ug5) and (Gn2.92) soils along the narrow valleys. Occurs on sheet(s): 4"
"Gd6"
"Mountainous land on andesite--steep to very steep slopes with many rock outcrops: chief soils are probably dark shallow often gravelly porous loamy soils (Um6.21). Associates include (Gn3.11), (Dr2.12), (Gn3.72), and (Um4.1) soils. Minor occurrences of other soils such as (Um2.12), (Uc2.12), (Dy5.41), (Db3.12), and (Gn3.42) are likely. Occurs on sheet(s): 4"
"Gd7"
"Steep hilly to mountainous serpentine country with much rock outcrop in places: chief soils are probably dark porous loamy soils (Um6.21), dark plastic clays (Uf6.32), and dark friable earths (Gn3.42): other soils may include (Ug5.12) on slopes, and (Dd) and (Dg) soils on creek flats. As mapped, areas of unit Fu5 and low hilly areas of unit Mm4 along some streams are included. Occurs on sheet(s): 4"
"Gd8"
"Hilly to steep hilly land on limestones with rough steep slopes, much rock outcrop and narrow stream flats: chief soils are dark porous loamy soils (Um6.21) on crests and slopes. Small areas of other soils include: (Dr2.21), (Dr2.22), and (Gn3.12) on some slopes; shallow (Gn3.42) soils on some slopes; and (Ug5) soils on stream flats. Occurs on sheet(s): 4"
"Ge1"
"Low hilly country on andesite with short moderate to steep slopes and very limited valley areas: chief soils are shallow porous loamy soils often stony (Um6.22) and possibly other (Um6) soils on hill tops and upper slopes. Associated are such soils as (Db1.22), (Dr2.42), and (Gn3.12) from mid to lower colluvial slopes. Minor soil occurrences include (Ug5.1) and (Dr3.42) on lower slopes and valley floors. Occurs on sheet(s): 4"
"Ge2"
"Gently to moderately undulating lands with low mesas having benched slopes and limestone outcrop: dominant soils are shallow soft loams (Um6.22), often with limestone gravels. Shallow gravelly calcareous loams (Um1.3), (Um1.1), and (Um5.11) occur on the bench margins. Associated on lower sites are grey cracking clays (Ug5.24, Ug5.22), and on stream levees are loamy red earths (Gn2.12, Gn2.13). Occurs on sheet(s): 7,10"
"Ge3"

"Undulating to moderately undulating lands with much limestone outcrop: dominant soils are shallow gravelly calcareous loams (Um6.22). Associated are other shallow gravelly calcareous loams (Um1.3), (Um5.61), and shallow to moderately deep calcareous earths (Gc2.22). In some lower sites are loamy red duplex soils (Dr2.13) and (Dr2.43). Red earths (Gn2.13) occur on stream levees. Occurs on sheet(s): 10"
"Ge4"
"Gently undulating to undulating lands with some rock outcrop: dominant soils are probably shallow calcareous loams (Um6.22). Associated are other shallow gravelly loams (Um5.51), (Um1.43), and (Um1.3). Shallow to moderately deep calcareous earths (Gc2.22) and red earths (Gn2.13) probably occur on lower slopes. Small areas of deep grey-brown cracking clays (Ug5.25, Ug5.24) and loamy red duplex soils (Dr2.13) may occur in depressions. Data are limited. Occurs on sheet(s): 10"
"Gf1"
"Steep ranges on basic lavas along with dolomites, tuff, banded iron formations, and dolerite dykes, with some narrow valley plains and high-level gently undulating areas of limited extent. The soils are generally shallow and stony and there are large areas without soil cover: chief soils are brown loams (Um6.23) along with significant areas of earthy loam (Um5.51) soils. (Dr2.33) soils occur on lower slopes with (Uf6.71) and (Ug5.37) soils on valley floors. Occurs on sheet(s): 6,10"
"Gf2"
"Gently undulating plains, occasionally with some high rocky ridges; limestone outcrop is very common: dominant soils are very shallow brown calcareous loams (Um6.23), with other shallow calcareous loams (Um5.61), (Um5.11), and (Um1.3) associated, particularly on higher ridges. Marginal to the unit are deeper calcareous earths (Gc2.22), red earths (Gn2.13), or deep cracking clays (Ug5.34, Ug5.37, and Ug5.38). Data are limited. Occurs on sheet(s): 10"
"Gf3"
"Gently undulating low limestone plateau with steep benched or scarped margins: dominant soils are shallow brown or red-brown calcareous loams (Um6.23, Um6.24) with similar calcareous clays (Uf6.12) associated. Most areas have limestone floaters or outcrop; adjacent to the latter are very shallow calcareous loams (Um1.3), (Um5.61), and (Um5.11). Also occurring are small areas of gravelly red duplex soils (Dr2.33) and brown calcareous earths (Gc2.22). Occurs on sheet(s): 10"
"Gg1"
"Steep rounded hills: red g porous loamy soils (Um6.24); small areas of shallow red subplastic clay soils (Uf5.31); hard alkaline red soils (Dr2.23); hard yellow mottled soils (Dy3.4); sandy yellow mottled soils (Dy5.4 and Dy5.8); and calcareous sands (Uc1.11) on the coast. Occurs on sheet(s): 1"
"Gg2"
"Plain with swamps: red and brown shallow porous loamy soils (Um6.24 and Um6.23) with highly calcareous loamy earths (Gc1); smaller areas of shallow cracking dark clays (Ug5.11); calcareous sands (Uc1.11) along coast; saline soils (unclassified) around swamps and lakes. Occurs on sheet(s): 1"
"Gg3"
"Undulating, broken terrain: red g porous loamy soils (Um6.24) with dark shallow porous loamy soils (Um6.21), shallow red-brown sandy soils (Uc6.13); smaller areas of sandy alkaline yellow mottled soils (Dy5.43); and calcareous sands (Uc1.11) near the coast. Occurs on sheet(s): 1"
"Gg4"
"Plain: red g porous loamy soils (Um6.24) with smaller areas of grey shallow porous loamy soils (Um6.22) and minor areas of soils from adjacent soil areas (map units). Occurs on sheet(s): 1"
"Gg5"
"Hilly country on intermediate and basic igneous rocks with residual mesas and buttes; numerous rock outcrops: chief soils are red and brown shallow porous loamy soils (Um6.24), (K-Um6.24), and (Um6.23) with scattered boulders on mesas, buttes, and crests and slopes of rounded hills. Associated are small areas of neutral red friable earths (Gn3.12) on moderate to gentle slopes and various (Ug5) soils, such as (Ug5.34), (Ug5.24), and (Ug5.37), on gentle lower slopes and flat areas. Minor soil occurrences include shallow and stony varieties of (Gn2.12). This unit merges with units Mo23 and CC55. As mapped, small areas of unit BX1 are included. Occurs on sheet(s): 8,9"
"Gg6"
"Low rounded hills on basaltic rocks; some lateritized flat-tops; numerous rock outcrops; narrow valley plains: chief soils are probably red and brown shallow porous loamy soils (Um6.24 and Um6.23) on the slopes but some dark pedal clays (Uf6.22) may be present also. Associated are cracking clays (Ug5) in the valley plains. Small areas of other soils may be present. Occurs on sheet(s): 8"
"Gh1"
"Alluvial plains with prominent terrace systems adjacent to the major rivers; low levee banks, and relic channel cut-offs associated with numerous minor streams: dominant soils are deep friable yellow or yellowish red loams (Um6.34), with lesser red loams (Um6.33). Similar friable loams with a well-developed A2 horizon (Um4.43,

Um4.41) are particularly common in the northern occurrences of the unit. Loamy earths (Gn2.44), (Gn2.64), (Gn2.24), and (Gn2.14) are common on the levees and more recent terraces. The very short gently sloping pediments of adjoining hills are also included in the unit; these have loamy earths, chiefly (Gn2.14), but with (Gn2.24), (Gn2.64), (Gn2.74), and (Gn2.94) also common. Some loamy duplex soils (Dy3.41) and (Dy3.21) occur in slightly depressed areas. Also included are some isolated low hills with deep friable loams (Um4.43) of unit LN1. Occurs on sheet(s): 7"
"Gj1"
"Mountains and hills formed in basalt; mainly rock outcrop on ridges and upper slopes: chief soils are shallow stony red pedal loamy soils (Um6.33) with associated (Gn3.12) soils on lower slopes, and grading to (Ug5.15) and (Ug5.24) soils on valley floors. Much loose basaltic stone occurs throughout. There are also some (Dy2.2 and Dy2.3) soils associated with adjacent sandstone units. Occurs on sheet(s): 9"
"Gj2"
"Undulating country on shales and limestones, many parts of which have been severely windand gully-eroded; much rock outcrop: chief soils are red pedal loamy soils (Um6.33) varying in depth from deep to shallow and from stone-free to very stony varieties. Small areas of (Ug5.34) soils occur on lower slopes and in depressions. Occurs on sheet(s): 8,9"
"Gk1"
"Low hilly to hilly terrain on metasediments--moderate side slopes to narrow valleys; beach ridges and tidal flats: chief soils are dark friable loamy soils (Um6.41). Associated are (Gn3.41 and Gn3.42) soils on mid and lower slopes. Minor soils occurrences include (Dy2.13) soils. Small areas of units A11, J5, and Tb121 are included in places. Occurs on sheet(s): 4"
"Gk2"
"Steep hilly to hilly lands on syenite rocks with basal fans, narrow creek flats, narrow ridge crests, and steep slopes; much rock outcrop and many boulders: chief soils are dark friable loamy soils (Um6.41). Minor soil occurrences include (Uc4.1) and (Gn2.24). Small areas of unit Cd20 are included. Occurs on sheet(s): 4"
"Gk3"
"Steep high hills: chief soils are likely to be dark friable loamy soils (Um6.41), often bouldery. Other soils may include (Uc2.12), (Um2.12), (Dr2.22), and (Dr2.21). Occurs on sheet(s): 4"
"Gz1"
"Stepped plateau remnants at high elevation (>3500 ft)--flat-topped benches in a series of steps from drainage divides down to stream valleys: chief soils are red and brown deep porous loamy soils (Um6.13* and Um6.12*), with some shallow porous loamy soils (Um6.2), and in the poorly drained valleys acid peats (O), and various (Um) soils some of which are underlain by plastic clays. Associated are organic loamy soils (Um7.11), also minor areas of red friable porous earths (Gn4.11), and less frequently dark cracking clays (Ug5.1). Occurs on sheet(s): 3"
"H1"
"Plain with lagoons: shallow red subplastic clay soils (Uf5.31) with smaller areas of dark shallow porous loamy soils (Um6.21) and hard alkaline red soils (Dr2.23). Occurs on sheet(s): 1"
"HF1"
"Gently to moderately undulating lands: dominant soils are thin-surfaced loamy duplex soils (Dd1.13) and (Dd1.33), but closely associated are areas of cracking clays (Ug5.22), (Ug5.12), and (Ug5.32) together with other loamy duplex soils (Db1.13), (Db1.33), (Dy2.33), (Dy2.43), and (Dy2.13). Occurs on sheet(s): 4"
"HF2"
"Moderate to strongly undulating lands with prominent low strike ridges and some elongate low hills areas: most soils are fairly shallow, often with a surface gravel layer, and rock outcrops are common Dominant are thin-surfaced loamy duplex soils (Dd1.13), (Dd1.33), and (Dd1.43), but these often alternate over short distances with similar brown soils (Db1.13) and (Db1.33), yellow-grey soils (Dy2.33) and (Dy2.43), and red soils (Dr2.13). Small areas of cracking clays (Ug5.22), (Ug5.12), and (Ug5.32) also occur. Local areas of extremely gravelly red soils (Dr3.43) and (Dr2.33) occur. Adjacent to drainage lines are small flood-plains with loamy (Dy2.43) soils. Occurs on sheet(s): 4"
"HF3"
"Level or very gently undulating plains: dominant are thin-surfaced dark loamy duplex soils (Dd1.13 and (Dd1.33). A slight (few inches) gilgai microrelief is often present, and when it is present the depressions have dark clays (Ug5.16). Associated are small areas of brown or grey loamy duplex soils (Db1.13), (Db1.33), (Dy2.13), (Dy2.33), and occasional small low rises of sandy red earths (Gn2.12). Occurs on sheet(s): 4"
"HF4"
"Alluvial plains fringing major drainage lines, the area may be inundated by high floods: dominant are siltyor loamy-surfaced dark duplex soils (Dd1.13), with (Dd1.12) also occurring. Associated are levees of old distributary channels with uniform loamy (Um5.5 and Um5.4) or sandy soils (Uc5.21). Occurs on sheet(s): 4"
"HF5"

"Alluvial flood-plains and stream levees: dominant are dark loamy duplex soils (Dd1.13) with lesser (Dd1.33) and (Dd1.43); some similar (Db1) and (Dy2) soils are associated. The younger levees have dark friable earths (Gn3.42 and Gn3.43). Also occurring on the flood-plains are small areas of slightly gilgaied clays (Ug5.15) and (Ug5.25). Occurs on sheet(s): 4"
"HG1"
"Plains associated with both functional and non-functional drainage lines: chief soils on the flat area are hard alkaline dark soils (Dd1.33) and (Dd1.43). Associated are hard alkaline yellow and mottle yellow soils (Dy2.33), (Dy2.43), and (Dy3.43); minor areas of soils of units Ro4, Wa13, and CC20; an occasional small sand dunes of (Uc1.2) or (Uc4.2) soils. Many areas deflated by wind. Occurs on sheet(s): 3,4"
"HG2"
"Similar to unit HG1 but the minor included soils belong to unit Wa12 and sand dunes with (Uc1.2) or (Uc4.2) soils vary from rare to common. Occurs on sheet(s): 3"
"HG3"
"Plain--old riverine terrace formation: chief soils are hard alkaline dark soils (Dd1.33), (Dd1.43 (Dd2.33), and possibly (Dd3.33) and (Dd4.43). Associated are small areas of related (Dy) and (D soils such as (Dy3.23), (Dy3.42), and (Dr3.31). Occurs on sheet(s): 4"
"HG4"
"Alluvial plains: the chief soils seem to be hard alkaline dark soils (Dd1.33) and (Dd1.43) with some (Dd1.23). Associated are: (Ug5) soils such as (Ug5.16) and (Ug5.4); (Dy2.43) soils; (Gn3.43) soils; and some (Um6.11) soils on newer terrace formations. Other soils are likely also. Occurs on sheet(s): 4"
"HG5"
"Level alluvial plains fringing drainage lines, often with numerous small braided stream channels; many areas are subject to irregular flooding and wind-deflated areas commonly occur: dominant are thinsurfaced dark loamy duplex soils (Dd1.33), (Dd1.43), and (Dd1.13). Similar (Dy2) soils also occur with, less commonly, (Dr2.33) and (Db1.33). Small areas of cracking clays (Ug5.24) and (Ug5.5) occur in lower more flood-prone sites. Occurs on sheet(s): 4"
"HG6"
"Alluvial plains fringing major streams; the area is inundated only by very high floods: the dominant soils occur on broad flat low terraces and are dark loamy duplex soils (Dd1.33), (Dd1.43), and (Dd1.13). In slightly lower sites cracking clays occur (Ug5.15 and Ug5.16) and (Ug5.24 and Ug5.25). Higher better-defined terraces have uniform loamy soils (Um1.41) and (Um5.4) with uniform clays (Uf6.32) immediately adjacent to stream banks. Limited areas of friable earths (Gn3.43) and (Gn3.23) also occur. Occurs on sheet(s): 4"
"HG7"
"Level alluvial plains that merge seaward into tidal flats, mangrove swamps, and salt pans; the area may be inundated for short periods by a combination of flood waters and very high tides, and is often dissected by minor stream channels: dominant are siltyor loamy-surfaced duplex soils (Dd1.33) and (Dd1.13). At lower levels the B-horizon dark grey clays are strongly mottled (gleyed). Some (Dd2) soils also occur. Closely associated in lower depressions and swampy areas are cracking clays (Ug5.24) and (Ug5.16), with, less commonly, (Ug5.5) and (Ug5.4). Adjacent to the salt pans saline clays (Uf6.61) may occur, and included in the unit, as mapped, are small areas of grey loamy duplex soils (Dy3.43). Occurs on sheet(s): 4,7"
"HG8"
"Level or very gently undulating plains rising to undulating low foothills: dominant are dark loamy duplex soils (Dd1.43) and (Dd1.33) with some areas of similar (Dy2) soils and dark clays (Ug5.15). On the slightly elevated undulating margins of the unit red loamy duplex soils (Dr2.12) are common. Data are limited. Occurs on sheet(s): 4"
"HG9"
"Alluvial plains with some prior stream channels and levees and some stranded low beach dunes; the unit merges into salt pans and mangrove swamps. The lower areas are subject to prolonged flooding after heavy rains and may also receive some tidal waters: dominant on the flatter marine plains are dark loamy duplex soils (Dd1.33) and (Dd1.43), with lesser (Dy2.43). Brown earths (Gn2.42) occur on most levees, with deep sands (Uc1.22) on the more recent and higher levees. Deep calcareous sands (Uc1.12) are common on the low relic beach ridges. Occurs on sheet(s): 7"
"HH1"
"Plains with stony rises and volcanic cones: plains of hard alkaline dark mottled soils (Dd 2.33) and smaller areas of rated soils, such as (Db2.32), (Dd1.12), and (Dr2.23); with lower-lying, sometimes swampy areas of cracking grey clays (Ug5.2) which form complexes with (Dd2.33) in some situations; ribbon development of cracking dark clays (Ug5.15) along some stream valleys; and with stony rises of friable loamy soils especially (Um6.21, Um6.41, and Um6.11) and others, often with cracking dark clays (Ug6.13) at the base of stony rises; and with friable red soils (Dr4.1) on and around volcanic cones. Ironstone gravels are a common feature of surface horizons of D soils. Occurs on sheet(s): 1,2"

"HH2"
"Undulating plain with volcanic cones: plains of hard alkaline dark mottled soils (Dd2.33) in association with (Dd2.43), (Db1.43), and commonly in Sheet 2 (Dr4.12 and Dr4.21), smaller areas of rated soils, such as (Dr2.12) and (Dy3.43); small areas of cracking grey clays (Ug5.2) in lowerlying situations; ribbon development of cracking dark clays (Ug5.15) along some stream valleys; and with friable red soils (Dr4.1) and friable earths (Gn3.11) on and around volcanic cones; ironstone gravs occur in surface horizons of some (D) soils. Occurs on sheet(s): 1,2"
"HH3"
"Hilly area with volcanic cones: hard alkaline dark mottled soils (Dd2.33) in association with (Dd2.43) and (Db1.43) and smaller areas of related soils; and with friable red soils (Dr4.1) and friable earths (Gn3.11) on and around volcanic cones; other soils (undescribed) also occur. Ironstone gravels occur in surface horizons of some D soils. Occurs on sheet(s): 1"
"HH4"
"Plains of hard alkaline dark mottled soils (Dd2.43) and hard alkaline red mottled soils (Dr3.43) and other undescribed soils on colluvium, and in association with friable alkaline dark soils (Dd3.13) and dark shallow porous loamy soils (Um6.21) on the limestone areas of the plain. Occurs on sheet(s): 2"
"Hc1"
"An undulating and hummocky fresh hard basaltic terrain surrounding an old volcanic cone: chief soils are red subplastic clays (Uf5.21 and Uf5.22). Other soils include: (Ug5.16) in swampy depressions; (Ug5.12), (Ug5.14), and (Um6.21) on boulder-strewn slopes and sides of the cone; (Uf6.32) on bouldery flow margins; and (Uf5.23) in some depressed areas marginal to unit Ij1. Occurs on sheet(s): 4"
"I1"
"Swamps of lower Murray River: dark plastic but somewhat friable clays (Uf6.32) of variable acidity and salinity due to irrigation. Incomplete data. Occurs on sheet(s): 1"
"I2"
"River floodplains with levees and terrace remnants: Levees and the better drained portions of the floodplain have plastic clay soils (Uf6) and possibly pale-coloured wet earths (Gn2.8) with plastic clay soils (Uf6); dark cracking clays (Ug6.1) and minor areas of peaty soils (O) occur on the poorly drained portions of the floodplains; and cracking clays (Ug5)--often showing gilgais-on the terrace remnants. Occurs on sheet(s): 2"
"I3"
"Swampy plain of highly organic (peaty) clays (Uf5 or Uf6) and possibly some acid peaty (O) soils or the remains of these situated more or less centrally with some low ridges of leached sands (Uc2.2 and Uc2.3) and also (Dy5) soils flanking the centre and the whole fringed by wet earths (?Gn2.8); some small areas of (Dy5.81 or Dy5.41) occur in the eastern part of the unit. Occurs on sheet(s): 2"
"II1"
"Flood-plains, terraces, residual islands, lakes: flood-plains, lake bottoms, and some terraces of cracking yellow-grey clays (Ug5.28). Associated are undulating to hillocky areas along former, and present, drainageways of (Ug5.28) and various unclassified and mostly undescribed (Uf) and (Um) soils; "islands"of dunes and sand sheets of brown sands (Uc5.13); and residual islands of brown calcareous earths (Gc1) (e.g. of unit DD3) and/or crusty loamy soils (Dr1.33) (e.g. of unit Nb4). The above description is slightly expanded from that given in Sheet 1, but data remain limited. Occurs on sheet(s): 1,3,10"
"II2"
"Former lake beds and flood-plains: cracking yellow-grey clays (Ug5.2), probably (Ug5.28), in association with low eroded and scalded mounds and lunettes of crusty loamy soils (Dr1.33 and Dr1.43) or their remnants. Incomplete data. Occurs on sheet(s): 1,3"
"II3"
"Alluvial plains associated with major drainage lines; the plains are often dissected by braided stream channels and the entire area may be subject to seasonal flooding: dominant soils are deep grey clays with a slight (few inches) gilgai microrelief. The chief forms are (Ug5.28), (Ug5.24), (Ug5.29), and (Ug5.25), with lesser brown clays (Ug5.34 and Ug5.35). Associated are occasional small clay pans with loamy duplex soils (Dy2.33). Occurs on sheet(s): 4,10"
"II4"
"Gently undulating plains: dominant soils are very deep clays, occasionally with linear gilgai on slopes. The chief forms are (Ug5.28) and (Ug5.29), with lesser (Ug5.24) and (Ug5.25). Occasional areas of very deep brown clays (Ug5.34) may occur, and also shallow highly calcareous soils (Uf6.32) and (Dr2.13). Near the margin of the unit loamy duplex soils (Dy2.43) occur. Occurs on sheet(s): 4"
"II5"
"Broad shallow valleys: chief soils are grey clays such as (Ug5.27, Ug5.29, and Ug5.28) with variable areas of neutral yellow-brown friable earths (Gn3.52). Occurs on sheet(s): 8"
"II6"

"Flat to very gently undulating plains with a thin scattering of gravel on the surface; widely spaced narrow drainage-ways; some shallow depressions and some low rises with gilgais: chief soils are deep grey clays such as (Ug5.28). The grey clays of this unit are notable for their thin (about 1 in. only) self-mulching surface, which contrasts with the lack of a self-mulching surface in many unit 006 soils and the normal (2 4 in.) self-mulching surface in unit CC60 soils. Small areas of units 006, CC60, JV4, My79, and II9 may be included. Occurs on sheet(s): 8"
"II7"
"Flat to gently undulating plains of grey clays (Ug5.28) of unit II6 interspersed with low undulating rises of red earths (Gn2.12) of unit My80. Dominance between the two areas varies locally. Occurs on sheet(s): 8"
"II8"
"Flat to gently undulating plains; narrow drainage-ways: chief soils are deep grey clays such as (Ug5.28) with a thin (about 1 in.) self-mulching surface. Associated are yellow earths, such as (Gn2.21 and Gn2.22), which may assume dominant proportions locally. Occurs on sheet(s): 8"
"II9"
"Low-lying swampy plains of low rises and shallow channels; some drainage-ways with large water-holes: chief soils are deep grey clays, notably (Ug5.29). Some alluvium and river gravels occur also. Occurs on sheet(s): 8,10"
"II10"
"Flat to very gently undulating low-lying plains with gilgais; some low gravelly rises: chief soils are deep grey clays, notably (Ug5.29), which is distinguished by its thick (up to 18 in.) self-mulching surface. Small areas of units II9, CC60, and II6 may be included. Occurs on sheet(s): 8"
"II11"
"Level plains with slight to moderate gilgai microrelief (12-18 in.): dominant soils are very deep grey cracking clays (Ug5.28), with lesser (Ug5.29, Ug5.24); the deep subsoils may be strongly acid. Associated are loamy duplex soils (Dy2.43) and (Dy3.43), particularly on non-gilgaied sites. Occurs on sheet(s): 7"
"II12"
"Level alluvial marine plains that may be seasonally inundated, a slight (4 8 in.) gilgai microrelief normally present: dominant soils of the gilgai mounds and level sites are deep grey cracking clays (Ug5.28), occasionally (Ug5.24). The depressions usually have massive cracking clays (Ug5.5) and (Ug5.4) or dark loamy duplex soils (Dd1.13). At the seaward margin the clay plains merge into salt pans of unit Iol; these also occur adjacent to small tidal streams. Small sandy old beach ridges or dunes with (Uc) soils also occur near the coast, while inland margins of the unit have loamy duplex soils (Dy2.33), (Dy3.33), (Dy2.13), and (Dy3.13) and occasionally (Ug3.2) soils. Occurs on sheet(s): 7"
"II13"
"Alluvial plains with numerous braided stream channels: dominant soils are deep grey cracking clays (Ug5.28, Ug5.24, and Ug5.25). Associated are loamy-surfaced duplex soils (Dy2.13), (Dy2.33), and (Dy2.43) and deep uniform clays (Uf6.33) often with a scalded surface. Nearer to main channels are other undescribed (Uf) and (Um) soils. Data are very limited. Occurs on sheet(s): 10"
"II14"
"Plains subject to inundation after rain: chief soils are deep grey clays (Ug5.28) with (Ug5.5) clays in clay pan areas. Other soils may occur. Occurs on sheet(s): 10"
"Ib1"
"Gently undulating plains, occasionally with low scarped margins; the soil surface is often strewn with siliceous and ironstone gravel: dominant soils are shallow to moderately deep friable brown clays (Uf6.12), but there are important areas of uniform clays (Uf6.31) and cracking clays (Ug5.32, Ug5.34). Adjacent to limestone outcrop shallow loams (Um6.24) occur. Data are limited. Occurs on sheet(s): 10"
"If1"
"Low mounds or rises of calcrete or calcareous clays, less than 20 ft higher than the surrounding plains: chief soils occurring on their slopes are dark highly pedal clays (Uf6.22) overlying marly clays; with shallow dark pedal clays (Uf6.11) over calcrete on the crests of the rises. As mapped, some areas of (Ug5.15) soils are included. Occurs on sheet(s): 4"
"If2"
"Low hilly lands on mixed intermediate plutonic rocks and metasediments; a close pattern of low hills with broad rounded crests and short moderate to gentle slopes: chief soils are dark highly pedal clays (Uf6.22) on crests and upper slopes with dark friable earths (Gn3.42). Associated are: (Dr2.22), (Dr2.42), (Dr2.12), and (Gn3.12) soils on slopes; gravelly (Um4.1) soils on narrow crests and spurs; (Dy2.42) and (Dy3.42) soils on lower slopes and terraces. Minor soil occurrences include (Ug5.13) and (Ug5.15) on pediments with linear gilgais. Occurs on sheet(s): 4"
"If3"

"Steep high ridges of dissected plateaux, with steep scarps and some small plains: chief soils seem to be shallow dark pedal clays (Uf6.22) and (Uf6.11) with shallow loams (Um6.21), (Um4), and (Um1.43). Other soils include (Ug5.12), (Uf6.31), (Gn3.12), (Dr2.12), and (Dy2.43). Occurs on sheet(s): 4"
"If4"
"Hilly country with mesas and buttes on basic igneous rocks: chief soils are shallow dark pedal clays (Uf6.22) on the mesas, buttes, and crests and slopes of rounded hills and upper slopes generally. Associated are (Gn3.12) soils on mid slopes together with the (Ug5) soils of unit CC56 on areas of gentler topography. Occurs on sheet(s): 8,9"
"Ii1"
"Gently undulating plains with occasional high ridges or low hills; many level areas possess a moderate gilgai microrelief (1-2 ft): dominant soils are very friable strongly self-mulching brown or grey clays (Uf6.31 and Uf6.33), with high amounts of soft carbonate at shallow depths. The chief associated soils are brown or grey cracking clays (Ug5.34), (Ug5.24), (Ug5.32), and friable earths (Gn3.23) and (Gn3.13). Smaller areas of loamy duplex soils also occur (Db1.13), (Dr2.13), and (Dr2.33). Occurs on sheet(s): 4"
"Ii2"
"Moderately undulating lands with occasional low hilly areas: dominant soils are friable clays (Uf6.31 and Uf6.33), often of shallow depth and with moderate soft carbonate. Associated soils include cracking clays (Ug5.32) and (Ug5.22), friable earths (Gn3.93), (Gn3.23), and (Gn3.53), and loamy duplex soils (Db1.13) and (Dd1.13). Adjacent to drainage lines small flood-plains with loamy (Dy2.33) and (Dy2.43) soils occur. Occurs on sheet(s): 4"
"Ii3"
"Strongly undulating to low hilly areas with some elongate stony mesas: dominant soils of higher and more steeply sloping areas are shallow very stony strongly structured red or brown clays (Uf6.31). Smaller areas of friable earths (Gn3.13, Gn3.12, and Gn3.23) also occur. In lower sites shallow stony cracking clays (Ug5.12) occur. Occurs on sheet(s): 4"
"Ii4"
"Low hilly to rolling country with some stream valleys: dominant soils seem to be red friable clays (Uf6.31) often of very shallow (less than 12 in) depth in association with neutral red friable earths (Gn3.12). Minor soils include those of unit Mm11, especially on slopes and higher ridges, and (Ug5.16) and (Db1.42) on lower slopes and in valleys. Occurs on sheet(s): 4"
"Ii5"
"Strongly undulating, rolling or low hilly lands, mostly with rounded crests: dominant soils are shallow (12-24 in.) often stony uniform clays (Uf6.31), with lesser (Uf6.32). On some slopes shallow stony loamy-surfaced duplex soils (Dr2.12) occur, while on lower slopes and occasionally in valley floors there are areas of cracking clays (Ug5.12), (Ug5.32), and (Ug5.22). Small valley floor flood-plains have loamy duplex soils (Dy2.43) and (Dy2.33). Occurs on sheet(s): 4"
"Ii6"
"Low hilly or strongly undulating lands: on ridge and hill crests and steeper slopes the dominant soils are very gravelly shallow uniform red or red-brown clays (Uf6.31). Less common are red friable earths (Gn3.12). On lesser slopes a range of gravelly red duplex soils (Dr2.42, Dr2.12, and Dr2.11) occur. Lower slopes and small valley floors have dark clays (Ug5.12 and Ug5.32) and small areas of loamy duplex soils (Dd1.13 and Dd1.33). Occurs on sheet(s): 4"
"Ii7"
"Broadly undulating plains, occasionally with isolated dissected sandstone or lateritic mesas that have steepscarped or benched margins. Nearly all soils are strewn with siliceous and ironstone gravel that may range up to 4 in. diameter; many areas have a scalded surface: dominant soils are deep to moderately deep red or redbrown uniform clays (Uf6.31), but important areas of cracking clays (Ug5.38, Ug5.37, Ug5.32, Ug5.22, and Ug5.34) also occur. The latter are dominant adjacent to associated small drainage lines. Also occurring are smaller areas of loamy red duplex soils (Dr2.33) and (Dr2.13) and occasional loamy red earths (Gn2.12). The dissected mesas are small occurrences of unit Fz35. Occurs on sheet(s): 10"
"Ii8"
"Gently undulating plains; the surface soil is often strewn with siliceous and ironstone gravel: dominant soils are brown to red-brown deep uniform clays (Uf6.31), but important areas of other clay soils (Ug5.32, Ug5.34) and (Uf6.12) are associated. Marginal to the unit there may be low silicified limestone ridges with shallow stony calcareous loams (Um5.61), (Um6.24). Data are limited. Occurs on sheet(s): 10"
"Ij1"
"Gently undulating and hummocky plain of thin basalt flows, 50-100 ft above sea level: chief soils are dark plastic clays (Uf6.32) on flat to gently sloping areas and dark porous loamy soils (Um6.21) on bouldery ridges and margins of the basalt flows. Associated are (Gn3.42) and (Gn3.22) soils. Other soils include: (Uc1.23) on included fore-dunes with (Gn2.31) soils behind the dunes; (Uf5.21) on high basalt steps; (Ug5.16) in depressional areas;

(Dy3.11) on some flats; (Um6.32) and (Um6.41) on some basaltic knolls; and (Uf5.23) marginal to unit Hc1. Occurs on sheet(s): 4"
"In1"
"Swampy plains that are often wet throughout the year, margined by gentle slopes and containing low stony hillocks: chief soils are probably plastic clays (Uf6), of which (Uf6.42) may be common but (Uf6.5 and Uf6.6) may occur also, probably with some (Ug5.4) soils. Yellow earths such as (Gn2.24) occur on the gentle slopes marginal to the plain. Shallow stony soils such as (Um4.1) occur on low emergent hillocks. Occurs on sheet(s): 8"
"Io1"
"Salt pans and tidal flats inundated by seasonal high tides; numerous small tidal streams are usually closely associated and are often fringed by mangrove swamps. The dominant soils are highly saline and often gypseous clays, usually with a very soft loose surface. The most common soil is probably (Uf6.51) but strongly mottled clays (Uf6.61) are also prominent. Also occurring are saline strongly structured clays (Uf6.33) and (Uf6.4) and saline clays that crack when dry (Ug5.5 and Ug5.4). These latter soils are less frequently inundated by tidal waters. Also included in the unit are small areas of slightly gilgaied cracking clays, old beach ridges and sand dunes too small to map separately, and small areas of eroded duplex soils (Dy3.33), (Dy3.13), and (Dy2.43). Occurs on sheet(s): 7,8"
"J1"
"Subcoastal plain: saline clays (Uf6.61) of the pipe-clay flats and swamps, other soils with loamy surfaces. Incomplete data. Occurs on sheet(s): 1"
"J2"
"Coastal plain: saline clays (Uf6.61); lesser areas of crusty loamy soils (Dr1.13) on the landward side; and calcareous sands (Uc1.11) along the coast. Incomplete data. Occurs on sheet(s): 1"
"J3"
"River flood-plains: flood-plain swamps of plastic clays (Uf6.61), some of which have peaty surfaces, extremely acid subsoils and/or D horizons, and high seasonal salinity. Associated are low levees of plastic clays (Uf6.41); other levee back slopes of pale-coloured earths (Gn2.81) and (Gn1.84); foothill swamps of acid peats (O); and remains of old beach dunes, with various (Uc) soils. As mapped, areas of unit Mc2 are included. Occurs on sheet(s): 3"
"J4"
"Tidal mangrove mud flats and salt pans: chief soils are probably saline clays (Uf) including (Uf6.61) and saline loamy soils (Um) over gleyed clays. Associated are (Dd2.12) and (Dy3.12) soils on the fringe of saline marshes, with some (Dy5.22) soils on younger deposits. Related to unit NX1. Data are inadequate. Occurs on sheet(s): 4"
"J5"
"Tidal mangrove mud flats and salt pans flanking tidal inlets and local creeks: chief soils are shallow saline clays (Uf) over strongly gleyed (Um2.23) soils. Associated are (Gn1.83), and (Dd1.13) and similar (D) soils in marginal areas. Related to unit NX1. As mapped, small areas of units B20 and JK1 are included. Data are very limited. Occurs on sheet(s): 4"
"J6"
"Level marine plains partially between tidal limits and traversed by numerous channels--generally alluvial materials on saline muds: chief soils seem to be saline clays (Uf) including (Uf6.61), saline loams (Um), and cracking clays (Ug) including (Ug5.28) and (Ug5.16). Data are very limited. There is a close similarity to units J4 and J5 and possibly unit NN2. Occurs on sheet(s): 4"
"JJ1"
"Undulating area of a calcareous dune formation with shallow sand soils (Uc4.11) and possibly other undescribed soils. Occurs on sheet(s): 2"
"JJ2"
"Mountainous: rugged mountains and hills of shallow sand soils (Uc4.11) with many rock outcrops and with some areas of leached sands (Uc2.33) flanking the area; the occurrence of other undescribed soils is likely. Occurs on sheet(s): 2"
"JJ3"
"Hilly to mountainous: steep slopes of bare granite and shallow sand soils (Uc4.11) with many rock outcrops, and in association with a variety of (D) soils including (Dy5.41 and Dy5.81) and (Dy4.41) on lower slopes, gullies, saddles, benches, and flat-topped ridges, and small areas of siliceous sands (Uc1.21) on granitic colluvium; where this unit is mapped to the coastline there are small areas of unit Cb16 around the coastline. Occurs on sheet(s): 2"
"JJ4"
"Mountainous: similar to JJ3 but (i) with pockets of organic loamy soils (Um7.12) and acid peaty (O) soils at the higher elevations, and (ii) with leached sands (Uc2.2) and various (D) soils on surrounding apron plains at the lower elevations. Occurs on sheet(s): 2"
"JJ5"
"Coastal peneplain with gentle seaward slopes: peneplain of shallow sand soils (Uc4.11) with highly organic (peaty) surface horizons, in association with yellow leached earths (Gn3.84), leached sands (Uc2.33 and Uc4.33)

especially on seaward slopes, some acid organic soils (O) and occasional rock outcrops: streams have narrow valleys of various undescribed soils. Occurs on sheet(s): 2"
"JJ6"
"Steep to rugged terrain, rock walls and rock outcrops: shallow sandy soils (Uc4.1) and siliceous sands (Uc1.21) with shallow loamy soils (Um4.1 and Um4.2). Associated are shallow forms of various (D) soils, especially (Dy3.41) and (Dy3.21). As mapped, small areas of unit Ub56 are included. Occurs on sheet(s): 3"
"JJ7"
"Mountainous--steep to rugged terrain with rock outcrops and rock walls: shallow sandy soils (Uc4.1). Occurs on sheet(s): 3"
"JJ8"
"Plateaux with very steep scarp slopes and associated dissected steep hilly country, generally on volcanic rocks (tuffs, trachyte, and rhyolite, some andesite); rock outcrops common; soils generally shallow: chief soils are shallow sands (Uc4.1 and Uc4.2). Minor soil occurrences include (Uc2.12) on ridge crests; (Gn4.54) on some slopes and crests; (Um2.12) on some crests; (Gn3.14) and (Gn2.34) on basal fans; (Dy5.41) and (Dr5.41) on some slopes; (Gn2.21) on alluvial flats; and (Gn3.74) on some ridge crests. Occurs on sheet(s): 4"
"JJ9"
"Dissected sandstone tablelands of moderately hilly relief, some precipitous scarps, narrow V-valleys with steep side slopes, some gently sloping fans: dominant soils are shallow sands (Uc4.11), often stony, with (Uc2.12) and (Uc2.22) soils on fans and lower slopes. Minor soil occurrences include (Dy5.41) on fans and lower slopes and (Gn2.75). Occurs on sheet(s): 4"
"JJ10"
"Hilly deeply dissected plateaux consisting of level stony plateau surfaces, high bluffs and cliffs bordering narrow valleys, and some undulating colluvial slopes and alluvial flats; massive sandstone outcrop is common: dominant soils of the higher sites are shallow often stony sands and sandy loams (Uc4.12), with some similar loams (Um4.1), and (Um1.43). Associated are: deep sandy duplex soils (Dy5.41 and Dy5.42); other sandy or loamy duplex soils (Dy3.42) and (Dy2.42); and occasional areas of sandy yellow earths (Gn2.22) or siliceous sands (Uc1.21). On some benched steep slopes shallow stony red duplex soils (Dr3.21) and (Dr2.21) occur. On more gentle slopes sandy duplex soils are common, chiefly (Dy5.42), (Dy3.42), (Dy2.42), and (Dy2.22), but there are also areas of sand soils (Uc4.21), (Uc2.23), and (Uc2.12). The soils of the alluvial valley floors are mostly loamy duplex types (Dy3.42) and (Dy2.33), but there are some areas of outwash sand (Uc1.21). Occurs on sheet(s): 4"
"JJ11"
"Low hilly or hilly dissected sandstone plateaux, often with narrow steep-sided gorges and ravines; massive sandstone outcrop is common: dominant soils are mostly shallow and often stony sands, chiefly (Uc4.11), but other shallow sands (Uc4.2), (Uc1.21), and (Uc2.12) also occur. Deeper, stone-free similar sandy soils occur in valley floors. Included in the unit, as mapped, are some level plateaux with sandy red earths (Gn2.12), as for unit My36 of Sheet 4. Data are limited. Occurs on sheet(s): 4,7,10"
"JJ12"
"High hills or rugged mountains with frequent steep scarps, benched slopes, and rocky bluffs; massive sandstone outcrops are very frequent: dominant soils are sands of very shallow to moderate depth; (Uc4.11) is probably most common but other sand soils (Uc1.21, Uc1.23), (Uc2.12), and (Uc4.2) also occur. On some lower slopes or on more clayey sediments sandy or loamy duplex soils occur, chiefly (Dr2.41), (Dy3.41), (Dy2.42), and (Dy5.41). Data are limited. Occurs on sheet(s): 4,7"
"JJ13"
"Strongly undulating lands with some low cuesta-like hills that frequently have massive sandstone outcrops: dominant soils are shallow sands (Uc4.1 and Uc4.2), with some leached sands (Uc2.12). In some areas much quartz gravel may occur. On lower slopes sandy or loamy duplex soils (Dy3.42), (Dy3.43), and (Dy2.32) are common. Data are limited. Occurs on sheet(s): 4"
"JJ14"
"Steep granitic ranges and hills with bare rock walls: chief soils are shallow sands (Uc4.11) and leached sands (Uc2.2) in colluvial positions. As mapped, areas of units JZ1 and JZ2 are included. Occurs on sheet(s): 5"
"JJ15"
"Ranges with steep to precipitous slopes, bare rock walls of quartzites, and gentler hilly ridges: chief soils seem to be shallow sandy soils (Uc4.11) with rock outcrops and various shallow (Dy) soils such as (Dy3.21) at the higher elevations. Associated are (Dy3.4) soils on hill and ridge slopes at lower elevations; and other undescribed soils. As mapped, small areas of soils of the adjoining units may be included along the margins of the ranges. Occurs on sheet(s): 5"
"JJ16"
"Broken terrain characterized by rock outcrops (granitic bosses and tors) which may cover very large areas within the unit: shallow and often stony or gritty sandy soils (Uc4.11), (Uc4.33), and (Uc4.22) form a soil scree around the areas of bare rock. Associated are small areas of many other soils, such as (Dr2.62) and (Gc2.22); their occurrence

reflects the chemistry of the individual rock outcrop. As mapped, small areas of units Va66 and Ms8 are included. Occurs on sheet(s): 5,10"
"JJ17"
"Small ranges of metasediments (whitestones), some rock outcrops: chief soils seem to be shallow sands (Uc4.11). Associated are shallow (Dy) and (Dr) soils such as (Dr2.32) and possibly some shallow (Um) soils. Occurs on sheet(s): 5"
"JJ18"
"Sandstone plateaux and hills with broad valleys; much rock outcrop on hills and upper slopes of scarps: chief soils are shallow stony and sometimes gravelly (Uc4.12) and (Uc4.2) soils. Associated on lower slopes are shallow sands (Uc1.22 and Uc1.23); while (Dr2.43) and (Dy2.43) soils occur on valley floors. Occurs on sheet(s): 9"
"JJ19"
"Mountainous--quartzite ridges with narrow valleys cut into basalt: chief soils are shallow sandy soils (Uc4.11) associated with much rock outcrop. Other soils include shallow stony sands (Uc1.22) on quartzite slopes (Gn3.12) on dissected basaltic areas; some (Ug5.15) along stream courses; and some extensive plains of (Gn2.12) with fine ferruginous gravel on the surface. Occurs on sheet(s): 9"
"JJ20"
"Rocky sandstone ridges with broad valleys associated with basalt layers. There is mainly rock outcrop on the high country with (Uc4.11) and (Uc1.22) soils on slopes. Valleys have (Dy5.43) and (Dr2.23) soils with (Gn3.12) soils on basalt. Occurs on sheet(s): 9"
"JJ21"
"Rounded granite hills with some lateritic remnants: chief soils are gravelly (Uc4.11) on crests and upper slopes together with much rock outcrop. Other soils include (KS-Uc4.2), (Uc5.11), and (Gn2.12) on lower slopes and valley floors. Occurs on sheet(s): 9"
"JJ22"
"Upland plains and rocky undulating country developed on sandstone and shale: main soils are shallow stony sandy soils (Uc4.11) with much rock outcrop. Associated are ironstone gravels with sandy (KS-Uc4.2) and earthy (KS-Gn2.22) and (KS-Gn2.42) matrices on interfluves and upper slopes. Small areas of (Um5) soils occur in valleys. Occurs on sheet(s): 9"
"JJ23"
"Rocky rounded hills with undulating pediments developed on conglomerate and sandstone; rock outcrops common: chief soils are shallow stony sandy soils (Uc4.11) on slopes. Associated on pediments are (Gn2.12), (Dy5.32), and minor areas of (Um5) soils. Occurs on sheet(s): 9"
"JJ24"
"Mountainous country developed from granitic rocks: main soils are shallow stony sandy soils (Uc4.11) with much rock outcrop on crests and upper slopes. Associated are (Dy2.42) soils on the lower slopes and (Dr2.43) and (Dr2.33) on valley plains. Occurs on sheet(s): 9"
"JJ25"
"Granite domes with intervening alluvial plains; mainly rock outcrop on higher country: chief soils are shallow gritty sandy soils (Uc4.11) with (Dy2.42 and Dy2.43) on valley floors. Occurs on sheet(s): 9"
"JJ26"
"Rocky sandstone plateaux and hills; some gentle lower slopes; some deeply incised valleys: chief soils are shallow sandy soils (Uc4.1) together with (Uc1.4) and (KS-Uc4.2). Other soils include (Uc1.22 and Uc1.23) and (Uc4.21) on slopes and (Gn2.12) on valley floors. Occurs on sheet(s): 8,9"
"JJ27"
"Undulating to low hilly shaly country with some rock outcrops: chief soils are shallow sandy soils (Uc4.1) and (K-Uc4.1), often stony and gravelly, with some shallow loams (Um4) on moderate to gentle slopes. Associated on the slopes are smaller areas of shallow and stony (D) soils such as (Dy2.42), (Dr2.22), (Dr2.42), and (Dy3.61). Small areas of the soils of unit Ms13 may occur in flats and depressions or fringing streamlines. Occurs on sheet(s): 8,9"
"JJ28"
"Low to steep hills, ridges, and cuestas interspersed with small sandy plain areas, mainly on sandstones, with some shales; rock outcrops common; narrow valleys: chief soils are probably shallow stony sands (Uc4.1), (Uc1.4) with (Uc4.2). Associated are slopes and plains of yellow earthy sands (Uc5.22) with (Uc5.21), (Gn2.1), (Gn2.2), and (Gn2.6) soils; and narrow valley plains of yellow earths such as (Gn2.74). As mapped, small areas of adjoining units may be included. Occurs on sheet(s): 8"
"JJ29"
"Mostly low rounded granitic hills: chief soils are probably shallow gritty sands and sandy loams (Uc4.1) and (Uc1.4). There may be some (Dy5.8) soils as for unit Wd13. As mapped, small areas of units AC13, MY2, and BY1 are included. Occurs on sheet(s): 8"
"JJ30"

"Ridges, cuestas, and/or hilly country mainly on sandstones, siltstones, and shales; rock outcrop is common: chief soils are shallow sands and sandy loams (Uc4.1), (Uc4.2), and (Uc1.4). Associated are small areas of a variety of soils. As mapped, small areas of units AC13 and MY2 may be included. Occurs on sheet(s): 8"
"JJ31"
"Low to steep hills and ridges--some cuestas; mainly on sandstones, greywacke, siltstones, and shales; rock outcrops are common; narrow valleys: chief soils are shallow stony sands (Uc4.1) and (Uc1.4) but other shallow sands including (Uc4.2) and (Uc2.12) occur. Other soils include stony (Dr2.21) and (Dy3.21); narrow valleys of the soils of unit Mb15; and in places deep sands (Uc). As mapped, small areas of units My76 and JV1 are included. Occurs on sheet(s): 8"
"JJ32"
"Low to steep hills on sandstones with some rock outcrop; undulating terrain on dolerite; narrow valley plains: chief soils are shallow stony sands (Uc4.1) and (Uc1.4) on the hills; (Gn2.12) soils on the undulating terrain; and (Gn2.74) and the other soils of unit Mb15 in the valley plains. Occurs on sheet(s): 8"
"JJ33"
"Prominent hills and ridges with "castle"topography in places; mainly developed on sandstones but with some siltstones and shales; rock outcrops are common: chief soils are shallow stony sands and sandy loams (Uc4.1) and (Uc1.4). Other shallow soils are likely too. As mapped, small areas of unit My76 are included. Occurs on sheet(s): 8"
"JJ34"
"Generally hilly country with ridges, domes, cuestas, and low plateaux, mainly on sandstones and siltstones, but a variety of rock types occur; many rock outcrops; some gentle lower slopes; narrow valleys: chief soils are a variety of shallow sands and sandy loams (Uc4.1), (K-Uc4.1), (Uc4.2), (Uc1.4), and (K-Uc1.4), often gravelly and stony. Some lateritic remnants including (KS-Uc) and (Uc2) soils occur locally. The common soils of the narrow valleys include (Gn2.6), (Dy3.4), and (Uc1.43) on levees; while shallow (Dy) and (Gn2) soils, including (Gn2.12), may occur on some gentle lower slopes. Small areas of units JJ35 and Fz23 may be included. Occurs on sheet(s): 8"
"JJ35"
"Generally low rough hills and ridges with some rocky steep slopes and some flat to gently sloping areas derived largely from dolomitic rocks; rock outcrops; narrow valleys: chief soils seem to be a variety of shallow sands and sandy loams (Uc4.1), (K-Uc4.1), (Uc1.4), (Uc4.2), and (K-Uc1.4), often gravelly and stony, on hill and ridge slopes. Associated in gently sloping areas are (Gn3.12 and Gn3.13) soils with some flats of (Ug5) soils; while the common soils of the valleys include (Dy3.4), (Gn2.6), and (Uc1.43) on levees. Some lateritic remnants with (KS-Uc) and (Uc2) soils occur locally. Some areas of adjoining units and especially units JJ34 and Fz23 are included. Occurs on sheet(s): 8"
"JJ36"
"Undulating country with low stony and rocky ridges and benches on dolomitic siltstones and allied rocks: chief soils seem to be a variety of shallow sands and sandy loams (Uc4.1), (K-Uc4.1), (Uc1.4), and (K-Uc1.4) often gravelly and stony, on sloping sites. In some areas of more gentle relief shallow (often only 6 in. deep) stone-covered hard alkaline red soils (Dr2.13) occur in complex with shallow cracking clays (Ug5) such as (Ug5.12). Other soils may occur. Occurs on sheet(s): 8"
"JJ37"
"Rough dissected country on sandstones; chief soils are shallow sands (Uc4.1), (K-Uc4.1), (Uc4.2), (Uc1.4), and (K-Uc1.4), often gravelly and stony. Small areas of other soils are likely. Occurs on sheet(s): 8"
"JJ38"
"Undulating terrain on lateritized sediments broken by rounded rubbly hills on siltstones and rugged ridges on sandstones: chief soils are a variety of shallow sands, sandy loams, and loams (Uc4.1), (Uc4.2), (K-Uc4.1), (KS-Uc4.1), (Uc1.4), (K-Uc1.4), (KS-Uc1.4), (Um1.4), and (K-Um1.4), often gravelly and stony. Associated are the soils of units AB30, JV6, and Qd9. Small areas of unit 006 occur in flats and depressions. Occurs on sheet(s): 8"
"JJ39"
"Generally hilly country on sandstones with mesas and scarps; some narrow valleys: chief soils are probably shallow, sometimes gravelly, sands (Uc4.1), (Uc4.2), (Uc1.4), (KS-Uc4.1), and (KS-Uc1.4). Associated are variable areas of red and yellow earthy sands (Uc5.2) and red and yellow earths (Gn2.1 and Gn2.2). Occurs on sheet(s): 8"
"JJ40"
"Moderately undulating lands on granite with broad rounded crests and slopes, and some high ridges with rock outcrop: dominant soils are probably shallow gravelly sands (Uc4.1 and Uc4.2) with occasional (Uc1.2 and Uc1.4). On flatter slopes are probably sandy duplex soils (Dr2.12), (Dy3.4) with some red and yellow earths (Gn2.12 and Gn2.11) and (Gn2.62) in valley floors. Data are very limited. Occurs on sheet(s): 7,8,10"
"JJ41"
"Undulating elevated plateaux with occasional low scarped margins and localized areas of sandstone outcrop: dominant soils are shallow, often gravelly, sands (Uc4.12, Uc4.11). Associated soils on outwash slopes are

bleached sands (Uc2.21); shallow gritty sands (Uc1.21) and (Uc2.12) occur adjacent to sandstone outcrop. Data are limited. Occurs on sheet(s): 7"
"JJ42"
"Rolling to strongly undulating lands with broad rounded ridge crests and occasional low hills; granite tor outcrop is common: dominant soils are shallow gravelly coarse sands that set hard when dry; the chief form is (Uc4.12) but (Uc4.21) and (Uc4.11) are also common. Less frequent are shallow stony bleached sands (Uc2.21) and (Uc2.12). A range of sandy to loamy stony mostly shallow duplex soils are associated. The most common are loamy red duplex soils (Dr2.12, Dr2.11) and (Dr2.22, Dr2.21), which occur on more basic rocks and may be locally dominant; usually they occur on mid and upper slope sites in areas of lesser rock outcrop. On lower slopes and in some valley floors mottled duplex soils are often common, the chief forms being (Dy3.43), (Dy3.33), (Dy3.42), (Dy3.41), (Dy3.22), and (Dy3.21). Similar (Dy2) soils occur less frequently. Small areas of sandy friable earths (Gn3.56) and (Gn3.75) occur on some slopes. Occurring throughout the unit on basic intrusions are small areas of red friable ear. Occurs on sheet(s): 7"
"JJ43"
"Strongly undulating to low hilly lands with granite outcrop, often capped by small sandstone mesas: dominant soils are very shallow stony sands (Uc4.12), with occasional bleached sands (Uc2.12). Some outwash slopes have deep sands (Uc4.22) and small areas of sandy yellow earths (Gn2.2). Areas of lesser relief have loamy red duplex soils (Dr2.12) and (Dr2.22). On the mesas are shallow stony loams (Um2.12) and sands (Uc2.12) with other loams and sands (Um4.2) and (Uc4.2) associated. Occurs on sheet(s): 7"
"JJ44"
"Hilly lands with steep slopes and much large granite tor outcrop: dominant soils are shallow gravelly sands, chiefly (Uc4.11) but with areas of (Uc4.12). Associated are other shallow sands (Uc4.21, Uc4.22), (Uc2.12), and (Uc2.21). On lower slopes and outwash fans there are some sandy or loamy red or yellow earths (Gn2.14, Gn2.15) and (Gn2.24). Occurs on sheet(s): 7,10"
"JJ45"
"Strongly undulating lands with some low hilly areas; rock outcrop is common on higher slopes; all soils have much gravel on the surface and in the A horizons: dominant are shallow gravelly sands, chiefly (Uc4.11), but with areas of (Uc4.22, Uc4.21), and lesser shallow bleached sands (Uc2.12). Moderately deep to deep loamy duplex soils, chiefly (Dy2.42) and (Dy3.41, Dy3.43), with lesser (Dr3.41), (Dr3.21), (Dr2.22), (Dy2.22), and (Dy3.21), are common on areas of lesser relief, lower slopes, and in minor drainage lines. Loamy red earths (Gn2.14) occur on the stream levees. Occurs on sheet(s): 7"
"JJ46"
"Low hilly sandstone mesas, often with steep-scarped margins; in some areas undulating outwash slopes are common: dominant soils on the mesas are shallow to moderately deep sands (Uc4.12), with other sands (Uc4.21), (Uc2.21), and (Uc1.22) associated. On more extensive plateau surfaces and undulating outwash slopes, sandy yellow or red earths (Gn2.14) and (Gn2.24, Gn2.21) are common. Data are limited. Occurs on sheet(s): 7"
"JJ47"
"Undulating lands with broad rounded ridge crests and very occasional low granite hills: dominant and associated soils are probably the same as unit JJ42, but there are probably greater areas of bleached sands (Uc2.12) and (Uc2.21). Data are extremely limited. Occurs on sheet(s): 7"
"JJ48"
"Hilly or low hilly lands forming an irregular dissected scarp margin to units Ca41 and Ca43; granite tor outcrop is very prominent; dominant soils are shallow to moderately deep gritty sands; (Uc4.11) is probably dominant but (Uc4.21), (Uc4.12), (Uc2.12), and (Uc2.21) also occur. Commonly associated are gritty duplex soils (Dr2.81), (Dy2.81), and (Dy3.81) and gritty grey earths (Gn2.84, Gn2.85, and Gn2.82). Data are fairly limited. Occurs on sheet(s): 7"
"JJ49"
"Broadly undulating lands with some strongly undulating areas and granite outcrop: dominant soils are shallow loamy sands (Uc4.12, Uc4.11) and (Uc5.21). Associated are massive sandy red duplex soils (Dr2.53, Dr2.51), with structured loamy or sandy duplex soils (Dr2.13, Dr2.43, Dr3.13, and Dr3.43) occurring on lower slopes. In areas of lower relief sandy red earths (Gn2.11, Gn2.12) often occur. On strongly undulating slopes and near rock outcrop are shallow coarse sands (Uc1.23, Uc1.21). Loamy red earths (Gn2.12, Gn2.11) occur on stream levees. Data are fairly limited. Occurs on sheet(s): 10"
"JJ50"
"Undulating lands with isolated low hills and much rock outcrop: dominant soils are shallow loamy sands (Uc4.12), (Uc4.22), and (Uc5.21), with occasional (Uc1.23) soils near rock outcrop. Associated are gravellysurfaced shallow red duplex soils (Dr2.13, Dr2.43, and Dr2.12), and their (Dr3) equivalents, shallow gravelly loams (Um5.51), (Um5.41), and loamy or sandy red earths (Gn2.12, Gn2.11). Data are limited. Occurs on sheet(s): 10"
"JK1"

"Low coastal dunes and plains less than 25 ft above sea level: chief soils are brown sands (Uc4.2) on dune crests and slopes, with leached sands (Uc2.21) in swales and on plains. Other soil occurrences include (Gn3.94) over calcareous clay D horizons, and (Dy5.51) and (Dg4.8) in swampy depressions. Occurs on sheet(s): 4"
"JK2"
"Low fixed sand dunes paralleling the coastline: dominant soils are those of the older (more inland) dunes that have deep sands (Uc4.2), or less commonly (Uc4.3). The near coastal dunes have (Uc5.11), (Uc1.21), (Uc1.22), and (Uc1.23) sands. The most recent dunes become calcareous (shelly) at variable depths (12 in. or more) and have (Uc1.11) or (Uc1.12) loose sands. As mapped, the unit may include small areas of mangroves and salt pans. Occurs on sheet(s): 4,7"
"JK3"
"Steep very stony quartzite hills with a linear orientation; massive rock outcrop is common: dominant soils are mostly shallow and always stony sands (Uc4.2), with lesser (Uc4.11), and (Uc1.21). On some lower slopes stony duplex soils may occur, chiefly (Dr2.22) and (Dy3.42). Data are limited. Occurs on sheet(s): 4"
"JK4"
"Strongly undulating lands with some low hills; granite piled-tor outcrop is very common, particularly on the low hills: dominant soils are shallow gritty sands (Uc4.2), with closely associated (Uc4.3), (Uc4.12), (Uc2.12), and (Uc2.22) soils. In some areas the leached gritty sands are dominant. Other soils occurring include smaller areas of shallow duplex soils (Dy2.21), (Dr2.12), and (Dy3.42), and some coarse-textured gradational soils (Gn2.15), (Gn2.42), and (Gn2.45). Occurs on sheet(s): 4"
"JK5"
"High hilly lands with steep slopes and high scarped margins; granite or other acid rock outcrop is very common: dominant soils are stony sands or sandy loams (Uc4.2) that grade into weathered rock at shallow depths. Associated are similar (Uc4.1), (Uc2.21), (Uc2.12), and (Um4.2) soils. In some lower slope sites stony duplex soils occur, chiefly (Dr2.12), (Dy3.42), and (Dy2.22). Occurs on sheet(s): 4,7"
"JK6"
"Low hilly or strongly undulating lands with much massive granite or other acid rock outcrop; all soils are shallow and stony: dominant are gritty sands (Uc4.2) with associated (Uc4.1), (Uc2.12), (Uc2.21), and (Um4.2) soils. On lower slopes shallow stony duplex soils may be common, chiefly (Dy3.42), (Dr2.12), and (Dy2.22). Occurs on sheet(s): 4,7"
"JK7"
"Strongly undulating lands with some small sloping plains and occasional high stony ridges or small low mesas: dominant soils are moderately deep coarse sands (Uc4.2), but (Uc1.21) and (Uc5.11) are closely associated. The small sloping plains have sandy yellow earths (Gn2.24, Gn2.21, and Gn2.25) that are usually strongly nodular at depth. The high stony ridges and low mesas have shallow stony sands (Uc2.12) and (Uc1.21), loams (Um4.1), or less commonly red earths (Gn2.12). Small areas of loamy duplex soils (Dy3.42) may occur in lower sites throughout the unit. Data are fairly limited. Occurs on sheet(s): 4"
"JK8"
"Low hilly lands with short steep slopes and much sandstone outcrop: dominant soils are shallow stony sands (Uc4.2) and (Uc4.11), with stony loams (Um4.1) and (Um1.43) also occurring locally. On lower slopes stony duplex soils may occur, chiefly (Dy3.42) and (Dy2.43). Data are limited. Occurs on sheet(s): 4"
"JK9"
"Undulating dune landscape with some steep dune slopes and underlain by aeolianite at depth: chief soils are brown sands (Uc4.22). Associated are siliceous sands (Uc1.22) on the deeper dunes, especially on the western side of the unit; and leached sands (Uc2.21) on the more subdued dunes, especially on the eastern side of the unit. Occurs on sheet(s): 5"
"JK10"
"Undulating low slopes of coastal dunes with aeolianite outcrops, caves, and sink holes: chief soils are brown sands (Uc4.2). Associated are small areas of other soils, probably including (Uc1.22) and (Uc2.21). Occurs on sheet(s): 5"
"JK11"
"Granitic massifs and their colluvial slopes, including headlands and off-shore islands; some bare rock walls: chief soils seem to be shallow sandy soils (Uc4.2) and possibly (Uc4.11) with leached sands (Uc2.3) on colluvial material. Associated are various (Dy) soils containing ironstone gravels and also their erosion products; areas of unit Ca20 or A15 that may be banked up against the granite; and some aeolianite areas of undescribed soils. As mapped, areas of adjoining units may be included. Occurs on sheet(s): 5"
"JK12"
"Gently undulating plain with low dunes: chief soils are brown sands (Uc4.22) with variable areas of siliceous sands (Uc1.22), shallow dark sands (Uc6.12), and shallow yellow-brown sands (Uc6.14). Area is underlain by fossiliferous limestone. Occurs on sheet(s): 5"
"JK13"

"Gently undulating plain with a few low dunes: chief soils are yellow sands (Uc4.22) with siliceous sands (Uc1.22) on the dunes and some areas of red sands (Uc4.23) marginal to unit AB9. Occurs on sheet(s): 6"
"JK14"
"Gently undulating country, developed on sandstone, with widely spaced steep-sided residuals: chief soils are sands (Uc4.2) and (Uc5.11) sometimes with much ferruginous gravel. Associated are shallow stony (Uc1.22) soils with much rock outcrop on interfluves; deeper (Uc1.22) sands on foot slopes; and gravelly hard yellow mottled soils (Dy3.42) on plateau tops where drainage is restricted. Occurs on sheet(s): 9"
"JK15"
"Rugged dissected sandstone plateaux with cliffs, gorges, and occasional small mesas; much rock outcrop occurs; steep scree slopes have large blocks of sandstone and quartzite: dominant soils are shallow sands (Uc4.22) that are often gravelly (K-Uc4.22). Associated are other shallow sands (Uc4.1), (Uc1.23), (Uc1.43), and occasional sandy red earths (Gn2.14). In lower flatter sites are loamy and sandy yellow earths (Gn2.6) and (Gn2.2) and yellow duplex soils (Dy2.1) and (Dy2.2). Data are limited. Occurs on sheet(s): 7,8"
"JK16"
"As for JK15 but less rugged with some lateritic remnants with shallow sands (Uc5.21), (Uc5.22), and (Uc4.22) often having ironstone nodules and overlying massive nodular laterite. Data are limited. Occurs on sheet(s): 7,8"
"JK17"
"Hilly lands with some steep slopes, narrow valleys, and undulating marginal ridges; much bare rock outcrop: dominant soils are shallow stony sands (Uc4.22), (Uc4.1), (Uc5.21), (Uc1.23), and (Uc1.43). Around the margins are some lateritic remnants with shallow sands (Uc4) and (Uc5) overlying nodular laterite. Small outwash plains bordering the unit have deep bleached sands (Uc2.21), possibly (Uc2.34), and sandy grey earths (Gn2.81, Gn2.82). Data are limited. Occurs on sheet(s): 7,8,10"
"JK18"
"Gently undulating plains with some small rises with sandstone outcrop: dominant soils are deep yellow sands (Uc4.21), with lesser (Uc4.22) and (Uc5.22, Uc5.21, and Uc5.23). On low sandy rises are deep less coherent sands (Uc5.11), while in drainage lines are deep sandy duplex soils (Dy3.43), sometimes with a hardpan at 14-30 in. On and near the sandstone rises are moderately deep red or yellow earths (Gn2.14) and (Gn2.24), and shallow sands (Uc5.11), (Uc4.2), (Uc2.12), and (Uc1.21). On levees of larger streams are deep earthy sands (Uc5.22, Uc5.21). Occurs on sheet(s): 7"
"JK19"
"Gently undulating plains with occasional slightly higher rises that have massive nodular laterite exposed at the surface: dominant soils are shallow sands, chiefly (Uc4.21) but with some (Uc4.22); these are generally underlain by a massive nodular laterite horizon at 18-30 in. On the slightly higher rises are shallow bleached sands (Uc2.3) and (Uc2.12), with an ironstone horizon or occasionally an indurated pan at 15-24 in. At the margins of the unit are deeper sands (Uc4.2) and (Uc5.11). In lower areas of the plain are weakly developed deep sandy yellow or grey earths (Gn2.21) and (Gn2.81). Occurs on sheet(s): 7"
"JK20"
"Gently undulating to undulating lands with occasional granite outcrop and some small sandstone mesas of unit JK22: dominant soils are shallow sands (Uc4.21), (Uc4.11), (Uc5.11), (Uc4.3), and (Uc2.12), often with a prominent ironstone nodule horizon. Associated in the lower areas are moderately deep loamy or sandy yellow earths (Gn2.24), (Gn2.25), (Gn2.34), and (Gn2.74). Occurs on sheet(s): 7"
"JK21"
"Undulating to strongly undulating lands with broad ridge crests; acid igneous rock outcrop is common: dominant soils are shallow stony sands (Uc4.21), (Uc4.11), and (Uc5.1l), which occur mainly on middle and upper slopes and crests. Associated soils include shallow stony loams (Um4.2), and bleached shallow stony sands (Uc2.12), (Uc2.21), and (Uc2.23), which occur on lower slopes and in broad valleys. The soils frequently overlie a prominent ironstone nodule horizon. Occurs on sheet(s): 7"
"JK22"
"Undulating slightly elevated lands with some short steep scarps and occasional sandstone outcrop: dominant soils are shallow gravelly sands (Uc4.21), (Uc5.21), and (Uc5.11), often with a prominent ironstone nodule horizon. Associated are shallow bleached sands (Uc2.12) and (Uc2.23), which also may be nodular. Where soils are developed on a truncated laterite profile, shallow bleached loams (Um2.12) and (Um2.2) occur. 1n lower drainage lines are bleached shallow sands (Uc2.3) overlying a nodular hardpan. Occurs on sheet(s): 7"
"JK23"
"Dissected sandstone plateaux or mesas with steep-sided gorges; sandstone is often exposed, particularly at the dissected margins: dominant soils are shallow to moderately deep fine sands or sands (Uc4.22) and (Uc4.12); closely associated are extremely shallow fine sands (Uc4.11, Uc4.12) and bleached fine sands (Uc2.12) and (Uc2.21). On more extensive gently undulating parts of the plateau surface red sands (Uc5.21) and sandy red earths (Gn2.11, Gn2.14) occur. Occurs on sheet(s): 7"
"JK24"

"Moderately undulating lands with some dissected margins: dominant soils are shallow very gravelly sands (Uc4.21) occurring mainly on higher sites; associated on lower sites are sandy duplex soils (Dy2.41) and (Dy4.81), with (Dy3.41) soils near drainage lines. Other associated soils are shallow sands (Uc3.31) and (Uc2.12), which occur on the dissected margins. Bleached sandy grey earths (Gn2.94) occur on finertextured rocks. Data are limited. Occurs on sheet(s): 7"
"JK25"
"Low hilly to hilly lands with very prominent limestone ridges; rock outcrop is common on higher slopes; dominant soils are shallow gravelly sands (Uc4.21), with lesser shallow gravelly loams (Um4.2). Moderately deep to deep loamy or sandy duplex soils (Dy3.43) and (Dy2.43) are common on lower slopes. The limestone ridges are very rocky and virtually devoid of soil except for some pockets of shallow friable clays (Uf6.31). Loamy red duplex soils (Dr2.12) and (Dr2.22) occur on the short pediment slopes. Also included are some small basalt mesas with soils of unit Mo30. Occurs on sheet(s): 7"
"JK26"
"Low hilly to hilly lands with short steep slopes; moderate rock outcrop occurs on higher slopes; also occurring are some prominent, very rocky, limestone ridges: dominant soils are shallow gravelly sands (Uc4.21), with lesser bleached sands (Uc2.12) and loams (Um4.2). Shallow to moderately deep loamy duplex soils, chiefly (Dr2.22) or (Dr2.32), but also (Dy3.41), (Dy3.31), (Dy3.42); (Db2), (Dy2), and (Dr3) equivalents are common on lower slopes and drainage lines. The unit also includes some small lateritic mesas with loamy red earths (Gn2.11) on the crests, and shallow gravelly loams (Um4.21), (Um4.2), and (Um5.2) on the scarps. Occurs on sheet(s): 7"
"JK27"
"Low hilly to hilly lands with steep slopes and much rock outcrop: dominant soils are shallow gravelly sands (Uc4.21), with lesser shallow bleached sands (Uc2.12) and occasional shallow loams (Um2.12) and (Um4.2). Shallow to moderately deep loamy duplex soils (Dy3.43) and (Dy3.33) are common on lower slopes and may be dominant in areas of lesser relief. Data are limited. Occurs on sheet(s): 7"
"JK28"
"Hilly to high hilly lands with very steep slopes and much rock outcrop: chief soils are shallow stony sands; (Uc4.21) is probably dominant but areas of (Uc4.22), (Uc4.12), (Uc2.12), and (Uc2.21) also occur. Moderately deep to deep loamy red or yellow earths (Gn2.14) and (Gn2.24) are also common and may be locally dominant. Loamy duplex soils, chiefly (Dy3.41) but with (Dy3.43), (Dy3.21), (Dr3.41), and (Dy2) equivalents, occur on lower slopes and in drainage lines. Loamy red earths (Gn2.11, Gn2.14) occur on the lateritic mesa remnants included in the unit. Occurs on sheet(s): 7"
"JK29"
"Moderately to strongly undulating lands with some low hills and much granite or other acid igneous rock outcrop: dominant soils are shallow to moderately deep sands, chiefly (Uc4.22), with lesser (Uc4.21). Bleached sands (Uc2.12), with lesser (Uc2.21, Uc2.22), are common in some areas. Sandy or loamy red or yellow earths (Gn2.14, Gn2.15) and (Gn2.24) occur on lower slopes, alluvial fans, and stream levees. Very shallow gravelly sands (Uc4.11, Uc4.12) occur on steeper slopes and adjacent to rock outcrop. Occurs on sheet(s): 7"
"JK30"
"Hilly to high hilly lands with very steep slopes and much granite rock outcrop: dominant and associate soils are as for unit JK29 but are usually very shallow and gravelly. Occurs on sheet(s): 7"
"JK31"
"Undulating lands with some hilly areas of unit JJ44: dominant soils are shallow to moderately deep sands (Uc4.22), with lesser (Uc4.21). Moderately deep loamy red duplex soils (Dr2.22) and (Dr2.12) are common and occasionally locally dominant in areas of lesser relief. Minor associated soils include gravelly sands (Uc4.12, Uc4.11), particularly on the low granite rises with tor outcrop. Also occurring are loamy red or yellow earths (Gn2.14) and (Gn2.24) on gentle pediment slopes and fans. Loamy duplex soils (Dy3.42), (Dy3.43), and (Dy3.22), and similar (Dy2) soils, occur in the minor drainage lines, and occasional deep bleached sands (Uc2.22, Uc2.21) occur sporadically throughout the unit. Occurs on sheet(s): 7"
"JK32"
"High hilly scarp slopes with much rock outcrop and many large granite tors: dominant soils are gritty sands (Uc4.21), with lesser (Uc4.12), (Uc2.12), and (Uc2.22). Soil depth ranges from very shallow to deep. Loamy and a few sandy earths, chiefly (Gn2.84), (Gn2.74), (Gn2.14), and (Gn2.24), are common on lower slopes and in drainage lines. Shallow loamy duplex soils (Dy3.41), (Dr3.41), and (Dr2.21) occur on small included areas of unit Tb141. Occurs on sheet(s): 7"
"JK33"
"Undulating sandy outwash slopes: dominant soils are deep reddish sands (Uc4.22), with some deep bleached sands (Uc2.22) and sandy yellow earths (Gn2.61) and (Gn2.24) associated. Adjacent to streams there are narrow levees with sandy red earths (Gn2.14). Occasional small eroded low sandstone mesas with shallow sands or loams are included in the unit, together with small areas of loamy red duplex soils (Dr2.12) of unit Qa25. Occurs on sheet(s): 7"

"JK34"
"Hilly lands with steep slopes and much granite tor outcrop: dominant soils are moderately deep to deep yellowish red coarse sands (Uc4.21), with lesser (Uc4.22) and bleached sands (Uc2.21). Sandy or loamy red or yellow earths (Gn2.14) and (Gn2.24) occur on the dissected outwash slopes and alluvial fans. Minor associated soils include deep friable earths (Gn3.74), (Gn3.14), and (Gn3.24) on more basic intrusions, and occasional sandy duplex soils (Dy3.41) on lower slopes. Deep sands of unit JK2 occur on the narrow beach ridges included in the unit. Occurs on sheet(s): 7"
"JK35"
"High hilly lands with some marginal very steep scarps; granite or massive schist outcrop is very prominent throughout: dominant soils are shallow stony sands (Uc4.21), but other shallow sands (Uc4.12), (Uc2.12), and (Uc2.21) are also common. Associated are shallow gravelly earths (Gn2.84) and (Gn2.14) and shallow duplex soils (Dy3.41), (Dy3.21), (Dy2.21), (Dy2.61), and (Dr2.61). Adjacent to units Mx1 and Mx2 are areas of shallow friable earths (Gn3.54, Gn3.51) and (Gn3.71). Data are fairly limited. Occurs on sheet(s): 7"
"JK36"
"Hilly or low hilly lands with much granite outcrop: dominant soils are shallow stony sands, chiefly (Uc4.21), but with (Uc4.22), (Uc4.12), (Uc2.12), and (Uc2.21) also common. Also occurring are shallow stony duplex soils (Dr2.41), (Dr2.21), (Dr2.61), (Dy3.21), and (Dy3.41) and shallow gritty red earths (Gn2.14). On lower slopes bleached mottled duplex soils (Dy3.42, Dy3.41) are common. Occurs on sheet(s): 7"
"JK37"
"Hilly sandstone scarps and dissected mesas: dominant soils are probably shallow gravelly sands (Uc4.22, Uc4.21), with other shallow sands (Uc2.21) and (Uc2.12) also probably present. On lesser slopes and more extensive plateau remnants, sandy or loamy red earths (Gn2.14) occur. Data are very limited. Occurs on sheet(s): 7"
"JK38"
"Low hilly lands with some linear high ridges; schistose rock outcrop is common: dominant soils are probably shallow gravelly sands (Uc4.22), with other shallow sands (Uc4.12), (Uc2.12), and (Uc2.21) also probably occurring. On lower slopes the unit merges into the deep sandy red earths (Gn2.14) of unit Mw50. Data are extremely limited. Occurs on sheet(s): 7"
"JV1"
"Lateritic plateaux, mesas, and buttes commonly margined by steep escarpments but sometimes grading into adjoining units; benched boulder-strewn outcrop slopes; many exposures of laterite or mottled-zone and pallid-zone rock: chief soils are ironstone gravels (KS-Uc4.12), (KS-Uc2.12) with sands (Uc2.12) and (Uc4.1) on the gently sloping crests and dissection slopes. Associated are red earths (Gn2.12) often containing ironstone gravels; and sometimes (Uc5.21) soils as for unit AB33 on the flat tops of the larger occurrences of the unit where they may be the dominant soils. Small areas of many other soils occur, especially stony (Uc) and (Um) soils on the escarpments and the soils common to unit My72. As mapped, small areas of adjacent units may be included. Occurs on sheet(s): 8"
"JV2"
"Numerous lateritic mesas and buttes and their dissection scarps separated by areas of undulating terrain: chief soils are ironstone gravels (KS-Uc4.12) and other shallow soils as for unit JV1. Associated are red earths (Gn2.12) and other earths such as (Gn2.24) on the undulating terrain. Small areas of a variety of soils as for unit My72 also occur. Occurs on sheet(s): 8"
"JV3"
"Gently undulating sandy terrain with low hills and some dissection scarps on lateritized sandstones and siltstones; some outcrop: soil dominance varies markedly but sandy and ironstone-gravelly soils (KS-Uc4.12) and (Uc4.1) together with red earths (Gn2.12) are probably dominant. The general order of soil occurrence is: (KS-Uc4.12) and (Uc4.1) soils containing ironstone gravels on crests, upper slopes, and hilly areas together with some (Gn2.12), (Gn2.2), and (Uc5.2) soils on mid and lower slopes; sandy and sometimes loamy red earths (Gn2.12) on the main floors; and (Gn2.64) and possibly other soils in low-lying sites. Occurs on sheet(s): 8"
"JV4"
"Generally undulating terrain with plain areas, flat-topped ridges, and low-lying flats developed from lateritized sediments: soils are variable in character but are mostly shallow and lateritic gravels are common. Chief soils are probably shallow sands (KS-Uc4.12), (Uc4.1) and (K-Uc4.1), often containing much ironstone gravel, overlying block laterite, or indurated mottled-zone or pallid-zone materials. Associated are redbrown varieties of (Um5.51) overlying laterite at shallow depth (<18 in.) on plain areas; (Uc5.22) on flat-topped ridges; (Uc2.2) with block laterite on flat-topped ridges and on slopes; (Gn2.6) in valleys; (Dg1.43) on some open flats margined by (Dy3.43) soils; and some small flats of unit 006. Occurs on sheet(s): 8"
"JV5"
"Gently undulating terrain as for unit JV4 but interspersed with narrow clay plains as for unit II6. Occurs on sheet(s): 8"
"JV6"

"Gently undulating country with poorly developed dune formations, some clay pans: chief soils are probably shallow sands often containing much ironstone gravel (KS-Uc4.12), (KS-Uc4.11), (K-Uc4.1), and (Uc4.1) in association with red and yellow earthy sands (Uc5.21 and Uc5.22). Small areas of red and yellow earths (Gn2.1 and Gn2.2) are likely together with small flats of unit 006 soils. Occurs on sheet(s): 8"
"JV7"
"Undulating terrain on lateritized sediments: chief soils are probably a variety of gravelly sands and sandy loams (KS-Uc4.12), (KS-Uc4.11), (KS-Uc1.4), (Uc4.1), and (Uc1.4) in association with red earths (Gn2.12) and red and yellow earthy sands (Uc5.21 and Uc5.22). Small flats of units 006 and II6 also occur. Occurs on sheet(s): 8"
"JX1"
"Valleys of undulating relief developed in granitic detritus; granite outcrops common: chief soils on mid slopes are shallow gritty yellow sands (K-Uc4.2) and (K-Uc5.11) with granite outcrops, while the tops of interfluves consist of bare granite. Associated are gritty sands (K-Uc1.22) and gritty alkaline, and also neutral, yellow mottled soils (Dy3.43 and Dy3.42) on lower slopes. Minor soil occurrences include gritty red earths (Gn2.12) on flat areas and (Dr2.21) soils on basic gneisses. Occurs on sheet(s): 8,9"
"JY1"
"Undulating land with small valleys and flats: chief soils are ironstone gravels (KS-Uc4.11) together with sand soils (Uc4.11) and/or (Uc2.12), both containing ironstone gravels on low flat-topped rises. These soils are underlain by hardened mottled-zone material by depths of 12-24in. Associated are valleys and flats of various (Dy) and (Dr) soils such as (Dy5.43), (Dy4.83), (Dy2.83), and (Dr3.43); deposits of earthy sands (Uc5.22) and siliceous sand (Uc1.22); and flat to gently undulating areas of calcareous earths (Gc1.12) and (Gc1.22). Occurs on sheet(s): 5"
"JY2"
"Dissected rolling lowlands; gravel pavements common: chief soils seem to be ironstone gravels (KS-Uc4.11) and shallow sands (Uc4.11) containing ironstone gravel together with shallow sandy, and ironstone-gravelly, yellow earths (Gn2.24). Dominance varies locally between these soils. Associated are sandy and ironstonegravelly red earths (Gn2.1) with gravelly (Dy3.4) and (Dy5.4) soils in small valley flats. Small areas of units Mw32, Mr8, AB32, and Va73 are included. Occurs on sheet(s): 8"
"JY3"
"Gently sloping terrain with some stony country and rock outcrop; gravel pavement: chief soils are ironstone gravels in a sandy matrix (KS-Uc4.11). Small areas of soils common to unit AC15 occur also. As mapped, small areas of units BA10 and AC16 are included. Occurs on sheet(s): 8"
"JZ1"
"Dissected plateau having a strongly undulating relief, and with some moderately incised valleys. The unit comprises much of the western part of the Darling Range south of the Swan River. It is characterized by lateritic gravels and block laterite. The chief soils are ironstone gravels with sandy and earthy matrices; the (KS-Uc4.2), (KS-Uc4.11), (KS-Uc2.12), and (KS-Gn2.24) soils blanket the slopes and ridges extending down into the upper ends of the minor valleys. They overlie duricrusts comprising recemented ironstone gravels, and/or vesicular laterite, and/or mottled-zone and/or pallid-zone material. Some (Dy3.81 and Dy3.82) soils containing ironstone gravels in the surface horizons may occur on some of the steeper slopes. Yellow loams (Um5.5), (Dy2.51) soils, and (Uc5.22) soils, all overlying pallid-zone clays and/or ironstone gravels at shallow depths (12-18 in.), occupy the swampy valley floors. Gravelly yellow earths (Gn2.2) are found downslope from granite bosses which occur occasionally in t. Occurs on sheet(s): 5"
"JZ2"
"Dissected plateau having a gentle to moderately undulating relief, and with broad swampy drainage-ways and basins. It is characterized by lateritic gravels and block laterite: the chief soils are ironstone gravels with sandy and earthy matrices (KS-Uc4.2), (KS-Uc4.11), (KS-Gn2.24), and (KS-Uc2.12). They overlie duricrusts of recemented ironstone gravels and/or vesicular laterite, and/or mottled-zone and/or pallid-zone material. These soils cover ridges and slopes where some (Dy3.81 and Dy3 .82) soils containing ironstone gravels also occur. Leached sands (Uc2.2 and Uc2.3) are a feature of the drainage-ways and basins. Areas of (Dy5.41) and (Dy5.82) soils occur on pediments in some areas of this unit where it merges with unit Tf3. Occurs on sheet(s): 5"
"JZ3"
"Deeply dissected lateritic plateaux: main soils are ironstone gravels (KS-Uc4.2) with laterite outcrop on the plateau tops. Associated are shallow stony sandy soils (Uc4.1) and (Uc1.4) on slopes and (Dr2.23) and (Gn2.12) on valley floors. Occurs on sheet(s): 9"
"Ja1"
"Extensive valley plains largely associated with the Fortescue River: chief soils are earthy clays (Uf6.71) along with some (Ug5.38), (Um5.5), and (Dr2.33) soils. Small areas of calcrete (kunkar) with (Um5.11) soils occur also. Occurs on sheet(s): 6"
"Ja2"

"This unit occupies the central position within the high-level valley plains represented by unit Fb3: chief soils are earthy clays (Uf6.71) along with extensive areas of (Ug5.38) soils. Occurs on sheet(s): 6"
"Ja3"
"Gently undulating pediplains and alluvial plains associated with Permian sediments: chief soils are earthy clays (Uf6.71), together with some cracking clays (Ug5.38). Associated are calcareous earths (Gc1.12) and (Gc1.22). Occurs on sheet(s): 10"
"Jb1"
"Salt pans and tidal flats or salt-water couch meadows merging into mangrove swamps; subject to frequent inundation by tidal waters: dominant soils on the salt pans are highly saline clays (Uf6.62), with some sandy duplex soils (Dy3.33), (Dy3.13), and (Dy2.43) on the margins. The duplex soils often have material added to or removed from the A horizons by wind or wave action. The small grassed areas in the unit have loamy duplex soils (Dy2.43), (Dy3.43), (Dd1.43), and (Dd1.33) or uniform clays (Uf6.41). Some areas of deep cracking clays (Ug5.14) and (Ug5.24) occur in minor depressions and various deep sands (Uc1.12), (Uc1.21), (Uc1.23), and (Uc4.2) occur on low included sand dunes or beach ridges. Occurs on sheet(s): 7"
"Jw1"
"Low-lying coastal plains with some sand dunes: chief soils are saline clays (Uf1.41) on the flat to very gently sloping plains. Associated are (Ug5) and (Uf) soils along the inland margin of the plains; areas of saline muds (Um1) on slopes and flats submerged at high tide; and very small areas of calcareous sands (Uc1.1) and/or siliceous sands (Uc1.2) on coastal dunes. Occurs on sheet(s): 6,8,9"
"KB"
"Kinrara basalt--as for unit TB but with small areas of stony friable red earths of unit Mo30 instead of red earths of unit My37. Occurs on sheet(s): 7"
"KK1"
"Mountainous: (1) dissected plateaux at high elevation; flat-topped, boulder-strewn ridges and high plains of organic loamy soils (Um7.11), shallow forms of (Um7.11) and also stony rises on some plateau remnants, small areas of (Um4.2) and (Uc) soils, with small swampy valley plains of acid peaty soils (O) and also various (Um) soils; and (2) broken by mountains, hills, and hilly ridges at high elevation of bare rock or boulder-strewn slopes with some areas of (Um7.11), (Um4.2), and (Uc) soils, with narrow deeply incised streams with small valley plains of (Um) soils and others undescribed. Occurs on sheet(s): 2,3"
"KK2"
"Mountainous--dissected plateau remnants at high elevation (>3700 ft): chief soils are shallow forms of organic loamy soils (Um7.11). As mapped, areas of unit Mw9 are included. Data are limited. Occurs on sheet(s): 3"
"KK3"
"Mountainous--dissected plateau at high elevation (>4500 ft): gently undulating plains of organic loamy soils (Um7.11) with boulders often strewn on the surface and embedded in the soil. Associated are rocky knolls, hills, and escarpments sometimes with other (Um) or (Uc) soils and granitic tors, and swampy valley plains and bogs of acid peaty soils (O) and other (Um) soils. Data are limited. Occurs on sheet(s): 3"
"KK4"
"Plateau remnants at high elevation (>4000 ft): low rolling tableland areas of organic loamy soils (Um7.11) dissected by relatively broad, shallow, and poorly drained valleys of acid peats (O) and various (Um) soils, some of which are underlain by plastic clays. Occurs on sheet(s): 3"
"KK5"
"Plateau remnants at high elevation (>4500 ft), rock outcrops: organic loamy soils (Um7.11) in the moister sites with (Um5) or (Gn2) soils in the drier sites. Small area. Data are limited. Occurs on sheet(s): 3"
"KL1"
"Steep slopes, often with cliffs at moderate to high elevation: slopes of organic loamy soils (Um7.12), and possibly (Um7.11) may occur: with smaller areas of sand soils with weak horizon formation (Uc4.31); small areas of acid peaty (O) soils on plateau remnants; boulders and rock scree common features throughout. Occurs on sheet(s): 2"
"KL2"
"Plateaux at high elevation: flat-topped ridges of organic loamy soils (Um7.12), and possibly (Um7.11) in association with acid peaty (O) soils and broken by steep slopes of (Um7.12), rock outcrops, bare rock walls, and rock scree, and with intervening small valley plains of acid peaty (O) soils dotted with boulders, marshy areas, and some lakes. Thin ironpans are present in or below the solum of many (Um7.12) soils. Occurs on sheet(s): 2"
"KL3"
"Plateaux at high elevation: plateau tops of organic loamy soils (Um7.12) and possibly (Um7.11) in association with acid peaty (O) soils, many rock outcrops and numerous chains of lakes. Thin ironpans are present in or below the solum of many (Um7.12) soils. Occurs on sheet(s): 2"
"KL4"
"Rugged plateaux and mountains at high elevation: ridges and slopes of ? organic loamy soils (Um7.12) and possibly (Um7.11) in association with acid peaty (O) soils, leached sands (Uc2.3), and shallow sand soils (Uc4.11),

both with highly organic (peaty) surfaces, and rock outcrops; some high plains of acid peaty (O) soils, and lakes; narrow stream valleys with gorges. Occurs on sheet(s): 2"
"KL5"
"Valley plains at high elevation of acidic peaty (O) soils, broken by low hills of unit KLl and with numerous boulders. Occurs on sheet(s): 2"
"Ka1"
"Relatively low-lying plains with small areas only subject to inundation unless drained; shallow dark clays (Ug5.11) of variable depth 2-12 in. and with limestone often exposed; smaller areas of deep dark clays (Ug5.14 and Ug5.16) and grey clays (Ug5.2). All these soils may occur in close association (complexes) with each other. Occurs on sheet(s): 1"
"Ka2"
"Plains with swamps, lakes, and lunettes: shallow dark clays (Ug5.11) with smaller areas of deep dark clays (Ug5.16) in association with hard alkaline dark soils (Dd1.13); sandy alkaline yellow mottled soils (Dy5.43) and dark shallow porous loamy soils (Um6.21) on lunettes; some areas of hard alkaline red soils (Dr2.23) on plains especially in the north-eastern portion of the unit. Occurs on sheet(s): 1"
"Ka3"
"Plains: shallow dark clays (Ug5.11) in association with fen soils (O); intergrades between these occur also. Occurs on sheet(s): 1"
"Ka4"
"Plain with swamps: shallow dark clays (Ug5.11) and saline variants of these. Incomplete data. Occurs on sheet(s): 1"
"Ka5"
"Alluvial plains associated with spring-fed streams originating in basalt flows: dominant soils are friable cracking clays (Ug5.11), with a soft highly calcareous horizon occurring at variable depths below 24 in. Other deep cracking clays (Ug5.16, Ug5.17) are closely associated and may be locally dominant; some small areas of grey cracking clays (Ug5.24) also occur. Small areas of loamy red earths (Gn2.12) of unit My37, red friable earths (Gn3.12) of unit Mo30, and cracking clays (Ug5.12) of unit Kb24 are included. Occurs on sheet(s): 7"
"Kb1"
"Undulating to low hilly areas of dark cracking clays (Ug5.13) in association with brown friable earths (Gn3.21 and Gn3.22). Note.--Kb1 is the new symbol for unit Ke8 of Sheet 2. Occurs on sheet(s): 2 (as Ke8), 3"
"Kb2"
"Dissected basaltic plateau at moderate elevation--hilly to low hilly with somewhat benched slopes, commonly bouldery or stony: chief soils are cracking clays (Ug5.12), (Ug5.13), and (Ug5.14) and less commonly (Ug5.3). Associated are shallow porous loamy soils (Um6); smaller areas of hard red alkaline soils (Dr2.13); and small undulating areas of unit Ke11 along the stream valleys. Occurs on sheet(s): 3"
"Kb3"
"Undulating areas sometimes broken by sharp ridges: undulating areas of shallow dark cracking clays (Ug5.12) in association with (Db3.12) soils on ridges, (Um6.11) soils on creek terraces, and other, undescribed soils. Data are limited. Occurs on sheet(s): 3"
"Kb4"
"Rugged hilly to mountainous with small valleys: steep, often stony hill slopes with rock outcrops of various shallow soils, notably shallow dark cracking clays (Ug5.12 and Ug5.13) with various loams (Um6) and (Um1). Many other soils such as those common to unit Mz1 are likely. The soils of the valleys are not described. Data are limited. Occurs on sheet(s): 3"
"Kb5"
"Gently sloping plain of dark cracking clays (Ug5.12) and/or other dark clays such as (Uf5.11) or (Uf6.11). Data are inadequate. Occurs on sheet(s): 3"
"Kb6"
"Rolling basaltic uplands: chief soils are dark cracking clays (Ug5.13) in association with many other soils, as follows: (i) crests and steep slopes of the flat-topped and rounded hills at the relatively higher elevations of dark shallow porous loamy soils (Um6.21), shallow friable clays (Uf6.11), and shallow cracking dark clays (Ug5.12); passing to (ii) gentle slopes on flat-topped hills, ridges, steps, and knolls of (Um6.21), red friable earths (Gn3.12), friable neutral red soils (Dr4.12), and shallow dark cracking clays (Ug5.12 and Ug5.13); passing to (iii) long gentle slopes of deeper dark cracking clays (Ug5.13) and (Ug5.5) with linear gilgai, also with smaller areas of (Uf6.21), (Uf6.31), and (Gn3.12) soils; and passing to (iv) narrow valley plains of unit Kd5 soils in the lower-lying situations. As mapped, small areas of units Kd10 and Oa7 are included in some localities. Occurs on sheet(s): 3,4"
"Kb7"
"Low hills and high steep-sided plateau remnants with mostly shallow stony dark clays (Ug5.12) and much rock outcrop. Associated are other stony uniform soils (Ug5.13), (Ug5.22), (Uf6.31), (Uf6.32), and (Um1.4). Occurs on sheet(s): 4"

"Kb8"
"Moderate to gently undulating lands with some extensive alluvial plains; surface is often strewn with billy gravel: dominant soils are dark clays of shallow to moderate depth (Ug5.12 and Ug5.13) with deeper soils in flatter sites (Ug5.14 and Ug5.15). Associated are some grey or brown clays (Ug5.22) and (Ug5.32). Some high ridges have friable uniform clays (Uf6.31 and Uf6.33) while small flood-plains immediately adjacent to drainage lines have loamy duplex soils (Db1.13) and (Dy2.43) as well as deep clays (Ug5.15), (Ug5.16), (Ug5.24), and (Uf6.33). Occurs on sheet(s): 4"
"Kb9"
"Moderate to strongly undulating lands with some low stony hills: dominant soils are dark cracking clays (Ug5.12, Ug5.13, and Ug5.15) on moderate slopes with shallow stony uniform soils with much rock outcrop on higher ridges or hills (Uf6.31), (Uf6.33), and (Um1.43). Also occurring in the unit are small areas of loamy duplex soils (Db1.13), (Dd1.13), and (Dr2.13 and Dr2.12), together with limited areas of red-brown clays (Ug5.32 and Ug5.37). Occurs on sheet(s): 4"
"Kb10"
"Gentle or moderately undulating plains with occasional higher stony ridges or broad low hill crests: dominant soils are shallow to moderately deep dark clays (Ug5.12, Ug5.13, and Ug5.14), often with linear gilgai on slopes. In lower sites small level plains occur, often as narrow stream flood-plains; on these areas soils are deep (Ug5.15 and Ug5.16). On the higher stony ridges shallow uniform clays (Uf6.31 and Uf6.32) occur. Occurs on sheet(s): 4"
"Kb11"
"Moderate or strongly undulating lands with stony low hills, benches, and bluffs; rock outcrops common: dominant soils are shallow mostly stony dark clays (Ug5.12, Ug5.13, and Ug5.14) and more friable shallow stony clays (Uf6.32 and Uf6.31), or clay loams (Um1.43 and Um1.41). Small areas of brown or red clays (Ug5.32 and Ug5.37) occur locally. Small alluvial plains may occur in lower sites which have deep clay soils (Ug5.15 and Ug5.16). Occurs on sheet(s): 4"
"Kb12"
"Gently rolling areas of the subcoastal lowland (less than 400 ft above sea level) on altered basic rocks; maximum relief is 50 ft between crests and valleys: chief soils are shallow dark cracking clays (Ug5.12) with hard neutral red and yellow soils (Dr2.12) and (Dy2.12). Associated soils are (Db3.12) and (Uf6.22) as found in unit Rh10. Occurs on sheet(s): 4"
"Kb13"
"Moderately hilly lands on basic rocks but with some trachyte and andesite; steep slopes and old volcanic cones: chief soils are shallow dark cracking clays (Ug5.12). Associated are (Gn3.11), (Gn3.12), and (Gn3.13) soils. Minor soil occurrences include (Uf6.2), (Ug5.15), and (Dr2.42). Occurs on sheet(s): 4"
"Kb14"
"Rolling to low hilly basaltic uplands with some stony rises, low stony scarps above long gentle slopes to narrow drainage flats: chief soils are shallow dark clays (Ug5.15 and Ug5.16) in alluvial depressions. Small areas of (Um6.24) and possibly (Uf6.31) soils occur on the stony rises and scarps. Minor areas of (Dr2.21) soils occur on included granites. Occurs on sheet(s): 4"
"Kb15"
"Dissected basaltic plateaux--high hills with broad gently sloping crests, bordered by steep hill slopes: chief soils are shallow dark clays (Ug5.12) on the crests. Associated are (Uf6.22), (Uf6.31), and (Um6.24) soils on crests with (Um4.1), (Dr2.41), and (Dr2.21) soils on sandstone exposed on the dissection slopes. Occurs on sheet(s): 4"
"Kb16"
"Steep hilly lands on basaltic materials below adjacent plateau scarps, grading down to long gentle colluvial fans, terraces, and shallow valleys: chief soils are shallow dark cracking clays (Ug5.12, Ug5.13, and Ug5.14) on basalt hills and slopes, often stony. Associated are: (Gn3.11 and Gn3.12) soils on valley slopes, fans, and terraces; (Uf6.11) and (Uf6.22) soils on crests of basalt hills; and (Ug5.15 and Ug5.16) on colluvial slopes and alluvial terraces. Minor soil occurrences include (Um4.1) and (Uc2.12) on non-basaltic hill crests, and (Dy3 43) and (Dr3.42) soils on non-basaltic hill slopes. Occurs on sheet(s): 4"
"Kb17"
"Low to moderately high hills with small alluvial plains: generally dark cracking clays (Ug5.12, Ug5.13, and Ug5.14) are associated with various (Dr2), (Db1), and (Dy2) soils on slopes. The soils of units LK13 and If 3 may be associated on steeper ridges and slopes. Other soils are likely. Data are limited. Occurs on sheet(s): 4"
"Kb18"
"Generally low rounded hills but with some steeper slopes in places: dominant soils are dark clays (Ug5.12) on erosional slopes, and (Ug5.13) and (Ug5.15) on lower slopes. There is some weak to moderate gilgai microrelief. Associated soils include (Ug5.3), (Ug5.1), and possibly (Uf6) soils on some crests. Small areas of other soils are likely. Occurs on sheet(s): 4"
"Kb19"

"Generally low rounded hills with some steeper slopes in places: chiefly dark clays (Ug5.12, Ug5.13, and Ug5.15) but with important areas of grey clays (Ug5.22 and Ug5.23). A slight gilgai microrelief may be present. Other soils include local occurrences of (Ug5.3), (Gn3.12), and possibly (Uf6.31). Occurs on sheet(s): 4"
"Kb20"
"Low rounded hills with moderate alluvial plains, broken by long narrow strike ridges and scarps of unit If3: chief soils are dark clays (Ug5.12 and Ug5.13) but with important areas of grey clays (Ug5.22) and brown clays (Ug5.3) on the slopes. Associated are (Ug5.15) and possibly other (Ug5) clays on the alluvial plains. The soils of unit If 3 occur on the strike ridges and scarps that run almost north-south across this unit in places. Occurs on sheet(s): 4"
"Kb21"
"Hilly or high hilly lands, often with very steep slopes: dominant soils are shallow stony dark clays (Ug5.12 and Ug5.13), with lesser areas of similar (Uf6.32 and Uf6.31) soils. The higher steeper hills have shallow stony loams (Um1.41) and (Um6) soils. On some lesser slopes small areas of red loamy duplex soils (Dr2.12) occur. Occurs on sheet(s): 4"
"Kb22"
"Moderately undulating lands with some level alluvial plains: dominant soils on the sloping sites are fairly shallow stony-surfaced dark clays (Ug5.13 and Ug5.12). Associated are brown clays (Ug5.32) and loamy duplex soils (Dd1.43), (Dd1.33), and (Dd1.13). Adjacent to rock outcrops are shallow stony clays (Uf6.31 and Uf6.32), clay loams (Um6.33), or occasionally shallow duplex soils (Dr2.12), (Dr2.42), and (Dy2.42). The associated small alluvial plains have deep dark clays (Ug5.15 and Ug5.16) and loamy duplex soils (Dd1.43) and (Dd1.33). On some marginal slopes gravelly red friable earths (Gn3.12) may occur. This unit is related to units Kc9 and Rb2. Occurs on sheet(s): 4"
"Kb23"
"Very gently undulating extensive basalt tablelands and elongate mesas that are extremely stony and are bounded by steep basaltic scree slopes: dominant soils are very stony-surfaced (boulders up to 2 or 3 ft) dark clays (Ug5.12) with lesser (Ug5.13). Very minor areas of stony red soils occur in the unit, chiefly (Gn3.12), (Gn2.11), and (Gn2.12). Beneath the boulder scree on the scarps are mainly grey or brown clays (Ug5.22), (Ug5.26), and (Ug5.32). Occurs on sheet(s): 4,10"
"Kb24"
"Level or gently undulating stony plains: dominant soils are dark clays of moderate depth (3 4 ft) that almost always have basalt surface stone to 12 in. diameter but often are stone-free below. The chief form is (Ug5.12) with very occasional deep soils (Ug5.16). Some areas of crabhole-type gilgai (8-12 in. deep) may occur. The plains are often terminated by low stony basalt flows or low hills with shallow (Um5.51) soils. Also mapped in the unit are small inclusions of red earths of unit My37. Occurs on sheet(s): 4,7"
"Kb25"
"Hilly or low hilly lands with some moderately undulating plateau surfaces; the unit is often bounded by steep dissected scarps; almost all soils are shallow and often stony: dominant are very dark brown clays (Ug5.12), but shallow red soils (Ug5.37) and (Gn3.12) are also common. On stronger slopes and high hills very shallow stony clays (Uf6.32 and Uf6.31) occur. Occurs on sheet(s): 4"
"Kb26"
"Undulating lands with gently sloping plains, moderate to high mostly stony ridges, and some low stony basaltic hills: dominant soils are those of the plains and lower ridge slopes; these have dark clays (Ug5.12) of moderate depth and often display linear gilgai. Lower landscape sites have deep dark clays (Ug5.14). Also occurring are smaller areas of red-brown clays (Ug5.37). The higher ridges and low hills have rock outcrop and shallow stony soils, chiefly (Uf6.31), (Gn3.12), (Ug5.12), and (Ug5.37). Commonly associated on the ridges are thin-surfaced loamy duplex soils (Dy2.43), (Dd1.43), and (Dr2.12). Occurs on sheet(s): 4,7"
"Kb27"
"Low hilly landscape with shallow soils (24 in. or less) over basalt: chief soils are shallow dark cracking clays (Ug5.12) with a little surface stone. Associated are shallow and stony (Ug5.12) soils on crests and upper slopes, and (Ug5.13) soils on mid and lower slopes. Small areas of other soils may occur. Occurs on sheet(s): 4"
"Kb28"
"Low hilly terrain on basalts and sedimentary rocks: chief soils are moderate and shallow forms of dark cracking clays (Ug5.14, Ug5.12, and Ug5.13) on the slopes. Associated are (Ug5.16) and (Ug5.28) soils on flats, and (Gn3.42) and (Gn3.91) soils on upper slopes. Minor soil occurrences include (Uf6.22) on limestones; (Uc4.1) and (Dy3.41) on sandstones; (Gn2.14) soils on sediments; and (Gn3.11) soils on basalts. Occurs on sheet(s): 4"
"Kb29"
"As for unit Kb24 but with inclusions of red friable earths (Gn3.12) of unit Mo30 rather than loamy red earths (Gn2.12) of unit My37. Occurs on sheet(s): 7"
"Kb30"
"Rocky scarps, low mesas, and undulating lands formed by stream dissection of basalt plateaux: dominant soils are very stony shallow to moderately deep dark cracking clays (Ug5.12). Included areas of deeper cracking clays

(Ug5.16) are usually associated with broad gently sloping drainage lines, and similar soils (Ug5.17) with very marked depositional layering occur on the flood-plains of the major streams. Shallow gravelly loams (Um6.33) and clays (Uf6.31) occupy the steep scarps while red friable earths (Gn3.12) are common on the mesa remnants. Minor associated soils include a range of loamy duplex soils formed on various rocks exposed by dissection of the basalt. Occurs on sheet(s): 7"
"Kc1"
"Undulating terrain broken by hills and steep ridges with bare rock walls: chief soils are dark cracking clay soils (Ug5.13 and Ug5.15). Associated are various (D) soils such as (Dr2.23) and (Db1.22); possibly small areas of (Gn3.12) soils; and steep ridges of undescribed but mostly shallow soils. Data are limited. Occurs on sheet(s): 3"
"Kc2"
"Dissected basaltic plateau: undulating terrain of dark cracking clays (Ug5.13) and (Ug5.15) in association with (Db3.12) and/or (Dr4.12) soils, often on the stony areas. Data are limited. Occurs on sheet(s): 3"
"Kc3"
"Dissected basaltic plateau--strongly rolling to hilly with some steep, broken slopes, bouldery: chief soils are dark cracking clays, principally (Ug5.13, Ug5.14, and Ug5.15). The associated soils are not known but are likely to include those recorded for unit Kc4 and, less commonly, soils of unit Ms1. Occurs on sheet(s): 3"
"Kc4"
"Dissected basaltic plateau with hills and flat-topped ridges, sometimes bouldery: gently rolling to rolling terrain of dark cracking clays, principally (Ug5.13, Ug5.14, and Ug5.15)and red-brown cracking clays (Ug5.37 and Ug5.38). Associated are (Um6.2), (Db3.12), and (Ug5.12) soils on hills, knolls, and ridges; and small areas of (Gn3.12) and (Gn2.11) soils, especially towards the boundary with unit Mo7. As mapped, areas of unit Kc3 may be included. Occurs on sheet(s): 3"
"Kc5"
"Dissected basaltic plateau with hills and flat-topped ridges, sometimes bouldery: gently rolling to rolling terrain of dark cracking clays, principally (Ug5.13, Ug5.14, Ug5.15), and red-brown cracking clays (Ug5.37 and Ug5.38), some of which may approach (Ug5.6) soils. Associated are (Um6.2), (Db3.12), and (Ug5.12) soils on hills, knolls, and ridges; unit Ms1 soils on ridges, principally the red and yellow earths (Gn2.12) and (Gn2.21), and on slopes, principally the (D) soils such as (Dr2.43); and the (D) soils of unit Ro2 on lower slopes adjacent to that unit. As mapped, areas of unit Kc3 may be included. Occurs on sheet(s): 3"
"Kc6"
"Undulating to hilly with some steep slopes, bouldery in places: chief soils are cracking clays (Ug5.13), (Ug5.15), and (Ug5.3) with red friable earths (Gn3.]2) and sometimes red earths (Gn2.1). Some variations exist between individual occurrences: this unit has similarities with units Kc4 and Mo7. Occurs on sheet(s): 3"
"Kc7"
"Very gently rolling with broad convex slopes: chief soils are dark cracking clays (Ug5.14) with strong gilgai microrelief. Associated are some (Ug5.34) soils in the depressions with (Dd3.13) soils on the banks of the gilgais. In the areas north-east of Jandowae, small areas of soils of unit X12 are included. Occurs on sheet(s): 4"
"Kc8"
"Moderately to strongly rolling with broad low convex crests and some smaller areas of concave lower slopes and bottoms; derived from shales and soft sandstones: chief soils are dark cracking clays (Ug5.14 and Ug5.13) from upper to lower slopes and showing weak gilgai microrelief. Associated are (Ug5.16) soils on upper to lower slopes, and (Dy2.33) and (Dy2.43) soils on lower slopes. Minor soil occurrences include (Gn3.43). Occurs on sheet(s): 4"
"Kc9"
"Low hills on ultrabasic rocks; smooth rounded crests and moderate slopes grading to fringing plains of pediments, fans, and colluvial slopes: chief soils are dark cracking clays (Ug5.13, Ug5.15, and Ug5.16) with (Dd1.13), (Db1.13), (Dd1.43), and (Db1.43) on the fringing plains. Associated are stony (Um6.21) soils on crests and upper slopes of hills and (Ug5.3) with (Gn3.43) in linear gilgai complexes. Minor soil occurrences are variable but include (Dr2.12), (Gn3.42), (Dd3.13), and (Gn2.1). This unit is related to units Rb2 and Kb22. Occurs on sheet(s): 4"
"Kc10"
"Dissected basalt plateau with many low stony flow scarps; residual basalt gravels from 3 to 18 in. in diameter are common on the surface and throughout the profile of all soils: dominant soils are moderately deep to deep dark cracking clays (Ug5.13), with lesser (Ug5.14, Ug5.15); some deep (Ug5.17) soils occur on the small areas of alluvium. Red and brown friable earths and shallow gravelly loams of units Mo30 and Me9 occur on the low plateau remnants and scarps. Occurs on sheet(s): 7"
"Kd1"
"Plains of slightly gilgaied (few inches) cracking clays associated with major and minor functional and non-functional drainage-ways: chief soils are dark cracking clays (Ug5.15 and Ug5.16); as mapped, small areas--"islands"--of units Kc1, Mo5, and Ob16 are included. Occurs on sheet(s): 3"
"Kd2"

"Plains as for unit Kd1 above but containing small islands of unit Ms1 and possibly some other undescribed (D) soils, such as (Dr2.33) and (Dd1.33) in transitional areas. Occurs on sheet(s): 3"
"Kd3"
"Valley plains of dark cracking clays (Ug5.15 and Ug5.16) with other undescribed soils: generally similar to unit Kd4. As mapped, soils of adjoining units are included. Occurs on sheet(s): 3"
"Kd4"
"Valley plains of dark cracking clays (Ug5.15 and Ug5.16). Associated are hillocks and valley side slopes of (Dr2) and (Dy3) soils; and soils locally peculiar to the various adjoining units. As mapped, the size of some areas of this unit tends to be exaggerated. Occurs on sheet(s): 3"
"Kd5"
"Valley plains of dark cracking clays (Ug5.15) with (Ug5.16) in the less well-drained sites, some slight gilgai development; and with minor areas of other undescribed soils. Occurs on sheet(s): 3,4"
"Kd6"
"Valley plains: chief soils are dark cracking clays (Ug5.15 and Ug5.16). Associated are areas of other soils including (Dd1.41) and (Dy2.41) on broad terraces; with narrower terraces of largely undescribed soils, but including (Um6.1) and (Uc4.2). Buried soils occur. Minor areas of adjacent mapping units are included. Occurs on sheet(s): 3,4"
"Kd7"
"Level alluvial plains adjacent to drainage lines; where the unit is adjacent to larger streams, braided channels may occur, and the area is subject to flooding: dominant soils are deep dark clays (Ug5.15 and Ug5.16) with smaller areas of grey clays (Ug5.24), other clay soils (Uf6.32 and Uf6.31), and thinsurfaced loamy duplex soils (Dd1.13). Occurs on sheet(s): 4"
"Kd8"
"Gentle or moderately undulating lands: dominant soils are mostly deep dark clays (Ug5.15 and Ug5.13) with important areas of deep red-brown clays (Ug5.38). On some high ridges shallow red soils (Gn3.12) and (Uf6.31) occur, together with small areas of dark clays (Ug5.12). Occurs on sheet(s): 4"
"Kd9"
"Plains: chief soils are dark cracking clays (Ug5.15) with small banks of (Dd1.23) and (Dd1.13) soils. Associated are some areas of (Dr3.13) soils. Occurs on sheet(s): 4"
"Kd10"
"Very gently sloping plains: chief soils are dark cracking clays (Ug5.15) with associate to codominant areas of (Ug5.16), which is common near streams. Associated are small areas of a number of soils including (Uf6.22), (Uf6.11), and (Dd1.33). Occurs on sheet(s): 4"
"Kd11"
"Upland valley floor with marginal rolling to low hilly lands with long colluvial slopes, some pediments, and knolls: chief soils are dark cracking clays (Ug5.15 and Ug5.16) on the valley floors and colluvial slopes. Associated are: (Ug5.12 and Ug5.13) soils on some pediment and hill slopes; (Dy2.43) and (Dy3.43) soils on colluvial slopes and fringes to the valley floor; (Gn3.43) and (Gn3.22) soils on higher colluvial slopes and brigalow areas; and (Um4.1) soils on crests of knolls and ridges. Minor soil occurrences include (Dd1.43) on lower slopes. Occurs on sheet(s): 4"
"Kd12"
"Undulating to rolling with long colluvial slopes and intervening plains, and with some low rises: chief soils are dark cracking clays (Ug5.15 and Ug5.16) on the colluvial slopes and plains. Associated are (Ug5.12), (Ug5.13), (Ug5.37), and (Ug5.38) soils on basalt rises that may be stony. Minor soil occurrences include (Ug5.4), (Dy3.43), (Dy2.43), and (Dd1.23). Occurs on sheet(s): 4"
"Kd13"
"Level flood-plains adjacent to major streams; small low levee terraces may occur locally and most areas are subject to inundation in high floods; braided distributary channels frequently occur: dominant soils are deep dark clays (Ug5.15 and Ug5.16) with smaller areas of grey clays (Ug5.24 and Ug5.25). Commonly associated on slightly higher sites are loamy duplex soils (Dd1.33), (Dd1.43), and (Dd1.13), together with similar (Db1) soils. Higher and better-defined terraces have uniform loams (Um1.41) and (Um5.4), clays (Uf6.32), or brown friable earths (Gn3.23). Occurs on sheet(s): 4"
"Kd14"
"Undulating or gently undulating plains: dominant soils are deep dark clays (Ug5.15 and Ug5.16), which have a prominent linear gilgai on slopes and an irregular slight (4-6 in.) microrelief on level areas. Associated drainage lines have small flood-plains with loamy-surfaced duplex soils (Dd1.33) and (Db1.33). Included in the unit, as mapped, are areas of thin-surfaced loamy duplex soils (Dd1.33) and (Dy2.33). Occurs on sheet(s): 4"
"Ke1"
"Hills, hill slopes, and valleys, remnants of tableland ridges: deep dark clays (Ug5.12, Ug5.13, Ug5.15, and Ug5.16) and some grey clays (Ug5.2) in association with hard alkaline yellow mottled soils (Dy3.43) and hard

neutral dark mottled soils (Dd2.22) on hill slopes and in valleys; with sandy yellow mottled soils (Dy5) and hard yellow mottled soils (Dy3) on hills; and with sandy yellow mottled soils containing ironstone gravel (Dy5.6) on tableland remnants. Smaller areas of (Uf5.22) and other soils (unclassified) on hills and hill slopes. Occurs on sheet(s): 1"
"Ke2"
"Hilly: moderate slopes of cracking clay soils (Ug5.1) and (Ug5.-2) and also some rounded hills of red friable porous earths (Gn4.1); undescribed soils likely also. Occurs on sheet(s): 2"
"Ke3"
"Hilly: steep to moderate, boulder strewn, hill slopes of cracking clay soils (Ug5.13), also with other cracking clay soils (Ug5.15 and Ug5.16) on some of the lower hill slopes. Occurs on sheet(s): 2"
"Ke4"
"Hilly: low rounded hills of cracking clay soils (Ug5.15 and Ug5.16) in association with hard yellow mottled soils (Dy3, including Dy3.22) and with friable dark soils (Dd3.1) on some hill crests; the soils of the narrow stream valleys are undescribed. Occurs on sheet(s): 2"
"Ke5"
"Hilly: Gentle to moderate, sometimes stony, slopes of deep dark clays (Ug5.14 and Ug5.13) with smaller areas of dark friable earths (Gn3.43) and minor areas of (Dr2.12 and Dr2.13); also steep slopes often stony, of dark clays (Ug5.12). Occurs on sheet(s): 2"
"Ke6"
"Dissected basalt ridges with narrow stream valleys: ridge tops of red friable earths (Gn3.12) and hard neutral brown soils (Db1.12 and Db1.52); slopes of dark clays (Ug5.12, Ug5.14, and Ug5.15); valley sides of dark clays (Ug5.14) and hard neutral red soils (Dr2.12); narrow valleys of deep dark clays (Ug5.16) and other undescribed soils; and occasional stony hills of (Ug5.14); some areas of (Db2.42), and (Dy3.41) and (Dy5.81) soils also. Occurs on sheet(s): 2"
"Ke7"
"Valley plains with intervening ridges: wide valley plains of dark clays (Ug5.16) with terraces of hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43) and alluvial fans of other soils (unclassified) divided by moderately steep ridges of dark clays (Ug5.12, Ug5.14, and Ug5.15) with small areas of hard neutral and alkaline red soils (Dr2.12 and Dr2.13). Occurs on sheet(s): 2"
"Ke8"
"See Kb1. Occurs on sheet(s): 2"
"Ke9"
"Dissected, stepped, plateau remnants at moderate elevation: undulating plateau tops of dark cracking clays, mainly (Ug5.13) and (Ug5.15), with very low rises of red friable earths (Gn3.12). Associated are plateau scarps and slopes of dark cracking clays, such as (Ug5.12), (Ug5.13), (Ug5.14), and (Ug5.16) with slabs of basalt; and basaltic ridges and knolls of various soils, including (Ug5.32) which may be common in the smaller areas of this unit. Occurs on sheet(s): 3"
"Ke10"
"Gently sloping plains with bouldery basalt knolls and ridges: chief soils are dark cracking clays, commonly (Ug5.15), and hard alkaline red soils (Dr2.13) with smaller areas of friable neutral red soils (Dr4.12). Associated are low hilly to hilly areas of unit Kb2; and small areas of unit Kd3 in valleys. Occurs on sheet(s): 3"
"Ke11"
"Dissected basaltic plateau--gently to moderately undulating country: chief soils on the undulating country are dark cracking clays (Ug5.15), (Ug5.16), (Ug5.13), (Ug5.14) and, less commonly, brown cracking clays (Ug5.3). Associated are: on the undulating areas, hard alkaline red soils (Dr2.13) and occasionally other (D) soils; inter-stream ridges of unit Kb2 with the shallow porous loamy soils (Um6) often very prominent; and smaller areas of unit Kd3 soils along the valleys. As mapped, minor areas of units Mo1 and Ms1 are included. This unit is similar to unit Ke10. Occurs on sheet(s): 3"
"Ke12"
"Undulating with shallow valleys: chief soils are dark cracking clays (Ug5.15), (Ug5.16), (Ug5.13), (Ug5.12), and (Ug5.14). Associated are small areas of other cracking clays, such as (Ug5.3), (Ug5.2), and (Ug5.5); dark friable earths (Gn3.42); and minor areas of all the soils common to unit Oc10. As mapped, small areas of unit LK1 are included. Occurs on sheet(s): 3"
"Ke13"
"Dissected basaltic plateau--generally undulating to hilly: chief soils are various dark cracking clays (Ug5.12, Ug5.13, Ug5.14, Ug5.15, and Ug5.16). Associated are: hilly areas with soils similar to those of unit JJ6; basaltic knolls and ridges of parts (i) and (ii) of unit Rh4; and occasionally (Gn2.11) soils on low bauxitized residuals. Occurs on sheet(s): 3"
"Ke14"

"Hilly--residual basaltic ridges and their slopes: chief soils are cracking clays (Ug5.1) with (Ug5.15 and Ug5.16) in the valleys and on their side slopes, (Ug5.12 and Ug5.13) on slopes flanking the ridges, on which (Db3.12) and/or (Dr4.12) and/or (Um6.2) soils occur. Associated are some areas of red earths (Gn2.14), and granitic tors with (Dy5), (Dy3), and other soils close by. Occurs on sheet(s): 3"
"Ke15"
"Flat to gently undulating plateau remnants: chief soils are dark cracking clays (Ug5.1), generally as follows: upper slopes of hard acidic brown soils (Db1.11) with ironstone gravel and boulders; mid slopes of (Ug5.12 and Ug5.13) with ironstone boulders; and lower slopes and valleys of (Ug5.15 and Ug5.16). Data are limited. Occurs on sheet(s): 3"
"Ke16"
"Hilly with long concave stepped slopes; some basaltic knolls and ridges: chief soils on the slopes are dark cracking clays (Ug5.16 and/or Ug5.14) in the gilgai depressions and brown cracking clays (Ug5.35) on the gilgai mounds. Associated are gilgai complexes of (Ug5.15) and (Ug5.25) with (Dd2.42) (Dd2.43), and (Dy3.43) soils on slopes; some (Dr2.22) soils occur on platforms within this complex. Also occurring are: (Ug5.12 and Ug5.13) soils with (Um6.21) soils on and around basaltic knolls and ridges; small areas of (Gn2.16) soils on platforms with the (Ug5.16) soils on the slopes; and small areas of (Ug5.28) in complex with (Dd2.33) soils in lower-lying situations. Occurs on sheet(s): 4"
"Ke17"
"Undulating to rolling lands on soft basic metasediments--long gentle slopes; occasional rock outcrops: chief soils are dark cracking clays (Ug5.15, Ug5.12, Ug5.13, and Ug5.14). Associated are: (Ug5.38), (Ug5.37),and (Ug5.4)soils; (Gn3.11)soils; (Gn2.11)soils; and a range of (D) soils including (Dy3.43), (Dr2.42), and (Db1.42). Occurs on sheet(s): 4"
"Ke18"
"Low hills with small to moderate areas of alluvial plains: chief soils are dark clays (Ug5.13 and Ug5.14) on the slopes and (Ug5.15) on the plains. Associated are (Uf6.31) and (Gn3.12) soils on the upper and often steeper slopes. Other soils are likely, including (Db1.13) and (Db2.33) on the plains. Occurs on sheet(s): 4"
"Ke19"
"Gently to broadly undulating plains interrupted by some stony ridges, basalt flow scarps, broad low hill crests, or occasional low conical hills: dominant soils are shallow to moderately deep dark grey or dark brown cracking clays (Ug5.12), with lesser (Ug5.13 and Ug5.14). Linear gilgai often occurs on slopes. Also occurring are areas of dark red or red-brown clays (Ug5.37, Ug5.38, and Ug5.32) usually on higher landscape sites. In lower areas small level plains occur, often as narrow flood-plains adjacent to streams. The soils are deep dark clays (Ug5.15 and Ug5.16) with smaller areas of (Uf6.32 and Uf6.31). On higher stony ridges shallow clay soils (Uf6.31), (Uf6.32), and (Ug5.12) occur. Locally there may be small areas of highly calcareous clays (Ug5.11). Occurs on sheet(s): 4"
"Kf1"
"River flood-plains: relatively narrow fair to poorly drained flat areas of dark cracking clays (Ug5.16) with some weak gilgai microrelief. Associated are lower hill slopes and alluvial cones of dark cracking clays (Ug5.14) with linear gilgai; terraces of dark porous loamy soils (Um6.11) along some streams; some lower hill slopes and/or benches of (Gn4.11 and Gn4.31) and/or (Gn2.1) soils; sandy knolls or foot-slope deposits of (Uc1.2) and/or (Uc2.2 and Uc2.3) soils; and occasional foot-slope occurrences of (Dy5.4, Dy5.6, or Dy5.8) soils. Buried soil layers occur. As mapped, small areas of adjoining units are included. Occurs on sheet(s): 3"
"Kf2"
"Plain with a few low banks separated by flats and ill-defined depressions: chief soils are dark cracking clays (Ug5.16). Minor occurrences are of (Ug5.15) soils; and (Dd1.33) and (Dd1.43) soils on banks and very low sandy rises. Occurs on sheet(s): 4"
"Kf3"
"Plain with very low sandy rises and banks separated by flats and depressions: chief soils are dark cracking clays (Ug5.16). Associated are (Dd1.33) and (Dd1.43) soils on the low rises and banks. Minor areas of (Ug5.15) soils may occur. Occurs on sheet(s): 4"
"Kf4"
"River terraces and adjoining plains: chief soils are dark cracking clays (Ug5.16) both on the terraces and on adjoining plains. Associated are (Ug5.15) soils on the plains east of the river channels and (Dd1.33) soils on low banks on the plains west of the river channels. These low banks are often continuous with areas of unit Kf3. Occurs on sheet(s): 4"
"Kf5"
"Valley plains with numerous channels: chief soils are dark clays (Ug5.16) on the more level situations. There is some slight gilgai microrelief. Minor soils include various (Uc1), (Um1), and (Uf1) soils in the channels; (Dy3.33) on rises in the plain; and (Dy2.43) on terraces. Occurs on sheet(s): 4"
"Kf6"

"Level alluvial plains associated with major streams; often dissected by distributary channels and old stream lines; much of the area is subject to severe flooding: dominant soils are deep dark clays (Ug5.16 and Ug5.15), with lesser (Ug5.24) and (Ug5.34). Levees associated with former channels have uniform loams (Um5.4 and Um5.5), or sands (Uc5.11). Limited areas of loamy duplex soils (Dd1.13) or friable earths (Gn3.23) and (Gn3.43) also occur. Occurs on sheet(s): 4"
"Kf7"
"Gently sloping plains with ill-defined drainage lines: chief soils are deep dark cracking clays (Ug5.16) with both crab-hole and swamp-hummock microrelief. Minor soil occurrences are: (Ug5.2) in some wetter localities; (Dd1.41), (Gn3.04), (Dy2.43), (Dy2.42), and (Dy5.42) on included fans and their margins; (Um2.12) and (Dy3.41) on truncated metamorphic hills; and (Uc2.12) on emergent trachyte plugs. Occurs on sheet(s): 4"
"Kf8"
"Very gently sloping depositional plain with some seasonally swampy low sites: chief soils are deep dark cracking clays (Ug5.16) and also grey forms (Ug5.24), both showing slight gilgai formation. Associated are: (Dd1.13) and (Dd1.43) with (Ug5.4) soils in linear gilgai complex; and (Ug5.15) with (Dy3.43) and (Dy2.43) soils with some linear gilgai on slightly higher fan areas. Minor soils include (Dr2.12) on crests and slopes of included stony rises. Occurs on sheet(s): 4"
"Kf9"
"Low-lying, poorly drained flats with some gilgais: chief soils are black and grey cracking clays (Ug5.16) and (Ug5.2). Associated are a variety of other soils including (Uf6.41) and (Dd3.42). Occurs on sheet(s): 5"
"Kf10"
"Swale formations behind the coastal dunes and made up of old estuarine materials: chief soils are probably black and grey cracking clays (Ug5.16) and (Ug5.2) but there are a variety of other soils, including (Uf) (Um), (Uc), and acid (O) soils. A single chain of dunes of unit A13 fronts the coast. Occurs on sheet(s): 5"
"Kf11"
"Alluvial plains with low levees and braided distributary channels: dominant soils are deep dark cracking clays (Ug5.16, Ug5.15), with smaller areas of grey clays (Ug5.24, Ug5.25). Commonly associated on slightly higher areas are loamy duplex soils (Dd2.33) and (Dd2.43), with (Dd1), (Dy2), and (Dr2) equivalents. Loamy earths (Gn2.14), (Gn2.15), and (Gn2.44) occur on the low terraces. Some shallow dark or grey clays (Ug5.14), (Ug5.13), or (Ug5.22) occur where the clays have been deposited on very recent basalt flows. Occurs on sheet(s): 7"
"Kf12"
"Level swampy plain that occasionally may be flooded: dominant soils are deep, slightly gilgaied, dark cracking clays (Ug5.16). Associated marginally are dark loamy or silty duplex soils (Dd1.11), and occasionally mottled yellow-grey duplex soils (Dy3.41, Dy3.43). Occurs on sheet(s): 7"
"Kf13"
"Level plains: dominant soils are deep dark cracking clays (Ug5.16), with lesser grey clays (Ug5.24, Ug5.29). A slight (6 12 in.) gilgai microrelief is often present; where it is more pronounced, the clays occur on the puffs, and in the depressions are loamy grey duplex soils (Dy3.43), (Dy2.43), (Dy3.33), and (Dy2.33), with lesser similar (Dd1) soils. Occurs on sheet(s): 7"
"Kg1"
"Lakeside plains: saline dark clays (Ug5.17) below which buried soil materials occur at shallow depths. Includes also small areas of soils common to adjacent soil areas (map units). Occurs on sheet(s): 1"
"Kh1"
"Plains along major and minor functional streams: chief soils are dark cracking clays (Ug5.16) and hard alkaline dark soils (Dd1.33 and Dd1.43) often occurring together as soil complexes, and showing weak (few inches) gilgai features. There is a general similarity with unit Kh2. Occurs on sheet(s): 3"
"Kh2"
"Flat to gently undulating plains showing slight (few inches) gilgai features: chief soils are dark cracking clays (Ug5.16) and hard alkaline dark soils (Dd1.33 and Dd1.43) often occurring together as soil complexes. Associated are cracking grey and brown clays (Ug5.2 and Ug5.3); and various (D) soils, such as (Db1.33 and Db1.43). Some deep subsoil and/or D horizon layers may be strongly acid. Occurs on sheet(s): 3"
"Kh3"
"Valley plains of dark cracking clays (Ug5.16) and various alkaline (D) soils, such as (Db1.33), (Dy2.33), and (Dd1.33). Occurs on sheet(s): 3"
"LK1"
"Hilly to steep hilly terrain with some very rugged portions, cliffs, ridges, or steep domes, rock outcrops common: chief soils are shallow loamy soils (Um4.1), (Um4.2), and (Um6), shallow sand soils (Uc4.1), and shallow clay soils (Uf). Associated are small areas of a wide range of soils including (Ug5.12), (Ug5.3), (Gn3.42), (Db3.12), (Dr2), (Dy), and (Gn2.1) soils. As mapped, small flat to undulating areas of unit Ke12 are included. Occurs on sheet(s): 3"
"LK2"

"Mountainous--ravine country generally extending eastwards as rugged ridges and spurs with many bare rock walls: chief soils are shallow loamy soils having an A, horizon (Um4.1 and Um4.2) and areas of red friable earths (Gn3.14) and hard acidic red soils (Dr2.21). As mapped, this unit includes areas of unit Mj4, particularly adjacent to the wetter portions of the plateau scarp where small areas of unit Mj6 may occur also; units Rh3 and Mg23 on small plateau remnants; and possibly areas of (Gn2.14) soils. Data are limited. Occurs on sheet(s): 3"
"LK3"
"Mountainous--very rugged to steep areas with rock outcrops and sometimes bare rock walls: shallow loamy soils having an A, horizon (Um4.1 and Um4.2) with shallow forms of many (D) soils, such as (Dy3.21), (Dy3.41), and (Dr2.21). As mapped, some areas of units Ub59 and Ub54 are included, and also minor areas of units Kc6 and Rh8. Occurs on sheet(s): 3"
"LK4"
"Hilly to steep hilly, some cliffs and scarps, rock outcrops: chief soils seem to be shallow loamy soils having an A2 horizon (Um4.1) in association with the (D) soils of unit Ub52. As mapped, areas of unit Ub52 are included. Data are limited. Occurs on sheet(s): 3"
"LK5"
"Undulating to low hilly areas, often with waterworn gravels throughout the soil: loamy soils having an A2 horizon (Um4.1 and Um4.2) often gravelly throughout. Associated are gravelly forms of (Dr), (Dy), and (Gn2) soils. Occurs on sheet(s): 3"
"LK6"
"Hilly to steep hilly areas, often with waterworn gravels through the soil: similar to unit LK5 but soils may be shallower. Occurs on sheet(s): 3"
"LK7"
"Steep hilly to mountainous land on fine-grained sandstones and shales--strongly dissected peaks with narrow crests and long steep side slopes: chief soils are shallow loamy soils having an A2 horizon (Um4.1). Associated are shallow gravelly (Um2.12) and (Uc2.12) soils on crests and slopes and (Gn3.54) soils on lower slopes and colluvial aprons. Other soils include (Um4.2) on steep slopes, (Gn2.64) in creek flats, and (Dr5.41) and (Dr3.41) on moderate slopes. Occurs on sheet(s): 4"
"LK8"
"Mountainous country of volcanic rocks and boulder-beds with steep to very steep slopes, scarps, and rock outcrops: chief soils are shallow loamy soils (Um4.1) having an A2 horizon and dark porous loamy soils (Um6.21). Associated are (Uf6.32) and (Gn3.14) soils on the more moderate slopes and crests. Other soils include (Db1.12), (Dd3.12), and (Gn3.42) on volcanic rocks and (Uc2.12) and (Dy3.41) on included sedimentary rocks. Occurs on sheet(s): 4"
"LK9"
"Mountainous land on metasediments with steep hilly foothills--narrow ridge crests and peaks, narrow valleys, some rock outcrops: chief soils are shallow loamy soils having an A2 horizon (Um4.1). Associated are (Gn3.42) soils on andesites and serpentine. Other soils include: (Um2.12), (Dy3.41), and (Dr3.41) on shales; (Db1.12) and (Gn3.12) on andesites; and (Dy3.41) on granites. Occurs on sheet(s): 4"
"LK10"
"Rugged steep hilly to mountainous country on basic, and some acidic, rocks: chief soils are shallow stony loams (Um4.1) on the basic rocks. Associated are (Dy3.42), (Dy3.43), (Dy2.41), (Dr2.41), (Um2.12), and (Uc4.1) soils on acid rocks. Minor soil occurrences include (Dd1.13), hill slopes of (Ug5.12), and plateau remnants with (Gn2.11). Occurs on sheet(s): 4"
"LK11"
"Steeply dissected hilly to mountainous land on siliceous rocks: chief soils are shallow stony loams (Um4.1) and leached loams (Um2.12). Associated are (Dy3.42 and Dy3.43) and (Dr2.42 and Dr2.43) soils on lower slopes, and gravelly (Uc2.12) soils on crests. Occurs on sheet(s): 4"
"LK12"
"Moderately hilly lands on metasediments--narrow but undulating ridge crests with moderate to steep side slopes to the streams: chief soils are shallow loamy soils (Um4.1) and leached loams (Um2.12), often very gravelly, but quite organic in the immediate surface. Associated are: a range of (D) soils such as (Dr2.21), (Db1.41), (Dy5.31), (Dy3.41), and (Dy4.11); and (Gn) soils such as (Gn3.91), (Gn3.21), and (Gn3.42). Together the various (D) and (Gn) soils are probably of greater area than the (Um) soils. Occurs on sheet(s): 4"
"LK13"
"Hilly to mountainous terrain: chief soils seem to be shallow loams (Um4.1) and (Um4.2), probably with other loamy soils (Um6.21), (Um2.12), and (Um1.43). Other soil occurrences include (Gn2.1), (Dr2.22), (Db1.4), (Dy3.12), (Dy2.12), (Dy3.4), (Dy2.4), and (Ug5) soils as for unit Kb17 in areas of gentler relief. Data are inadequate. Occurs on sheet(s): 4"
"LK14"

"Strongly dissected hilly lands with short steep slopes; rock outcrop is common: dominant soils are shallow stony clay loams (Um4.1), with lesser areas of (Um1.43) and (Um3.12). Other soils occurring are stony fairly shallow duplex soils (Dr3.43), (Dr3.42), (Dr2.41), (Dr2.42), and (Dy2.43), the last being most common on flatter slopes. Small densely vegetated areas have gravelly earths (Gn2.14), (Gn3.41), and (Gn2.81), friable earths (Gn3.43) and (Gn3.13), or uniform clays (Uf6.31). Occurs on sheet(s): 4"
"LK15"
"Strongly dissected hilly lands with short steep slopes; rock outcrop is frequent: dominant soils are shallow stony loams (Um4.1), but on lower slopes duplex soils are common, chiefly (Dr2.22), (Dr2.12), (Dy2.22), and (Dy2.32). Included in the unit, as mapped, are some (Uc4.2) soils of unit JK3. Data are limited. Occurs on sheet(s): 4"
"LK16"
"Steep-sided low stony linear hills and high ridges with much sandstone outcrop: dominant soils are shallow very stony loams (Um4.1), (Um1.43), and (Um2.12), with associated similar (Uc4.11), (Uc2.12), and (Uc1.21) soils. On lower slopes stony duplex soils occur, chiefly (Dy2.42), (Dr2.42), and (Dy3.42). The hills and ridges often have a parallel orientation and the intervening valleys have loamy or sandy duplex soils (Dy3.43), (Db1.33), and (Dy2.43). Some more extensive mesa-like hills have shallow loamy red earths (Gn2.12) or loamy yellow earths (Gn2.22). The unit is very similar in topographic form to unit Bz8. Occurs on sheet(s): 4"
"LK17"
"High stony hills, often with precipitous scarps; massive acid volcanic rock outcrop is common: dominant soils are shallow stony loams (Um4.1) with lesser (Um2.12). On lower slopes shallow stony duplex soils occur, chiefly (Dy3.42), (Dy2.43), and (Dr2.12). Data are limited. Occurs on sheet(s): 4"
"LK18"
"Low hilly to hilly lands with strongly undulating marginal slopes; rock outcrop is common: dominant soils are shallow stony loams (Um4.1), with (Um1.43) and (Um1.41) commonly associated. Less common are leached loams (Um2.12) or shallow sands (Uc4.2). On lower slopes shallow stony duplex soils occur, chiefly (Dy2.42), (Dy3.42), and (Dr2.12). Included in the unit, as mapped, are small areas of red and yellow earths (Gn2.12 and Gn2.22). Data are fairly limited. Occurs on sheet(s): 4"
"LK19"
"Strongly undulating or low hilly lands with smooth rounded ridges and hill crests: dominant soils of the higher landscape sites are shallow stony loams (Um4.1) and (Um1.43). On lower slopes and valley floors loamy duplex soils occur, chiefly (Dy2.43), (Dy2.42), (Dr2.42), and (Dr2.33), less commonly (Dr2.12). Occurs on sheet(s): 4"
"LK20"
"Mountainous to steep hilly lands with steep scarps, some mesaand cuesta-like areas; very narrow valleys; rock outcrop is common: chief soils seem to be shallow stony loams (Um4.1), (Um4.2), (Um1.4), and (Um2.12), with (Uc1.2) and (Uc2.12) soils. Associated are pockets of many other soils, such as (Dy3.41), (Dy3.42), (Dr3.41), (Dr2.12), (Dy2.33), (Dr2.33), (Dy3.43), (Ug5.1), and (Ug5.2). Occurs on sheet(s): 4"
"LK21"
"Ranges of granites and granodiorites with some bare rock walls: chief soils on the steeper slopes seem to be shallow loamy soils (Um4.1), some with quite dark crumbly organic surface horizons. Associated are a variety of soils including acid red earths (Gn2.14) in colluvial pockets on the slopes (karri areas), where some (Dr4.22) and (Db3.22) soils are present; also areas of (Dy5.41) soils on the lower to mid slopes of the range; and areas of undescribed soils in other topographic positions. Occurs on sheet(s): 5"
"LK22"
"Hilly to steep hilly ranges and strike ridges mainly on greywacke, siltstones,and some sandstones; a surface stone cover is common; rock outcrops are frequent chief soils of the hill slopes are shallow stony and gravelly loams (Um4.1), (Um1.4), and sand (Uc4.1) and (Uc2.12). Associated are variable areas of stony and gravelly (D) soils such as (Dr2.21), (K-Dy2.21), and (Dr2.51). Other soils include yellow earths such as (Gn2.24), (Gn2.34), and (Gn2.74), and red earths such as (Gn2.1) on dolerite sills and andesites. Occurs on sheet(s): 8"
"LK23"
"Similar to unit LK22 but interspersed with areas as for unit Tb134 and occasionally small valley plains as for unit Va73. Occurs on sheet(s): 8"
"LK24"
"Dissected scarps with narrow moderate to steep-sided valleys: chief soils seem lo be shallow stony and~or gravelly loams such as (Um4.1) and (Um1.4) on the upper slopes generally and often associated with block laterite and exposures of mottled-zone materials. Other soils include (Dy3.82) and (Dy3.42) usually containing ironstone gravels and occurring on lower slopes generally. As mapped, areas of the adjoining units may be included. Occurs on sheet(s): 8"
"LK25"
"Low hilly to hilly lands with some strongly dissected outwash slopes: dominant soils are shallow stony loams (Um4.12); the chief associates are similar (Um4.21) soils and loamy red earths (Gn2.14). Sandy-surfaced duplex

soils (Dy3.43), (Dy3.33), (Dr2.13), and (Dy3.2) are common on the lower slopes and outwash fans. Data are limited. Occurs on sheet(s): 7"
"LK26"
"Low hilly lands with short steep slopes and much rock outcrop: dominant soils are very shallow gravelly loams (Um4.12), with lesser (Um4.23) and (Uc4) equivalents. Associated soils are those described in unit Va83. Occurs on sheet(s): 7"
"LK27"
"Strongly undulating to low hilly lands, often closely dissected by many small streams: dominant soils of higher landscape sites are shallow stony loams (Um4.1), with (Um4.21) and similar bleached loams (Um2.12) and (Um2.21) closely associated and locally dominant. Occasional shallow bleached sandy loams (Uc2.12) may also occur. On more gentle slopes and valley floors fairly shallow and usually gravelly loamy duplex soils are common, chiefly (Dy2.43), (Dy3.43), (Dy3.33), and (Dr2.43). Occurs on sheet(s): 7"
"LK28"
"Hilly to low hilly lands, usually with rounded hill crests and fairly short steep slopes: dominant soils are probably shallow stony loams (Um4.12), but similar sandy loams (Uc4.12) are also common. Other shallow loams and sands also probably occur. On lesser slopes small areas of shallow gravelly yellow duplex soils (Dy2.21), (Dy2.22), and (Dy2.81) occur, with some similar (Dr2) soils. In parts of the unit on more basic rocks, there are small areas of shallow to moderately deep red friable earths (Gn3.12, Gn3.11). Data are very limited. Occurs on sheet(s): 7"
"LK29"
"Hilly or high hilly linear ranges with very steep slopes and much rock outcrop: dominant and associated soils are probably the same as unit LK28. Data are extremely limited. Occurs on sheet(s): 7"
"LL1"
"Hills and plains--multicyclic erosional landscape of hills and hillocky areas with intervening plain-like areas, the whole traversed and dissected by variously incised stream valleys--some layering of soil materials: (i) relatively higher hills and ranges of loamy soils having an A2 horizon (Um4.2) and yellow-brown earths (Gn2.44) with (Um5.41 and Um5.51), many stones, and rock outcrops; gullies of (Dr2) and (Dy3.32 and Dy3.42) soils; (ii) relatively lower hills and hillocky areas of hard acidic red soils (Dr2.21) and (Uc6.11), (Um) soils and rock outcrops with (Dy3.4) soils on lower slopes and (Dy3.43) in depressions; (iii) undulating plain-like areas with slopes and benches of red and yellow earths including (Gn2.14, Gn2.15, and Gn2.24); (iv) stream valleys of (Um6.11), some with clay D horizons and other (Uc) and (Um) soils; (v) also remains of various soil materials such as ironstone boulders in various situations. Soil dominance is difficult to assess: the most common soils are likely to be the. Occurs on sheet(s): 2,3"
"LL2"
"Ridge and valley complex, steep to very steep ridges with narrow crests, rock outcrops, undulating to hilly valleys: chief soils are loamy soils having an A2 horizon (Um4.2) and yellow earths (Gn2.44) and/or (Gn2.24). Associated are various (D) soils including (Dy3.42), (Dy3.41), (Dr2.22), and (Db1.42); minor areas of other soils such as (Ug5.1) are likely. As mapped, areas similar to unit LL4 and to a lesser extent unit Mf4 are included along the eastern limits of this unit, especially in the head valleys of the major streams. Occurs on sheet(s): 3"
"LL3"
"Ridge and valley complex, some rock outcrops: steep to very steep hill slopes of loamy soils having an A2 horizon (Um4.2) and yellow earths (Gn2.24 and/or Gn2.44). Associated are (Dy2.21), (Dy3.21), (Dy3.41), (Dr2.21), and (Dr3.41) soils on side slopes; colluvial hill-slope mantles or terraces of (Dr4.21), (Gn3.14), or (Gn4.14) soils. The narrow terraced stream valleys are of variable development, levee soils are chiefly dark porous loamy soils (Um6.11) and other loamy soils (Um5.2), sometimes with sand D horizons; denser (undescribed) soils may occur on levee back slopes. Note that the total aggregate of (D) soils may be dominant in some areas. Occurs on sheet(s): 3"
"LL4"
"Ridge and valley complex, rock outcrops common: very steep to rugged hill slopes of loamy soils having an A2 horizon (Um4.2) and yellow earths (Gn2.24 and/or Gn2.44) with (Dy2.21), (Dy3.21), (Dy3.41), (Dr2.21), (Dr3.41), and (Db1.21) soils on side slopes. Stream valleys are narrow and deeply incised. As mapped, small areas of units Ta7, LL3, and Mj5 are included. Occurs on sheet(s): 3"
"LL5"
"Steep to very steep hill slopes: chief soils are loamy soils having an A2 horizon (Um4.2) and/or dark shallow porous loamy soils (Um6.21). Associated are various acid (Dy), (Db), and (Dr) soils and some deeply mantled colluvial slopes of various soils, including (Gn2.14). Data are limited. Occurs on sheet(s): 3"
"LL6"
"Mountainous: steep slopes of loamy soils with an A2 horizon (Um4.2), yellow-brown earths (Gn2.44), and rock outcrops. Associated are: many other shallow (Uc) and (Um) soils; red and yellow friable earths such as (Gn3.14) and (Gn3.74); hard acidic red soils (Dr2.21) and hard acidic yellow mottled soils (Dy3.21) in the drier situations; and narrow stream valleys with undescribed soils. Occurs on sheet(s): 3,4"

"LL7"
"Alluvial stream flood-plains often with old stream channels and sandy levees: dominant soils are uniform loams of variable depth (Um4.2) which may be stratified or have D horizons of older soils. Associated are similar earthy soils (Um5.5), or soils with a bleached horizon overlying an earthy pan (Um2.32). Old sandy levees have uniform sands (Uc5.11) or sandy loams (Uc5.21). In depressed areas loamy duplex soils (Dy2.43) occur. Data are fairly limited. Occurs on sheet(s): 4"
"LL8"
"Low hilly to hilly lands with much schistose rock outcrop; crests are usually rounded: dominant soils are very shallow stony loams, chiefly (Um4.21) with lesser (Um4.1). Occasional areas of shallow stony sands (Uc4.2) also occur. On some slopes loamy red duplex soils with extremely quartz-gravelly A horizons (Dr2.12) and (Dr2.22) are common, while on small basic intrusions are red friable earths (Gn3.12) of unit Mo29. Occurs on sheet(s): 7"
"LL9"
"Moderately to strongly undulating lands: the dominant and associate soils are as for unit LL8. Occurs on sheet(s): 7"
"LL10"
"Dissected lateritic plateaux. The greater part of the unit is made up of steep rocky scarp slopes with lesser flat mesa remnants and rounded valley floors: dominant soils are those of the scarps; shallow gravelly loams (Um4.21) are probably most common but other (Um4), (Um5), and (Um1) soils also occur. Shallow sands (Uc4.22), (Uc4.12), and (Uc2.12) may also occur. Loamy red and yellow earths (Gn2.11, Gn2.14) and (Gn2.24) occur on the mesas and a range of loamy duplex soils occurs in the valley floors. Data are very limited. Occurs on sheet(s): 7"
"LL11"
"Level alluvial plains cut by numerous old meander channels and small gullies: dominant soils of the floodplains are deep brown or red-brown uniform silty loams (Um4.21). Loamy duplex soils (Dy3.43), (Dy3.33), (Db1.33), (Db1.23), and (Dd1.23), with moderate to deep (8-15 in.) A horizons, are common on the back slope of the flood-plains. Loamy red earths (Gn2.14), occasionally red friable earths (Gn3.14), and deep uniform sands (Uc5.21) occur on stream levees. Occurs on sheet(s): 7"
"LL12"
"Hilly to high hilly lands with very steep slopes, narrow ridge crests, and much intermediate to acid volcanic rock outcrop: dominant soils are shallow gravelly loams (Um4.21), with similar (Um4.1) and (Um5.51) soils closely associated. Loamy duplex soils, chiefly (Dy2.32), (Dy3.32), (Dy3.22), (Dy3.42), (Dy3.41), and (Db2.32) are common on the undulating foot slopes and included areas of unit Sh1. Loamy red duplex soils (Dr2.22) and loamy red friable earths (Gn3.14) occur on basic rock intrusions. Shallow stony sands (Uc4.12) occur on some of the steeper slopes and ridge crests. Occurs on sheet(s): 7"
"LL13"
"Moderately undulating lands with fairly short steep slopes to the drainage lines; small areas of strongly undulating and low hilly lands are also included. All sedentary soils are shallow and rock outcrop is common on higher slopes: dominant soils are gravelly loams (Um4.21), with lesser (Um2.12). A range of loamy duplex soils is associated, chiefly (Dy3.42), (Dr3.32), (Dr3.42), (Dr3.31), and (Dr2.21); these may be locally dominant on areas of lesser relief. Moderately deep to deep loamy earths (Gn2.25), (Gn2.65), and (Gn2.12) occur on gently sloping outwash fans. Occurs on sheet(s): 7"
"LL14"
"Low hilly to hilly lands with some steep scarps: dominant soils are shallow gravelly loams (Um4.21). Associated soils are the range of red and yellow loamy duplex soils described in unit Qb35. Occurs on sheet(s): 7"
"LL15"
"Low hilly lands with some very steep limestone hills and intervening elongate undulating valleys: dominant soils of the rounded hills are shallow stony loams and sandy loams; (Um4.21) is probably most common but (Um4.1), (Um2.12), (Um2.21), (Uc2.12), and (Uc4.12) also commonly occur. On gentler slopes gravelly loamy duplex soils (Dy2.43), (Dr2.43), and (Dr2.12) are common. The valley floors may have small areas of red earths of unit My97. The steep limestone hills are mostly bare rock with small areas of shallow red loams (Um5.51). Occurs on sheet(s): 7"
"LL16"
"Hilly to high hilly linear ranges with some narrow intervening valleys: dominant soils are shallow stony loams; (Um4.21) is probably most common but (Um4.1) and (Um2.12) also occur widely; rock outcrop is common. Smaller areas of shallow sandy loams (Uc4.12) and (Uc2.12) also occur. The intervening undulating valleys have loamy red duplex soils of unit Pa3. In parts of the unit there are steep limestone hills with much bare rock outcrop and only small areas of shallow loams (Um5.51). Occurs on sheet(s): 7"
"LL17"
"Dissected siltstone mesas with low steep-scarped margins: dominant soils are shallow stony loams (Um4.21). On some level surfaces there are areas of nodular loamy red earths (Gn2.11, Gn2.14). Data are limited. Occurs on sheet(s): 7"

"LM1"
"River terraces and levees: chief soils are loamy soils having an A2 horizon and red pedal subsoils (Um4.31), and yellow-brown earths (Gn2.43) with a general pattern as follows: younger terraces and levees of (Um4.31), (Um6.12), (Um6.11), and (Uf6.3) soils; older terraces and levee slopes of (Gn2.43), (Dr2.42), (Dr2.63), and smaller areas of (Gn2.8) soils. Associated are sand-ridge formations of (Uc1.2), and (Dy2.43) in areas of restricted surface drainage. As mapped, slopes of adjoining hilly country may be included. Occurs on sheet(s): 3"
"LN1"
"Elevated low hilly plateaux which may have steep-scarped margins; areas of lesser or stronger relief also occur on the plateau surfaces: dominant soils are moderately deep to deep yellowish red or yellow friable loams (Um4.43); red friable loams (Um4.41) are also common and in some areas are locally dominant. Similar loamy soils (Um6.33, Um6.34, and Um6.32) are the chief associates in the southern part of the unit, while in the northern extremities uniform friable clays (Uf4.43 and Uf4.41) become increasingly common. A range of moderately deep to deep friable earths (Gn3.74), (Gn3.71), (Gn3.54), (Gn3.14), and (Gn3.11) occur throughout the unit and are more common on the drier western slopes where the unit adjoins unit Mf17. Occurs on sheet(s): 7"
"LN2"
"High hills and mountains and the steep-scarped margins of unit LN1; slopes are very steep with much rock outcrop; most soils are shallow and very gravelly: dominant are friable loams (Um4.41) with lesser (Um4.43). Chief associated soils are a range of friable earths (Gn3.14), (Gn3.11), (Gn3.54), (Gn3.71), and (Gn3.74), with lesser loamy earths (Gn2.14), (Gn2.44), and (Gn2.74). Shallow gravelly loams (Um4.12, Um4.11) are common on very steep slopes with much rock outcrop. Included in the unit, particularly along the eastern margins, are small areas of deep friable loams (Um6.34, Um6.33) of unit Gh1. Occurs on sheet(s): 7"
"La1"
"Plain with tracts of dunes: plains of dark highly calcareous loamy earths (Gc1.11) with shallow forms of hard alkaline red soils (Dr2.23) and small areas of cracking brown clays (Ug5.3) interspersed with dune tracts of brown calcareous earths (Gc1.21) and brown sands (Uc5.11). Occurs on sheet(s): 1"
"Lb1"
"Plains: grey-brown highly calcareous loamy earths (Gc1.12) in association with crusty loamy soils (Dr1.33 and Dr1.43) or their eroded remnants. Occurs on sheet(s): 1"
"Lb2"
"Undulating to hilly with some tracts of dunes: grey-brown highly calcareous loamy earths (Gc1.12) in association with shallow calcareous loamy soils (Um5.11); dunes of brown sands (Uc5.1) and small areas of saline soils (unclassified). Occurs on sheet(s): 1"
"Lb3"
"Undulating: grey-brown highly calcareous loamy earths (Gc1.12) in association with red shallow porous loamy soils (Um6.24). Occurs on sheet(s): 1"
"Lb4"
"Undulating plains with dune formations: plains of grey-brown highly calcareous loamy earths (Gc1.12), exposed sheet limestone, coherent sandy soils (Uc6.11, Uc6.13), and other sandy soils including (Uc2.11) and (Uc4.11), smaller areas of shallow hard alkaline red soils (Dr2.33) and sandy alkaline yellow mottled soils (Dy5.4 and Dy5.8); dunes of brown calcareous earths (Gc1) and leached sands (Uc2.21). Occurs on sheet(s): 1"
"Lb5"
"Plains and dunes: grey-brown highly calcareous loamy earths (Gc1.12) in association with sandy alkaline yellow mottled soils (Dy5.83); dunes of brown sands (Uc5.1). Other soils include (Dy4.83). Occurs on sheet(s): 1"
"Lb6"
"Hills and valleys: hills and hill slopes of grey-brown highly calcareous loamy soils (Gc1.12) with shallow calcareous loamy soils (Um5.11) and brown shallow porous loamy soils (Um6.23) and rock outcrops, traversed by valleys and valley plains of hard alkaline red soils (Dr2.23 and Dr2.33). Occurs on sheet(s): 1"
"Lb7"
"Undulating with small valleys: grey-brown highly calcareous loamy soils (Gc1.12) with hard alkaline red soils (Dr2.23 and Dr2.33) in the small valleys. Occurs on sheet(s): 1"
"Lb8"
"Plains with tracts of east-west dunes: plains of grey-brown highly calcareous loamy soils (Gc1.12) in association with hard alkaline red soils (Dr2.33) and cracking grey and brown clays (Ug5.2 and Ug5.3); dunes of brown calcareous earths (Gc1) and brown sands (Uc5.1). Incomplete data. Occurs on sheet(s): 1"
"Lb9"
"Plains with low or mound dunes: plains of grey-brown highly calcareous loamy soils (Gc1.12) in association with hard alkaline red soils (Dr2.33) and cracking grey and brown clays (Ug5.2 and Ug5 .3); dunes of brown calcareous earths (Gc 1) and hard alkaline red soils (Dr2.33) . Other unclassified soils probably occur too. Includes areas of high salinity and also of gypsum accumulations. Incomplete data. Occurs on sheet(s): 1"
"Lb10"

"Gently undulating plains with some granitic bosses and tors; acid clays common below depths of 6*: chief soils are grey-brown highly calcareous earths (Gc1.12) commonly in intimate and complex association with hard alkaline yellow and yellow mottled, and red mottled soils (Dy2.83, Dy3.83, Dy3.73) and (Dr3.83, Dr3.43, Dr2.33). Associated are smaller areas of sandy yellow and yellow mottled soils (Dy4.43, Dy4.83, Dy5.43, and Dy5.83). As mapped, areas of units DD12,Ya29, and JY1 are included, as are small areas of many other soils such as those in the vicinity of granitic tors. Occurs on sheet(s): 5"
"Lb11"
"Small saline plains, some areas of calcrete (kunkar): chief soils are grey-brown calcareous earths (Gc1.12) possibly with some (Dr1) soils. Occurs on sheet(s): 5"
"Lb12"
"Valley flats along major drainage lines, associated with limestone and calcareous gravels (kunkar): chief soils are highly calcareous earths (Gc1.12) with minor areas of shallow calcareous loams (Um1.1). Associated are areas of hard red soils (Dr2.33) and some cracking clays (Ug5.37). Occurs on sheet(s): 6,10"
"Ld1"
"Undulating to hilly limestone country: chief soils are calcareous earths (Gc1.22) and (Gc2.12). Associated are (Uc1.3) and (Um5.11) soils on steep sites. Areas of (Dr1.33) and (Dr1.43) soils and also (Gn2.13) soils may occur locally. Occurs on sheet(s): 10"
"Ld2"
"Undulating or occasionally level low limestone plateaux, the margins of the unit are usually scarped and have much silicified limestone outcrop; the soil surface throughout the unit is usually strewn with chalcedony and silicified limestone gravel: dominant soils are shallow to moderately deep gravelly brown calcareous earths (Gc1.22), with lesser (Gc2.22) and (Gc1.12). In parts of the unit, moderately deep to deep loamy red earths (Gn2.13) occur. Adjacent to limestone outcrop, shallow gravelly calcareous loams (Um1.3), (Um5.11), and (Um5.61) are common. Occurs on sheet(s): 10"
"Lg1"
"Very gently undulating or level plains, occasionally with a siliceous gravel-strewn surface: dominant soils are deep to moderately deep red to red-brown loamy calcareous earths (Gc2.21), with other calcareous earths (Gc2.22), (Gc1.22), and (Gc1.12) associated. Also occurring are small areas of loamy red earths (Gn2.13) and red cracking clays (Ug5.38). Throughout the unit are low limestone ridges with shallow calcareous loams (unit Fd1) and much outcrop. Occurs on sheet(s): 10"
"Lg2"
"Gently undulating plains with some low limestone ridges: dominant soils are moderately deep to deep slightly gravel-strewn brown or reddish brown loamy calcareous earths (Gc2.21) with lesser (Gc2.22). The low limestone ridges have shallow gravelly calcareous loams (Um5.61) and (Um1.3) or clays (Uf6.12). Associated throughout the unit in lower sites are deep red-brown clays (Ug5.38) and (Uf6.31). Data are fairly limited. Occurs on sheet(s): 10"
"Lh1"
"Coastal plains mainly beyond marine flooding influence: main soils are pedal calcareous earths (Gc2.22) with some associated highly calcareous earths (Gc1.12). On the seaward side are firstly samphire flats (Gc1.1) and then bare saline mud (Uf). Calcareous dunes (Uc1.11) commonly occur on the seaward edge of the plains. Occurs on sheet(s): 6,9"
"Lh2"
"Level or very gently undulating plains with occasional low rises with limestone outcrop: dominant soils are moderately deep brown or red-brown loamy calcareous earths (Gc2.22), with lesser (Gc2.21) and (Gc1.12). Associated on the low rises are shallow to moderately deep red-brown and brown calcareous loams (Um6.24, Um6.23) and shallow gravelly calcareous loams (Um5.61) and (Um1.3), together with some loamy red (Gn2.13) or brown (Gn2.43) earths. Throughout the unit are small areas of deep red-brown or brown cracking clays (Ug5.38, Ug5.34), uniform clays (Uf6.31), and loamy duplex soils (Dr2.13) and (Db1.13). Occurs on sheet(s): 10"
"Lh3"
"Undulating lands with broad ridges with limestone outcrop; the surface soil is usually strewn with quartz gravel: dominant soils are moderately deep brown calcareous earths (Gc2.22) with associated (Gc2.21), and (Gc1.12) and (Gc1.22). Adjacent to limestone outcrop shallow calcareous loams (Um5.61), (Um5.11), (Um1.3), and (Um6.23) are common. There are also gravel-strewn red duplex soils (Dr2.33), and in flatter sites red or brown deep cracking clays (Ug5.38, Ug5.34). Data are fairly limited. Occurs on sheet(s): 10"
"M1"
"Plain: brown and red friable earths (Gn3.22 and Gn3.12) in association with friable neutral red soils (Dr4.12); small areas of shallow red-brown sandy soils (Uc6.13). Occurs on sheet(s): 1"
"M2"
"Crater lakes and immediate surround: brown and red friable earths (Gn3.22 and Gn3.12) in association with friable neutral red soils (Dr4.12). Occurs on sheet(s): 1"
"MB1"

"Outcrop plains with extensive scalded areas; ferruginized outcrop and strew; some sand-plain areas: chief soils are neutral yellow leached earths (Gn2.32) and (Gn2.62) and alkaline red leached earths (Gn2.19). Associated are (Dr2.33) and (Ug5.34) soils on the plains, (Uc1.23) soils on sand plains, and areas of unit JJ18. Occurs on sheet(s): 9"
"MD1"
"Moderately undulating lands with occasional low hilly areas: dominant are dark friable loamy soils with brown clay subsoils (Gn3.25). On sloping sites associated soils include dark cracking clays (Ug5.12 and Ug5.13) with linear gilgai, and thin-surfaced loamy duplex soils (Dd1.12), (Dd1.22), (Dd1.43), and (Dr2.12). Small stream flood-plains have loamy duplex soils (Dy3.43 and Dy3.42), and small areas of dark cracking clays (Ug5.16). Occurs on sheet(s): 4"
"ME1"
"Strongly undulating or low hilly lands with occasional higher steep hills: dominant soils are loamy brown friable earths (Gn3.24), with lesser (Gn3.21) and local occurrences of (Gn3;14), (Gn3.11), and (Gn3.41). On many lower, flatter slopes loamy duplex soils occur, chiefly (Dy2.21), (Dy2.41), (Dy3.21), (Dy3.41), (Dy3.42), and (Db1.21); while in some lower areas there may be small areas of dark cracking clays (Ug5.13). Occurs on sheet(s): 4"
"ME2"
"High hilly or hilly lands with some strongly undulating marginal areas: dominant soils are loamy brown friable earths (Gn3.24) but other friable earths are closely associated, chiefly (Gn3.14) with lesser (Gn3.21), (Gn3.11), (Gn3.91), and (Gn3.94). In all soils stone is often present in the solum, which ranges from 20 to 40 in. in depth. On areas of lower relief loamy duplex soils are common, chiefly (Dy3.41), (Dy3.42), and (Dr2.21). Some high stony hill crests have shallow loams (Um1.43) and (Um2.12). Occurs on sheet(s): 4"
"ME3"
"Elongate narrow valleys bounded by very steep mountainous scarps; the geomorphic units include the most recent alluvial stream terraces and higher, older terraces that rise to undulating or low hilly areas flanking the scarp: dominant soils of the low hills and higher terraces are loamy friable earths (Gn3.24) with lesser (Gn3.14) and (Gn3.21). The (Gn3.14) soils are more common on the higher foothills where they are associated with some shallow stony loams (Um1.43) and (Um4.1). The most recent terraces and small flood-plains have very variable soils but loamy types (Um6.31), (Um6.11), and (Um5.4) are most common; most soils are stratified at shallow depths. Occurs on sheet(s): 4"
"MF1"
"Flat to gently undulating and poorly drained coastal plain less than 50 ft above sea level: chief soils are acid grey friable earths (Gn3.04 and Gn3.01) with acid yellow leached friable earths (Gn3.84) -- these soils are underlain by nodular sesquioxidic (?laterite) sheets from depths of about 3 ft. Associated are leached sands (Uc2.2 and Uc2.3) underlain by clay D horizons, (Dy3.31) soils on flat areas, and (Gn3.74) soils on slightly higher banks. Occurs on sheet(s): 4"
"MF2"
"Gently undulating coastal plain between 25 and 50 ft above sea level: chief soils are acidic grey friable earths (Gn3.94), (Gn3.01), and (Gn3.04). Associated are (Dg2.41) soils on low banks. Other soils include (Dg4.81) in swampy depressions and (Dy3.41) and (Dy2.12) soils. Data are limited. Occurs on sheet(s): 4"
"MF3"
"Gently undulating coastal plain between 25 and 50 ft above sea level: chief soils are acidic grey friable earths (Gn3.94), (Gn3.01), and (Gn3.04). Associated are (Dy3.41), (Dy2.41), and (Dg2.41) soils throughout. Other soils include (Gn3.95), (Gn3.84), (Dg4.81), and (Gn2.94). Data are limited. Occurs on sheet(s): 4"
"MF4"
"Flat to very gently undulating coastal plain less than 25 ft above sea level: a few low sandy rises (planedoff sandstone hills) are included: chief soils are acid grey friable earths (Gn3.04) and (Gn3.94). Associated are (Dg4.81) soils and in some localities (Dy4.41) soils. Small areas of other soils occur including (Gn2.82), (Gn2.24), and (Gn2.84) on stream levees and terraces--some have clay D horizons below the solum; (Dy5.41) on the sandstone areas. As mapped, small areas of soils of adjoining units are included. Occurs on sheet(s): 4"
"MF5"
"Flat to very gently undulating coastal plain less than 25 ft above sea level as for unit MF4, but with remnants of a higher rolling dissected coastal plain as for unit Mt3: soils are those for units MF4 and Mt3 respectively, with the grey friable earths (Gn3.04) and (Gn3.94) dominant. Occurs on sheet(s): 4"
"MF6"
"Rolling terrain of broad river and creek flats and terraces with low rises or hills on sandstones and volcanic rocks (tuff, trachyte, and basalt): chief soils are acid grey friable earths (Gn3.94 and Gn3.91) on the flats. Associated are (Gn3.74 and Gn3.84) soils on sandstone rises, and (Gn3.11) and (Gn3.54) soils on basaltic rises and high terraces of local tributary streams. Minor soil occurrences include (Dy5.41) on lower hill slopes and (Gn3.42) soils on low river terraces. As mapped, there are inclusions of areas of unit Wa18. Occurs on sheet(s): 4"
"MF7"

"Level alluvial plains with terraces near streams: the dominant soils that occupy the plains are dark grey-brown friable earths (Gn3.91), rusty mottled at depth. Closely associated are other friable earths (Gn3.92, Gn3.93) with lesser (Gn3.51, Gn3.54) and (Gn3.24). Small areas of loamy duplex soils (Dy3.41, Dy3.42) also occur. The terraces also have (Gn3.91) soils but in addition there are a variety of (Um) soils with little profile development. Brown earths (Gn2.41) may also occur. Occurs on sheet(s): 4,7"
"MF8"
"Flat to gently undulating plains with both entrenched and ill-defined drainage-ways: chief soils are acid grey friable earths (Gn3.04 and Gn3.01) on the broad silty plains. Associated are (Gn2.92 and Gn2.95) soils on levees of the entrenched streams, and (Gn3.05 and Gn3.06) soils with swamp hummock microrelief along the ill-defined drainage-ways. Minor soil occurrences include (Dy2.42 and Dy2.43) and (Ug5.2). Occurs on sheet(s): 4"
"MF9"
"Level alluvial plains: dominant soils are deep grey-brown friable earths that may be weakly mottled at depth. The chief form is probably (Gn3.91), but (Gn3.94, Gn3.92) also occur. Associated are small areas of loamy bleached duplex soils (Dy3.42, Dy3.41) and (Dg2.41). Data are fairly limited. Occurs on sheet(s): 7"
"MF10"
"Very Gently undulating alluvial plains with some low sandy rises: dominant soils of the plains are loamy or silty bleached mottled grey friable earths (Gn3.04), with other friable earths (Gn3.64) and (Gn3.95) associated. Also occurring are similar loamy duplex soils (Dy3.41, Dy3.42, and Dy3.43), particularly near drainage lines. Small areas of loamy bleached grey earths (Gn2.94) also occur. On the low sandy rises are sandy bleached earths (Gn2.74) and (Gn2.94) or deep bleached sands (Uc2.21). Data are fairly limited. Occurs on sheet(s): 7"
"MF11"
"Undulating or occasionally gently undulating lands with a few isolated siltstone low hills or eroded mesas: dominant soils are loamy or silty bleached mottled grey friable earths (Gn3.04) that often have small ironstone nodules throughout the profile. Similar duplex soils (Dy3.41), (Dr3.41), and (Dg2.41), other friable earths (Gn3.01) and (Gn3.61), and nodular yellow earths (Gn2.61, Gn2.64) are associated. In lower sites there are small areas of the slightly gilgaied brown friable earths (Gn3.51) and (Gn3.71) of unit MW1. The occasional low siltstone hills have shallow stony bleached loams (Um2.12). Occurs on sheet(s): 7"
"MG1"
"Low hilly lands on metamorphic rocks: chief soils seem to be neutral leached friable earths (Gn3.75, Gn3.82, and Gn3.85) on colluvial fans, gentle slopes, and broad gently sloping depressions. Associated are: (Dy3.41), (Dy2.31), and (Dy2.42) soils on crests, saddles, and some lower slopes fringing depressions; (Gn3.12) and (Dr2.12) soils on some low spurs and pediments; and (Um1.4) and (Um4.1) soils on stony crests. Minor soil occurrences include (Uc2.12), (Gn3.4), (Um6.21), and (Dy2.43). As mapped, small areas of units Fu11, J4, and NN2 are included. Occurs on sheet(s): 4"
"MJ1"
"Flat to gently sloping plain on mudstone, sandstone, grit, and conglomerate: chief soils are neutral yellowbrown friable earths (Gn3.52) often in complex with grey clays, such as (Ug5.27, Ug5.29, and Ug5.28) on gentle slopes. Associated are patches of red earths (Gn2.12). Small areas of other soils, including (KS-Uc) soils, may occur. Occurs on sheet(s): 8"
"MK1"
"Alluvial delta plains with a complex pattern of present and prior stream channels and levees: dominant soils are loamy or fine sandy brown earths (Gn2.42) which occur on the older and flatter levees. Associated soils include (Gn2.43), (Um5.42), and (Um5.52), all usually strongly stratified at depth. The younger levees have coarse uniform sands, chiefly (Uc1.23, Uc1.22), but with some (Uc5.22) and (Uc1.21). Dark loamy duplex soils (Dd1.3) and (Dd1.1) occur in the drainage lines and depressions that carry water for long periods after rain. Occurs on sheet(s): 7"
"MK2"
"This unit consists of a complex pattern of relic stream channels and levees but it forms the lower end of a delta system and merges into salt pans and mangrove swamps: dominant soils are fine sandy brown earths (Gn2.42), with lesser similar red or yellow earths (Gn2.12), (Gn2.15), and (Gn2.22). Minor associated soils include organic-surfaced dark duplex soils (Dd1.13) and (Dd1.33) in the wet relic channels, with other loamy dark duplex soils (Dd1.33), (Dd1.43), and lesser (Dy2.43) on the areas of marine plain included in the unit. Occurs on sheet(s): 7"
"ML1"
"Very gently undulating alluvial plains cut by numerous sharp gullies and old stream levees: dominant soils are probably loamy brown earths (Gn2.44) which occur on the levees. Also occurring are loamy brown duplex soils (Db1.22), and loamy red earths (Gn2.14) on the old levees. Associated soils include sandy and loamy duplex soils of units Va57 and Va78. There are also small areas of dark duplex soils (Dd1.43) in minor depressions. Data are limited. Occurs on sheet(s): 7"
"MM1"

"Very gently undulating cracking clay plain in some places with moderate (1-2 in.) gilgai microrelief: chief soils are deep brown clays (Ug5.34) with some (Ug5.24) and (Ug5.38). Commonly associated are loamy-surfaced (Dr2.33) and (Db1.33) soils, and small areas of red earths (Gn2.12). Occurs on sheet(s): 3,4"
"MM2"
"Undulating landscape with linear gilgai on some slopes: crests and upper ridge slopes of cracking redbrown clays (Ug5.37) or loamy soils with red clay subsoils (Dr2.33), passing down the slope to cracking brown clays (Ug5.32) on gilgai puffs and cracking grey clays (Ug5.23) in gilgai depressions. Associated are cracking grey clays (Ug5.25) at the foot of slopes and in the intervening valleys, and minor occurrences of unit HG1 soils on the lower slopes of some ridges. Occurs on sheet(s): 3,4"
"MM3"
"Flat to gently undulating with slight gilgai (few inches) formation: chief soils are deep cracking clays (Ug5.3), (Ug5.2), and sometimes (Ug5.16). Associated are shallow forms of (Dr2.33) often containing ironstone gravels (see unit Oc20 also). These areas are usually underlain by strongly mottled acid clays. Occurs on sheet(s): 3"
"MM4"
"Undulating plains: dominant soils are brown clays (Ug5.32 and Ug5.37) with a very slight (few inches) gilgai microrelief; this is linear on slopes. A surface gravel strew may occur. Associated soils include deeper brown or grey clays (Ug5.38) and (Ug5.24) and some (Ug5.12) and (Ug5.22). Adjacent to most drainage lines and lateritic mesas are red loamy duplex soils (Dr2.33). Similar (Db1) soils also occur. Occurs on sheet(s): 4"
"MM5"
"Gently undulating clay plains with a slight (few inches) gilgai microrelief; where the unit is exposed by stream erosion in deep wide valleys in the north-west corner of Sheet 4, topography may be strongly undulating and much dissected: brown clays (Ug5.32) of moderate depth (30 36 in.) are dominant but similar grey clays (Ug5.26 and Ug5.22) are also common. The soils often contain much gypsum. In some areas, particularly adjacent to lateritic scarps or eroded lateritic mesa-like hills, red-brown clays are locally prominent (Ug5.37 and Ug5.38), together with small areas of red loamy duplex soils (Dr2.33). Throughout the unit there are local areas where a veneer of silcrete (billy) gravel is prominent. Associated lower-level plains or small stream flood-plains have deeper clay soils, chiefly (Ug5.28), (Ug5.29), (Ug5.24), and (Ug5.34). Occasional small low lateritic mesas (unit Fz5) may occur in the unit. Occurs on sheet(s): 4,7,10"
"MM6"
"Gently undulating or almost level plains: dominant soils are brown clays (Ug5.32 and Ug5.34) with important areas of grey clays (Ug5.22 and Ug5.24) and smaller areas of dark clays (Ug5.12). A slight (6-12 in.) gilgai microrelief may be present and some areas may have a surface veneer of silcrete (billy) gravel. The chief associated soils are loamy duplex soils (Db1.13 and Db1.33) and (Dd1.13 and Dd1.33). Small stream flood-plains have (Dy2.43) soils. Occurs on sheet(s): 4"
"MM7"
"Moderate to gently undulating lowlands and plains: dominant soils are moderately deep to deep clays, which in some areas have a moderate gilgai microrelief (1-2 ft). In some areas the soil surface may be strewn with silcrete (billy) gravel to 4 in. diameter. Brown clays (Ug5.34, Ug5.38, Ug5.32, and Ug5.37) are dominant but grey forms (Ug5.25, Ug5.24, and Ug5.22) are also common; dark clays (Ug5.13, Ug5.15, and Ug5.16) also occur. Closely associated are thin-surfaced loamy duplex soils, chiefly (Dr2.13 and Dr2.33), (Db1.13 and Db1.33), and (Dy2.33 and Dy2.43), which occur particularly on flood-plains of small streams. Small areas of friable earths (Gn3.13 and Gn3.12) also occur, particularly where the unit borders the high mountains of unit Bz1. Occurs on sheet(s): 4"
"MM8"
"Gently undulating or level plains: dominant soils are brown or grey cracking clays with a moderate to strong gilgai microrelief (2-4 ft). Chief soils are (Ug5.34), (Ug5.38), (Ug5.32), and (Ug5.24) with some dark clays (Ug5.15). Some areas may be strewn with silcrete (billy) gravel to 4 in. diameter. Closely associated are small areas of thin-surfaced loamy duplex soils (Db1.13), (Db1.33), (Dd1.13), and (Dr2.13). Soil reaction values of the cracking clays (Ug5) vary and comprise: (i) alkaline or neutral surfaces with acid subsoils (common); (ii) acid throughout (fairly common); and (iii) alkaline throughout (rare). Occurs on sheet(s): 4"
"MM9"
"Terraced valley plains: chief soils are brown and grey cracking clays (Ug5.34), (Ug5.39), and (Ug5.2) which occur on the third terrace with (Gn3.21), (Dy3.41), and (Dy3.13) soils. Associated are: (Gn3.42 and Gn3.43) soils on the second terrace, with (Ug5.15), (Ug5.16), and (Ug5.24) soils on back slopes, (Dy2.22) soils on sandy levees, and smaller areas of (Dd1.52), (Ug6.11), (Um6.22), (Db1.13), and (Db2.41); and (Uc) soils common on the first terrace and on lateral fans. Buried soils occur throughout. As mapped, small areas of adjoining units may be included. Occurs on sheet(s): 4"
"MM10"
"Moderate to gently undulating lowlands and plains broken by high strike ridges and hills: chief soils are brown clays (Ug5.34, Ug5.38, Ug5.32, and Ug5.37), with grey clays (Ug5.25, Ug5.24, and Ug5.22) and dark clays (Ug5.13, Ug5.15, and Ug5.16). Associated are loamy duplex soils (Dr2.13), (Dr2.33), (Db1.13), (Db1.33),

(Dy2.33), and (Dy2.43) on flood-plains along small streams, and the soils of unit If3 on the narrow strike ridges and hills. Occurs on sheet(s): 4"
"MM11"
"Broadly undulating or level plains: dominant soils are deep brown clays (Ug5.34), with lesser red-brown (Ug5.38) and grey clays (Ug5.24). All are non-gilgaied or with only a very slight (6 in.) microrelief. Marginal to the unit are small areas of brown or red loamy duplex soils (Db1.13 and Db1.33) and (Dr2.13 and Dr2.33). Occurs on sheet(s): 4"
"MM12"
"Alluvial plains, sometimes with slight to moderate (1-2 ft) gilgai microrelief: dominant soils are brown deep clays (Ug5.34) with lesser grey clays (Ug5.25 and Ug5.24). Associated are many small areas with thin-surfaced loamy duplex soils (Db1.13 and Db1.33) and lesser similar (Dy2) soils. Occurs on sheet(s): 4"
"MM13"
"Undulating or level plains, occasionally with slight to moderate gilgai microrelief (1-2 ft): dominant soils are brown clays of moderate depth (Ug5.33 and Ug5.32) associated with similar grey clays (Ug5.22, Ug5.23, and Ug5.24). Included in the unit, as mapped, are small areas of red-brown friable earths (Gn3.12); deeper clay soils (Ug5.25), (Ug5.15), and (Ug5.34); some small low basaltic hills with shallow stony (Um6) and (Uf6) soils; and small alluvial plains with loamy duplex soils (Db1.33), (Dd1.33), and (Dy2.33). Occurs on sheet(s): 4"
"MM14"
"Rolling landscape of very low rounded hills with gentle side slopes passing to gently sloping fans and alluvial flats: chief soils are brown cracking clays (Ug5.35 and Ug5.38), but dark (Ug5.16) and grey (Ug5.24) forms have local importance. There is a moderate development of melon-hole type microrelief. Associated are (Gn3.11 and Gn3.12) soils on the low hills. Minor soil occurrences include gilgai complexes of (Gn3.21) on banks and (Gn3.91) in depressions, and of (Dy2.43) on banks and (Gn3.9) in depressions; and (Gn3.22) on basal hill slopes. As mapped, hills of unit Sk8 are included, as is a singular trachyte plug with (Uc2.12) soils. Occurs on sheet(s): 4"
"MM15"
"Rolling to undulating terrain: the soils are brown and grey cracking clays (Ug5.37) and (Ug5.27) and similar shallow (Ug5) soils on the more rolling areas, with a complex association of (Dr3.43), (Dr2.43), and (Dr2.63) soils often containing some ironstone gravels; various (Dy) soils such as (Dy3.43); and various (Gc) soils such as (Gc1.12) in the areas of gentler relief. As mapped, areas of unit BB4 may be included. Data are limited. Occurs on sheet(s): 5"
"MM16"
"Alluvial plains dominated by deep cracking clays (Ug5.38) along with some areas of (Uf6.71) soils, and minor areas of (Dr2.33) soils. Occurs on sheet(s): 6,10"
"MM17"
"Alluvial plains with occasional stony residuals of basic and ultrabasic rocks: chief soils are deep cracking clays (Ug5.38) but extensive areas of (Dr2.33) and (Uf6.71) soils occur. (Uc5.32) and (Uc1.22) soils occur as narrow bands along stream channels. Occurs on sheet(s): 6"
"MM18"
"This unit comprises a complex pattern of steep stony hills and valley plains along with some steep pediments. The hills are largely formed by metamorphosed basic and ultrabasic rocks as well as basic lavas, dolerite, and metamorphosed sediments. There are extensive areas without soil cover on the hills: chief soils are cracking clays (Ug5.37) on the valley plains where they are associated with (Uf6.71) soils. Shallow stony (Dr2 33) soils occur on the pediments and (Um5.51) soils on the hills. Occurs on sheet(s): 6"
"MM19"
"High-level gently undulating plain flanked by areas of basaltic ranges of unit Gfl: chief soils are cracking clays (Ug5.37). Areas of (Uf6.71) and (Dr2.33) soils occur also. Occurs on sheet(s): 6"
"MM20"
"Narrow alluvial plains with gilgai microrelief flanking the rivers: chief soils are deep cracking clays (Ug5.38). Associated are various hard red (Dr) soils of unit Oc58. Occurs on sheet(s): 6"
"MM21"
"Very gently undulating plains developed on sandstones and shales: main soils are brown clays (Ug5.35) on the plains with minor occurrences of (Ug5.24) and (Dr2.32) soils. Associated are (Dy2.32) soils on the broad interfluves. Occurs on sheet(s): 9"
"MM22"
"Plains developed on shales, siltstone, limestone, and sandstone, with some rock outcrop on broad interfluves: chief soils are brown and grey clays (Ug5.35) and (Ug5.25) with small occurrences of (Dy5.43) soils. Occurs on sheet(s): 9"
"MM23"

"Active flood-plains with extensive back plains and broad levee banks: chief soils are brown cracking clays (Ug5.35) associated with dark clays (Ug5.24). Other soils include (Uf5.11 and Uf5.12) on levee banks and intractable (Uf5) soils in channels and billabongs. Occurs on sheet(s): 9"
"MM24"
"Gently undulating plain derived from limestone and shales; occasional limestone outcrops; low-lying sites may be flooded seasonally: chief soils are brown and grey clays (Ug5.34) and (Ug5.24), with a gilgai microrelief to about 12 in. on the plains. Small areas of shallow (Um6) soils occur on limestone rises and (Um6.33) soils on shales. Occurs on sheet(s): 8,9"
"MM25"
"Alluvial plains with many old channels and levees: chief soils are deep brown and grey-brown cracking clays (Ug5.34, Ug5.35) and (Ug5.24, Ug5.25), varying locally in dominance. Some uniform non cracking clays (Uf6.31, Uf6.33) also occur. On old channels and levees are deep loamy red earths (Gn2.12, Gn2.13), with lesser (Gn2.42, Gn2.43). Associated with these are areas of loamy duplex soils (Dr2.13), (Db1.13), and (Dy2.13), which are often scalded. Some small depressions have massive cracking clays (Ug5.5) and (Ug5.4). Occurs on sheet(s): 7,10"
"MM26"
"Alluvial plains with some old infilled channels: dominant soils are deep brown cracking clays (Ug5.34, Ug5.35) with lesser grey clays (Ug5.25, Ug5.24). Small areas have a weak gilgai microrelief, and in some depressions there are massive cracking clays (Ug5.5) and (Ug5.4). The chief soils on stream levees are deep loamy earths (Gn2.12), with lesser (Gn2.42) and deep loams (Um5.52). Fringing the clays are loamy duplex soils (Dr2.13), (Db1.13), and (Dy2.13) which are often scalded. Some smaller levees have deep uniform clays (Uf6.31) and (Uf6.51). Deep sandy red earths (Gn2.13, Gn2.12) occasionally occur in old infilled channels, and there are occasionally small gravelly rises with deep loamy yellow earths (Gn2.22). Occurs on sheet(s): 7,10"
"MM27"
"Outwash plains subjacent to ranges of basic igneous rocks; some low hills of basic rocks occur in the unit; occasional dunes: chief soils are deep cracking clays (Ug5.38) and earthy clays (Uf6.71). Other soils include (Um5.52) on the plains, (Um5.11) on low calcrete (kunkar) rises, and (Uc1.23) on the dunes. Occurs on sheet(s): 10"
"MM28"
"Alluvial plains: dominant soils are deep cracking clays (Ug5.38), often in gilgai complex with (Dr1) soils such as (Dr1.33) and (Dr1.43), both of which have a variable stone and gravel mantle. Associated are (Gn2.12, Gn2.13) soils which may be locally prominent. Some (Um 1) and (Uc1) soils occur also. Occurs on sheet(s): 10"
"MM29"
"Alluvial plains with variable gilgai formation: chief soils are cracking clays (Ug5.3). Associated are some (Dr1.33) soils and (Dr4.82) soils. Occurs on sheet(s): 10"
"MM30"
"Plains: chief soils are (Ug5.38) with some (Ug5.6). Small areas of other soils may occur. Occurs on sheet(s): 10"
"MM31"
"Gently undulating to undulating lands with calcareous rock outcrop common on higher slopes and ridge crests: dominant soils are the deep brown and grey-brown cracking clays of unit MM5. Associated on higher slopes and ridge crests, particularly adjacent to rock outcrop, are a range of shallow loams (Um5.41), (Um5.61), (Um5.11), (Um6.22), and (Um1.3) and shallow clays (Uf6.33, Uf6.34) and (Uf6.12, Uf6.13). On some slopes there are small areas of calcareous earths (Gc2.21, Gc2.22). Occurs on sheet(s): 10"
"MM32"
"As for unit MM5 but almost all soils have a veneer of billy or ironstone gravel. Moderately deep to deep red crusty uniform clays (Uf6.31) and loamy red duplex soils (Dr2.33) with shallow (1-3 in.) A horizons are common in areas with heavy gravel cover. Occurs on sheet(s): 10"
"MM33"
"Level alluvial plains with many braided distributary channels: dominant soils are deep brown cracking clays (Ug5.34), with other deep cracking clays (Ug5.24, Ug5.25, and Ug5.28) closely associated and in some areas locally dominant. Deep uniform clays (Uf6.31, Uf6.33, and Uf6.34) with a scalded and crusted surface are also widespread. Small areas of moderately deep cracking clays (Ug5.32) and (Ug5.22, Ug5.26) of unit MM5 occur on isolated low rises between stream channels. Occurs on sheet(s): 10"
"MM34"
"Alluvial plains with numerous old infilled channels: dominant soils are deep brown cracking clays (Ug5.34), with associated deep red-brown and grey-brown cracking clays (Ug5.38) and (Ug5.25, Ug5.24). On scalded areas and adjacent to stream channels are loamy red duplex soils (Dr2.13), (Dr2.43), and (Dr2.33), deep uniform clays (Uf6.31), and lesser loamy grey duplex soils (Dy2.13) and (Dy2.33). These soils are often gravel-strewn. On stream levees and infilled channels are deep loamy, and occasionally fine sandy, red earths (Gn2.13, Gn2.12). Occurs on sheet(s): 10"
"MM35"

"Alluvial plains with occasional low broad sandy rises: dominant soils are deep brown cracking clays (Ug5.34), with lesser grey clays (Ug5.28, Ug5.24), and occasional red clays (Ug5.38). In some areas the clays may be scalded and have a surface crust up to 1 in. thick. These are tending towards loamy duplex soils (Dy2.33) and (Dr2.33). Sandy or loamy red earths (Gn2.11, Gn2.12) occur on the low rises. Occurs on sheet(s): 10"
"MM36"
"Level to very gently undulating plains: dominant and associate soils are as for unit MM35, but in most areas all soils have a veneer of billy and ironstone gravel. In areas of heavy surface gravel, loamy red duplex soils (Dr2.33) or uniform clays (Uf6.31) may be locally dominant. Occasional areas have a prominent gilgai microrelief. Occurs on sheet(s): 10"
"MM37"
"Alluvial flood-plains of major streams with very numerous braided channels; the unit is subject to inundation by high floods and most channels are flooded seasonally: dominant soils are deep brown cracking clays (Ug5.34), with much lesser grey clays (Ug5.24). In small channels and gutters and seasonally flooded areas the soils are self-mulching, but between the braided channels the soils normally have a scalded surface. Unit MM38 occupies the smaller tributary flood-plains and throughout the unit there are small areas of unit MM41. Occurs on sheet(s): 10"
"MM38"
"Alluvial flood-plains of minor streams; in parts of the unit small braided stream channels are common; almost all soils have a scalded surface and in some areas are strewn with small siliceous and/or ironstone gravel: dominant soils are deep red-brown or brown cracking clays (Ug5.34), but in parts of the unit, more particularly small side valley flood-plains, red cracking clays (Ug5.38) may be dominant. In the lower reaches of some flood-plains small areas of deep grey clays (Ug5.24) may occur. Associated throughout the unit are small areas of thin-surfaced (1-3 in.) gravel-strewn loamy red duplex soils (Dr2.33, Dr2.32) together with occasional similar (Dr1) soils. Occurs on sheet(s): 10"
"MM39"
"Alluvial flood-plains with many small distributary channels; throughout the flood-plain are many small wind-piled areas of sand and occasional active longitudinal dunes: dominant soils are deep brown cracking clays (Ug5.34) with lesser grey clays (Ug5.24). These are often saline with a very soft surface, and in some areas small mound springs occur with a prominent salt efflorescence. Adjacent to the sand accumulations the clays usually have a variable surface cover of blown sand. The more extensive sand systems have deep to moderately deep light brown sands (Uc1.22), occasionally (Uc1.21). More prominent dunes have deep reddish sand (Uc1.23). Occurs on sheet(s): 10"
"MM40"
"Flood-plains of major rivers consisting of very numerous anastomosing small channels and gutters that are seasonally flooded and much smaller slightly higher scalded areas between larger channels that are not regularly flooded: dominant soils of the flooded areas are self-mulching deep brown cracking clays (Ug5.34) with lesser grey clays (Ug5.24). The scalded areas also have brown clays (Ug5.34) or occasionally grey clays (Ug5.24). The unit differs from unit MM37 in that there are fewer deep well-defined channels, a greater part is subject to inundation, and there is a much higher proportion of self-mulching soils. Occurs on sheet(s): 10"
"MM41"
"Older alluvial flood-plains of major rivers that are only rarely flooded; the soils all have a severely scalded surface and occasionally are slightly gravel-strewn: dominant are deep brown cracking clays (Ug5.34), with, less commonly, red-brown (Ug5.38) or grey clays (Ug5.24). In some areas there are slightly higher gravel-strewn rises with uniform clays (Uf6.31) or thin-surfaced (1-2 in.) loamy red duplex soils (Dr2.33). Occurring throughout the unit are well-defined shallow drainage lines that are seasonally flooded and have self-mulching deep brown cracking clays (Ug5.34), less commonly grey clays (Ug5.24). Where the unit occurs as part of the flood-plain of the Diamantina River there are some isolated semi-active linear sand dunes (Uc1.23). Occurs on sheet(s): 10"
"MM42"
"Level alluvial plains with occasional drainage channels: dominant soils are strongly self-mulching deep brown cracking clays (Ug5.34), with occasional grey-brown clays (Ug5.24) in lower sites. In parts of the unit very low gravel-strewn rises occur with red clays (Ug5.38) and (Uf6.31) or occasional thin-surfaced loamy duplex soils (Dr2.33). Occurs on sheet(s): 10"
"MM43"
"Very gently undulating or level plains, usually with dissected very low scarped or benched margins with limestone outcrop: dominant soils of the plains are deep brown cracking clays (Ug5.34) that have a deep very soft and loose self-mulching surface. The soils are often highly gypseous. Associated are similar red-brown clays (Ug5.38, Ug5.37), with smaller areas of red-brown uniform clays (Uf6.31) that are often gravel-strewn. At the dissected margins of the unit the soils are shallow and highly calcareous, the chief forms are (Um5.61), (Um5.11), (Um1.3), and (Uf6.12). Occurs on sheet(s): 10"
"MM44"

"Gently undulating plains with many low ridges with limestone outcrop: dominant soils are shallow to moderately deep red or red-brown clays (Ug5.37), with lesser deep red clays (Ug5.38). Associated soils are brown and grey-brown clays (Ug5.32) and (Ug5.22) of unit MM5. A range of shallow uniform calcareous clays (Uf6.31) and (Uf6.12, Uf6.13) and loams (Um6.32, Um6.34), (Um6.23, Um6.24), (Um1.3), (Um5.61), and (Um5.11) occur on the areas of limestone outcrop. Occurs on sheet(s): 10"
"MM45"
"Undulating plains with broad ridge crests and long gentle slopes; more extensive level plains also occur: dominant soils are moderately deep to deep red or red-brown clays (Ug5.37), with brown clays (Ug5.32) often associated. Also occurring, particularly in lower sites, are deep red, red-brown, or brown clays (Ug5.38, Ug5.34). The clay soils may be slightly gravel-strewn. Throughout the unit there are many slightly higher rises with gravel-strewn loamy red duplex soils (Dr2.13) and (Dr2.33) and red uniform clays (Uf6.31). Occurs on sheet(s): 10"
"MM46"
"Alluvial plains with some slightly higher scalded areas that are often gravel-strewn: dominant soils are deep red-brown cracking clays (Ug5.38), with associated deep brown (Ug5.34) or occasionally grey (Ug5.24) cracking clays in lower sites. In some areas the clays are slightly gravel-strewn. On the low rises and adjacent to streams are gravel-strewn loamy red duplex soils (Dr2.33), (Dr2.43), and (Dr2.13) and occasional uniform clays (Uf6.31). Crusty duplex soils (Dr1.33) and (Dr1.43) may also occur. On some stream levees are deep loamy or occasionally sandy red earths (Gn2.13, Gn2.12). Occurs on sheet(s): 10"
"MM47"
"Gently undulating plains, often strewn with siliceous or ironstone gravel: dominant soils are deep red-brown or red cracking clays (Ug5.38), with lesser areas of brown clays (Ug5.34). Locally there are small areas of grey clays (Ug5.24) with a slight gilgai microrelief. In some localities marginal to the unit, there are areas of red calcareous earths (Gc2.21, Gc2.22) and occasional low limestone ridges with shallow calcareous loams (Um5.61). Occurs on sheet(s): 10"
"MM48"
"Level or very gently undulating plains; the soil surface may be strewn with small siliceous or ironstone gravel: dominant soils are deep red-brown cracking clays (Ug5.38), occasionally (Ug5.37), with lesser deep brown clays (Ug5.34) associated. In slightly depressed areas deep grey clays (Ug5.24) occur. On slightly higher rises silicified limestone may outcrop; and the soils are brown calcareous earths (Gc2.22, Gc2.21) and (Gc1.12) or shallow calcareous loams (Um5.61) and (Um6.23). Occurs on sheet(s): 10"
"MM49"
"Gently undulating to undulating lands with some isolated low lateritic mesas: dominant soils are probably deep red cracking clays (Ug5.38), but also common are areas of brown and grey-brown clays (Ug5.34) and (Ug5.24) with lesser areas of similar moderately deep clays (Ug5.37, Ug5.32) and (Ug5.22). Associated are loamy red duplex soils (Dr2.33) and uniform clays (Uf6.31) which may be locally dominant. All soils have a veneer of siliceous and ironstone gravel. The low mesas included in the unit are small outliers of unit Fa42. Data are limited. Occurs on sheet(s): 10"
"MM50"
"Gently undulating lands with some areas of prominent gilgai microrelief. Dominant and associate soils are as for unit MM49. Occurs on sheet(s): 10"
"MM51"
"Undulating lands with many lateritic mesa remnants with steep scarped margins. Dominant and associate soils are as for unit MM49. Data are limited. Occurs on sheet(s): 10"
"MM52"
"Gently undulating plains with very broad ridge crests and long slopes; the soils usually have a variable surface strew of billy gravel: dominant are deep red or red-brown clays (Ug5.38), with lesser deep brown clays (Ug5.34); these occur more commonly as small alluvial plains associated with drainage lines. Throughout the unit there are numerous gravel-strewn areas, devoid of vegetation, with thin-surfaced (1-3 in.) loamy red duplex soils (Dr2.32, Dr2.33) and red uniform clays (Uf6.31). In some areas there are very low eroded mesa remnants of unit Fz46 with shallow stony (Um1.43) soils. Occurs on sheet(s): 10"
"MM53"
"Broadly undulating lands with gentle slopes to the drainage lines; the soil surface has an almost continuous cover of billy gibbers (silcrete) up to 4 in. diameter, occasionally greater: dominant soils are deep red-brown or red cracking clays (Ug5.38), less commonly (Ug5.37). Occasionally there is a slight (few inches) gilgai microrelief. Closely associated are similar stony-surfaced loamy red duplex soils with thin A horizons (1-3 in.); the common form is (Dr2.32) but occasionally (Dr2.33) and similar (Dr1) soils also occur. Drainage lines have small alluvial plains with scalded red-brown or brown deep cracking clays (Ug5.34) and occasionally (Ug5.38); these soils are often stone-free. In parts of the unit are small low mesas of unit Qc1O, too small to map separately. This unit is very similar to unit Qc9 but clay soils are much more prominent. Occurs on sheet(s): 10"
"MM54"

"Old alluvial flood-plains that are mostly not subject to flooding; the surface soil is usually severely scalded: : dominant soils are deep red or red-brown cracking clays (Ug5.38), but deep brown clays (Ug5.34) occur in those parts of the unit that are subject to seasonal flooding. Locally, there are small sandy plains or old stream levees of red earthy sands (Uc5.2), and occasional relict low dunes of (Uc1.23) sands. Adjacent to the sandy areas and stream channels there are small areas of loamy red earths (Gn2.13), uniform loams (Um6.24), and occasional loamy red duplex soils (Dr2.33). Occurs on sheet(s): 10"
"MM55"
"Very gently undulating plains with a slight gravel-strewn surface; in some areas a continuous cover of small (1/2 - 1 in.) ironstone gravel may be present: dominant soils are deep red-brown cracking clays (Ug5.38) and occasionally (Ug5.37). On some gravel-strewn areas, red uniform clays (Uf6.31) or thin-surfaced (1-2 in.) loamy red duplex soils (Dr2.32) may occur. Adjacent to drainage lines there are small flood-plains of deep brown clays (Ug5.34) with a strongly scalded surface. Occurs on sheet(s): 10"
"MM56"
"As for unit MM52 but the soils usually have an almost continuous surface cover of small ironstone gravel and there is probably a higher proportion of red uniform clays (Uf6.31) and loamy red duplex soils (Dr2.33, Dr2.32). Occurs on sheet(s): 10"
"MM57"
"Very gently undulating to strongly rolling downs with low mesas and buttes of calcareous sandstones; locally, gravels may cover the surface, but large areas do not have a gravel cover: dominant soils are brown cracking clays (Ug5.32, Ug5.34, Ug5.37, and Ug5.38). Other soils include (Uf6.33) on mesas and buttes and (Ug5.24) in some drainage-ways. There are similarities with unit MM5. Minor inclusions of unit Nd2 may occur in places. Occurs on sheet(s): 10"
"MM58"
"Similar to unit MM57 but rises of crusty loamy soils (Dr1.32, Dr1.33) with gilgai depressions of (Ug5.3) clays as for unit Nd2 occur throughout. Occurs on sheet(s): 10"
"MM59"
"Clay plains: dominant soils are brown and grey cracking clays (Ug5.3), notably (Ug5.34, Ug5.38), and (Ug5.2), notably (Ug5.24). Associated are a variety of (Dr), (Dy), and (Db) soils, as for units Oc86 and Si17, on slightly raised portions of the plains. There are occasional small dunes with (Uc1.2) sands. Occurs on sheet(s): 10"
"MM60"
"Gently undulating plains with a light scatter of silicified gravel and stone: dominant soils are brown clays (Ug5.38, Ug5.37, and Ug5.34). Associated are crusty loamy soils (Dr1.32, Dr1.33) on which there is a heavier stone and gravel mantle. Other soils include (Ug5.2) in low-lying sites. Occurs on sheet(s): 10"
"MM61"
"Gently undulating plains as for unit MM60 but traversed by sand dunes of (Uc1.23) sands and possibly other soils on dune flanks. Occurs on sheet(s): 10"
"MM62"
"Undulating to very gently rolling pediments and outwash fans covered with silicified gravels and stones: chief soils are brown clays (Ug5.37) with a weak (< 6 in.) gilgai microrelief. Other soils may occur. Occurs on sheet(s): 10"
"MM63"
"Undulating pediments and plains with a variable scatter of silicified gravels and stones: chief soils are brown clays (Ug5.37, Ug5.38, and Ug5.34), with a weak gilgai microrelief in some areas. Other soils may occur. Occurs on sheet(s): 10"
"MM64"
"Flood-plains with variable occurrence of stream channels: chief soils are brown clays (Ug5.34), but grey clays (Ug5.2) occur also and may be locally dominant. Associated are various (D) soils, such as (Db0.33), sometimes in microassociation with the (Ug5) clays. Data are limited. Occurs on sheet(s): 10"
"MM65"
"Broad uneven plains in part with a silcretic gravel and stone cover: chief soils are brown and grey clays (Ug5.34) and (Ug5.24). Associated are (Dr2.33) and (Db1.33) soils, sometimes in microassociation with the (Ug5.3) clays, and (Dy2.33) and (Dy1.33) soils, sometimes in microassociation with the (Ug5.2) clays. There is often a weak gilgai microrelief. The (Dr2.33) soils also occur extensively on some level areas with gilgai depressions of (Ug5.3) clays. Occurs on sheet(s): 10"
"MM66"
"Stony downs--very gently rolling to strongly rolling downs covered by variable silcrete gravel and stones: chief soils are brown clays (Ug5.38) with lesser (Ug5.34). Associated are variable areas of (Dr1.32, Dr1.33) soils often in microassociation with the (Ug5) clays and producing a weak gilgai microrelief. On some drainage divides there are gravelly rounded crests of (Um5.51) soils on mottled rock and (Um5.3) and (Gn2.12, Gn2.13) soils on red-brown hardpan. Occurs on sheet(s): 10"

"MM67"
"Gently sloping plains to gently rolling downs; silicified gravels mantle the surface in places: chief soils are cracking clays (Ug5.34), and possibly other (Ug5.3) clays, in gilgai microassociation with crusty loamy soils, notably (Dr1.32, Dr1.33). Occurs on sheet(s): 10"
"MM68"
"Gently sloping plains with some distributary channels and a light scatter of silicified gravel and stone: dominant soils are brown clays (Ug5.34, Ug5.38). Associated are crusty loamy soils (Dr1.32, Dr1.33) and (Ug5.2) clays in the channel areas. Occurs on sheet(s): 10"
"MM69"
"Valley plains often with many distributary channels: chief soils are brown and grey clays (Ug5.3) and (Ug5.2). Associated are alluvial deposits of sandy and loamy (U) soils. Occurs on sheet(s): 10"
"MM70"
"Rolling downs with a stone and gravel mantle of variable density; occasional hillocks with outcrops of calcareous sandstones: chief soils are brown clays (Ug5.34, Ug5.38, and Ug5.32) with some grey clays (Ug5.22). Associated are (Dr1.32, Dr1.33) soils in microassociation with the clays and varying in local frequency of occurrence from rare to common. Small areas of (Um5.11) soils occur on the calcareous sandstone hillocks. There may be inclusions of unit MM66. Occurs on sheet(s): 10"
"MM71"
"Plains with variable frequency of distributary channels: chief soils are brown clays (Ug5.34). Associated are grey clays (Ug5.2). Small areas of other soils may occur. Occurs on sheet(s): 10"
"MM72"
"Valley plains; some clay pans; some seasonal lakes: chief soils are brown clays (Ug5.3). Associated are a variety of soils including (Gn2.12, Gn2.13) and (Dr1.43), any of which may be locally dominant. There are some sandy areas of (Uc1.43) and (Uc1.23) soils. Occurs on sheet(s): 10"
"MM73"
"Flat to moderately undulating terrain: chief soils are brown clays (Ug5.3) with crusty loamy soils (Dr1.33) and (Dr1.43) on which there is a variable cover of gravel and stone. There are some sandy areas with (Gn2.13) and possibly other soils. Occurs on sheet(s): 10"
"MM74"
"Plains of brown clays (Ug5.3) with occasional gravel-covered areas of (Dr1.33) and (Dr1.43) soils. Associated are sandy areas with (Gn2.13) soils and lower-lying sites with (Ug5.2) clays. Occurs on sheet(s): 10"
"MN1"
"Gently undulating to undulating lands with occasional steep stony rises with granite outcrop: dominant soils are moderately deep loamy brown earths (Gn2.45). Associated are moderately deep sandy brown duplex soils (Db2.22), yellow duplex soils (Dy2.22), and some moderately deep red earths (Gn2.12). Shallow coarse sands (Uc4.1) and (Uc4.21) and sandy duplex soils (Dy2.2) occur on steeper rises and near rock outcrop. Data are fairly limited. Occurs on sheet(s): 7"
"MN2"
"Gently undulating to undulating lands, occasionally with some isolated marginal low hills: dominant soils are moderately deep loamy brown earths (Gn2.45), with lesser yellow or red earths (Gn2.25) and (Gn2.15). Chief associates are shallow loamy red duplex soils (Dr2.22); these are developed on more basic rocks and in some areas may be locally dominant. Other loamy duplex soils (Dy3.42), (Dy2.22), and (Dy2.42) occur on lower slopes and in drainage lines. Shallow sands, chiefly (Uc4.21) and (Uc2.12) with lesser (Uc4.22) and (Uc4.12), occur on ridge crests adjacent to rock outcrop. Occurs on sheet(s): 7"
"MO1"
"Level plains with occasional old sandy infilled channels: dominant soils are deep loamy mottled yellow earths (Gn2.61), with lesser similar grey earths (Gn2.81). Also associated are other loamy earths (Gn2.75), (Gn2.95), (Gn2.22), (Gn2.21), and (Gn2.62). In the old infilled channels deep sands (Uc5.11), (Uc5.21), and (Uc2.22) occur, together with some deep sandy grey earths (Gn2.81). In marginal areas there are some loamy duplex soils (Dy2.33), (Dy2.13), and (Dy3.33) of unit Si12. Occurs on sheet(s): 7"
"MO2"
"Undulating or gently undulating plains: dominant soils of the middle and upper slopes are loamy or sandy mottled yellow earths (Gn2.61 or Gn2.64), with other earths (Gn2.22), (Gn2.44), and (Gn2.94) associated. On lower slopes loamy or sandy duplex soils (Dy2.81) and (Dy3.81) occur. In valley floors there are small areas of grey cracking clays (Ug5.24), slightly gilgaied yellow friable earths (Gn3.51) and (Gn3.71), and loamy duplex soils (Dy2.43) and (Dy3.43). Occasional small dissected low sandstone hills are included in the more western occurrences of the unit. Data are fairly limited. Occurs on sheet(s): 7"
"MO3"
"Gently undulating plains with occasional higher stony ridges: a complex array of soils is present but loamy nodular mottled yellow earths (Gn2.61), with lesser (Gn2.64) and (Gn2.74), are probably dominant. Closely

associated are important areas of loamy or, less commonly, sandy red earths (Gn2.11, Gn2.14); these usually occur on well-defined stream levees. Smaller areas of friable earths (Gn3.71) and (Gn3.91) and deep loamy duplex soils (Dy3.81) also occur. The higher stony ridges have shallow gravelly duplex soils (Dy3.41) and shallow stony loams (Um2.12) and (Um4.1). Data are fairly limited. Occurs on sheet(s): 7"
"MO4"
"Gently undulating to broadly undulating plains with areas of stronger relief where the unit rises to the low scarped margins of units Mw52, Mr11, Mr18, Mu17, and MR6: dominant soils are loamy mottled yellow earths, almost always with a prominent ironstone nodule horizon at depth; in many areas massive nodular laterite outcrops at the surface. The chief soil is (Gn2.61), but (Gn2.64) is often closely associated; less common are other nodular loamy earths (Gn2.41, Gn2.44) and (Gn2.21, Gn2.24). Loamy red earths (Gn2.14, Gn2.11) occasionally occur on higher sites. Throughout the unit, mostly in lower sites or adjacent to drainage lines, there are small areas of the slightly gilgaied yellow or brown friable earths (Gn3.51) and (Gn3.71) of unit Mw1, or occasional areas of slightly gilgaied cracking clays (Ug5.26) and (Ug5.33). In shallow drainage depressions or swampy areas, which are common in parts of the unit, loamy mottled bleached yellow or grey earths (Gn2.74) and (Gn2.94), grey bleached friable ear. Occurs on sheet(s): 7"
"MP1"
"Very gently undulating plains with occasional broad shallow drainage lines; the plains have low scarped margins, often with massive nodular laterite exposed: dominant soils are loamy or occasionally sandy mottled yellow earths (Gn2.62), usually with a prominent ironstone nodule horizon at depth. Associated soils are sandy and loamy yellow earths (Gn2.22), (Gn2.64), and (Gn2.21) and some similar grey earths (Gn2.81) and (Gn2.94). Near the margins loamy red earths (Gn2.12) often occur, and adjacent to the low scarps are shallow gravelly loams (Um5.51) overlying massive nodular laterite. Small stream levees have deep loamy brown or red earths (Gn2.42) and (Gn2.12), while in the shallow drainage lines loamy yellow-grey duplex soils (Dy2.12) and (Dy3.41) and loamy and sandy bleached grey earths (Gn2.94) occur. Occurs on sheet(s): 7"
"MQ1"
"Very gently undulating or level plains: dominant soils are loamy grey earths (Gn2.85) that have a strongly developed ironstone nodule horizon at 15-20 in.; often this is cemented to form massive nodular laterite. Associated in lower sites are loamy duplex soils (Dy2.43) and (Dy3.43). Also present in the unit are small areas of loamy yellow earths (Gn2.22 and Gn2.25). Occurs on sheet(s): 4"
"MR1"
"Undulating lands consisting of some level or sloping plains interrupted by low mesas or their dissected remnants; marginally the unit may be more strongly dissected: dominant soils of the plains and slopes are loamy yellow earths (Gn2.25) with (Gn2.22, Gn2.24, and Gn2.21) also occurring. Most soils contain much nodular ironstone at depth. Associated are areas of loamy red earths (Gn2.11 and Gn2.12) and grey earths (Gn2.95) and (Gn2.82). The low mesas consist of mottled or pallid rock or kaolinized sandstone; the chief soils are shallow stony loams (Um2.12), (Um4.1), and (Um1.43), also shallow earths (Gn2.11 and Gn2.12). In lower sites throughout the unit, particularly adjacent to drainage lines, pale loamy duplex soils occur, chiefly (Dy2.43), (Dy3.42), and (Dy3.43). Included in the unit in the Mt. Coolon area are some small areas of units Cd14 and CC33. Occurs on sheet(s): 4"
"MR2"
"Alluvial terraces and gently sloping levees associated with major rivers: dominant soils are fine sandy earths (Gn2.25), occasionally (Gn2.52), that may tend to be weakly pedal at depth. On the back-levee slopes sandy duplex soils (Dr2.22) occur together with some inclusions of loamy duplex soils (Dy2.33), (Dy2.43), or (Dy3.33). Occurs on sheet(s): 4,7"
"MR3"
"Gently undulating lands with some level plains; in some areas the unit may have a marginal strongly dissected scarp: dominant soils are moderately deep loamy yellow earths (Gn2.25), with lesser red earths (Gn2.14). Laterite outcrops around the margins of the unit where loamy red earths (Gn2.15, Gn2.14) are more common, while nodular sands (Uc4.3), (Uc4.1), (Uc2.12), and (Um) equivalents are common on the dissected scarps. In minor depressions and drainage lines throughout the unit moderately deep loamy duplex soils occur, chiefly (Dy3.43), (Dy3.22), (Dy3.32), and (Dy2) equivalents; all are strongly nodular at depth. Occurs on sheet(s): 7"
"MR4"
"Very gently undulating outwash plains with very broad drainage depressions: dominant soils are loamy or sandy earths, chiefly yellow earths (Gn2.25), but with areas of (Gn2.24) and similar red earths (Gn2.14, Gn2.15) and occasional mottled yellow earths (Gn2.64) and (Gn2.74). Associated soils include loamy duplex soils (Dy3:41), (Dy3.43), (Dy5.41), and (Dr2.22); deep bleached sands (Uc2.22), (Uc2.21), (Uc2.3); and very occasional friable yellow earths (Gn3.75). Small areas of deep cracking clays of unit Kf11 may also be included. Occurs on sheet(s): 7"
"MR5"
"Gently undulating alluvial plains with many old stream channels and shallow lagoons, old levees, and infilled prior stream channels; much of the area may be inundated by high floods. A complex array of soils is present;

loamy yellow earths (Gn2.25), with lesser (Gn2.24), are probably dominant, and occur on the broader terraces and levees and slightly elevated old flood-plains. Associated with them are other yellow earths (Gn2.34), (Gn2.65), and (Gn2.74), with loamy red earths (Gn2.14, Gn2.15) occurring on slightly higher sites and adjacent to some stream channels. More recent stream levees and areas subject to more frequent flooding have uniform loams (Um4.23) and (Um3.2), or earthy sands (Uc5.22). Associated throughout the unit, more particularly in the north, are slightly lower old flood-plains with loamy or silty grey duplex soils (Dy3.42, Dy3.43). Old sand-filled channels occurring throughout the unit usually have deep bleached sands (Uc2.21). Other undescribed soils are probably present in th. Occurs on sheet(s): 7"
"MR6"
"Gently undulating plains with only occassional shallow drainage depressions; the eastern margin of the unit may have low scarps: the soils of the unit are very similar to those of unit Mu17, but dominant are loamy yellowish red to reddish yellow pisolitic (bauxitic) earths (Gn2.25), with similar (Gn2.24), (Gn2.15), (Gn2.22), and (Gn2.14) soils associated. The pisolitic bauxite occurs as in the soils of unit Mu17, occasionally massive pisolitic bauxite outcrops. In the shallow drainage depressions the chief soils are nodular mottled yellow earths (Gn2.74) and (Gn2.61, Gn2.64). Occurs on sheet(s): 7"
"MS1"
"Gently undulating or level plains: dominant soils are sandy or, less commonly, loamy yellow earths (Gn2.22), occasionally (Gn2.21 and Gn2.24). These soils are mostly underlain by nodular or concretionary laterite at shallow to moderate depths and occasionally outcropping. Closely associated are sandy to loamy red earths (Gn2.12) and (Gn2.42), which are much deeper. In broad shallow drainage lines loamy duplex soils (Dy2.43), (Dy2.42), (Dy3.33), (Dy3.43), and (Dy3.42) occur. Throughout the unit are small areas of earthy sands (Uc5.22). Occurs on sheet(s): 4"
"MS2"
"Gently undulating or level plains: dominant soils are loamy yellow earths (Gn2.22) with some (Gn2.21), (Gn2.62), (Gn2.25), and (Gn2.32). Most soils have a prominent ironstone nodule horizon at moderate to shallow depths (18-30 in.). Closely associated and locally dominant are areas of hard loamy red earths (Gn2.12), less commonly (Gn2.11); these may or may not have an ironstone horizon. Much smaller areas of sandy red and yellow earths may occur locally. Broad shallow drainage lines have loamy duplex soils (Dy2.33), (Dy2.43), (Dy3.43), and (Dr2.13), or occasionally small areas of gilgaied cracking clays (Ug5.24). Outcrops of lateritic materials (billy and porcellanite) may occur with very shallow stony loams (Um1.43) and sands (Uc4.12). Occurs on sheet(s): 4"
"MS3"
"Level or very gently undulating outwash plains dissected by numerous small shallow prior stream channels, some of which are sand-filled: the dominant soils of the higher landscape sites are deep sandy yellow earths (Gn2.22) with lesser (Gn2.25) and (Gn2.12). In most drainage depressions loamy yellow earths (Gn2.22) and (Gn2.35) or grey earths (Gn2.95) occur, but in better-defined old channels loamy duplex soils (Dy3.32), (Dy3.33), and (Dy2.43) occur. The sand-filled channels have deep sands (Uc1.22), (Uc1.23), and (Uc5.22). Occurs on sheet(s): 4"
"MS4"
"Gently undulating plains: dominant soils are sandy or occasionally loamy yellow earths (Gn2.22) and (Gn2.62). Very small areas of sandy red earths (Gn2.12) are associated. Near the sloping margins of the unit the yellow earths are underlain by a strongly developed ironstone nodule horizon. In lower sites throughout the unit loamy duplex soils (Dy3.43), (Dy2.33), and (Dy2.43) occur together with occasional small areas of grey cracking clays (Ug5.24). Occurs on sheet(s): 4"
"MS5"
"Level plains with many broad very shallow lake-like depressions: dominant soils are loamy yellow earths (Gn2.22), lesser (Gn2.21), with some areas of loamy red earths (Gn2.12 and Gn2.11). In many of the yellow earths nodular or massive nodular laterite occurs at relatively shallow depths (15-20 in.). The shallow depressions have cracking clays with a slight sink-hole-type gilgai (Ug5.24). Marginal to the depressions are loamy duplex soils (Dy2-33) and (Dy3-33). Occurs on sheet(s): 4"
"MS6"
"Undulating low plateaux, often with low scarped margins: dominant soils are loamy yellow earths (Gn2.22), often with a prominent ironstone nodule layer at shallow depths. Associated are smaller areas of loamy red earths (Gn2.12 and Gn2.11), and some shallow stony loams (Um1.43) on exposed lateritic (mottled rock) materials. On lower gentle slopes loamy mottled duplex soils (Dy3.42) and (Dy3.32) commonly occur, and in lower sites brown or grey loamy duplex soils are common (unit Ro10). Occurs on sheet(s): 4"
"MS7"
"Very gently undulating plains: dominant soils are sandy or, less commonly, loamy yellow earths (Gn2.22 and Gn2.25), with lesser loamy red earths (Gn2.12). Closely associated are slightly depressed areas with grey cracking (Ug5.25, Ug5.24, and Ug5.29) clays of unit CC38. Marginal to the small clay plains are loamy duplex soils (Dy2.43), (Dy3.43), and (Dy3.42). Occurs on sheet(s): 4"

"MS8"
"Gently undulating plains with broad shallow drainage depressions: a wide range of loamy yellow earths and related soils occurs but (Gn2.22) is probably most common. On higher landscape sites (Gn2.21, Gn2.24, and Gn2.25) are commonly associated. In slightly depressed areas (Gn2.35), (Gn2.95), (Gn2.34), and (Gn2.55) all may occur locally. All of these earth soils commonly contain a horizon of ironstone nodules at 30 36 in. and occasionally at shallower depths. In the broad shallow drainage depressions loamy duplex soils occur, chiefly (Dy2.43), (Dy3.43), and (Dy3.42), together with some grey leached earths (Gn2.95) and (Gn2.85). Also occurring in the unit as mapped are very small areas of loamy red earths (Gn2.12 and Gn2.11) and small inclusions of slightly gilgaied clays (Ug5.24). Occurs on sheet(s): 4,7"
"MS9"
"Extensive gently undulating elevated plains often bounded by low dissected scarp margins: dominant soils are loamy yellow earths (Gn2.22) with lesser (Gn2.25 and Gn2.24), which almost always have a prominent ironstone nodule layer at depths ranging from 20 to 30 in. In some areas the yellow earths are underlain by a strongly pedal clay D horizon at moderate depths (18-24 in.). In slightly depressed areas in the unit grey earths occur, chiefly (Gn2.82), while adjacent to drainage lines are loamy duplex soils (Dy3.42 and Dy3.43). Loamy red earths (Gn2.1) occur on small low rises and there are also small inclusions of unit Sl21. Adjacent to the scarped margins are shallow stony sands or loams (Uc2.12), (Um1.43), and (Um4.1), usually underlain by lateritic materials. Occurs on sheet(s): 4"
"MS10"
"Moderately undulating lands: dominant soils are loamy yellow earths (Gn2.22) on the higher parts of the landscape and loamy duplex soils (Dy3.42 and Dy3.43) on lower slopes and valley floors. Small areas of leached grey earths (Gn2.94 and Gn2.95) also occur. Also associated in the unit are small areas of loamy red earths (Gn2.12) and red loamy duplex soils (Dr2.12) and (Dr2.22). Occurs on sheet(s): 4"
"MS11"
"Alluvial plains with laterite residuals: chief soils are gravelly neutral yellow earths (Gn2.22). Associated on the plains are neutral hard yellow soils (Dy2.42) together with some (Dr2.32) soils. Other soils include red earths (Gn2.12) and occasional dunes of red sands (Uc1.23). There is often much stone and gravel on the soil surface. Occurs on sheet(s): 9"
"MS12"
"Very gently undulating plains with some low rises with gravels and massive nodular laterite: dominant soils are shallow to moderately deep loamy yellow earths (Gn2.22), (Gn2.62, Gn2.61), and (Gn2.23). Common associated soils are loamy grey or brown earths (Gn2.81), (Gn2.94), (Gn2.41), and occasionally (Gn2.14). Ironstone nodules usually occur in the profile and sometimes massive nodular laterite occurs at shallow depths. On the low rises are shallow nodular loams (Um5.51), (Um4.22), and (Um1.1). In depressions loamy duplex soils (Dr2.13), (Db1.13), and (Dy2.13) occur associated with grey-brown cracking clays (Ug5.22, Ug5.24, and Ug5.25). Occurs on sheet(s): 7"
"MS13"
"Undulating to gently undulating lands with broad low rises: dominant soils are nodular loamy yellow earths (Gn2.22), with lesser (Gn2.24). Associated are some red earths (Gn2.12, Gn2.11), mostly on higher sites. Also occurring, particularly on high ridge crests or adjacent to dissected drainage lines, are inclusions of unit Qb41, with gravelly shallow to moderately deep duplex soils (Dr2.22, Dr2.21), (Dr2.12), (Dy2.21, Dy2.22), and (Dy2.61). Small basic intrusions have (Gn3.12) soils of unit Mo29 and occasional areas of dark clays (Ug5.14). Occurs on sheet(s): 7"
"MS14"
"Gently undulating plains: dominant soils are moderately deep loamy yellow earths (Gn2.22, Gn2.21), with associated loamy red earths (Gn2.12, Gn2.11). In slightly lower sites are loamy grey earths (Gn2.82) and bleached grey earths (Gn2.95). Deep loamy red earths (Gn2.12) occur on small alluvial plains and stream levees. Occurs on sheet(s): 7"
"MT1"
"Flat to very gently sloping coastal plain more than 50 ft above sea level--probably old fan formations: chief soils are acidic and neutral grey leached earths (Gn2.94 and Gn2.95) with acidic yellow leached earths (Gn2.74) and (Gn2.34) on slightly raised portions of the plain. All these soils contain some ironstone gravels and most overlie clay D horizons and/or silcretes at depths of 3-5 ft. Associated are (Dy3.41) soils on the slopes above the streams and (Dg1.81) and (Dy3.82) soils along some stream valleys. As mapped, small areas of units Ca9, Tb74, and Mt1 are included. Occurs on sheet(s): 4"
"MT2"
"Gently sloping coastal plain rising from about 50 ft near the coast to about 150 ft above sea level: chief soils are acidic and neutral grey leached earths (Gn2.94 and Gn2.95) with acidic yellow leached earths (Gn2.74)--these soils are in places underlain at 3 to 5 ft by clay D horizons which in turn may overlie silcretes. Associated are (Uc2.21) soils on sandy fan material and (Gn2.34), (Gn2.64), and (Gn2.14) soils on river levees. Other soils include

(Dy3.42) on terraces, (Dy3.41) on dissection slopes, (Uc2.3) on sandy fans and banks, and (Dg4.81) along drainage lines.. Occurs on sheet(s): 4"
"MT3"
"Coastal plain generally 25-50 ft above sea level with some rises to 100 ft: chief soils are acidic grey leached earths (Gn2.91 and Gn2.94) on extensive plains. Associated are yellow earths (Gn2.24) and (Gn2.34) on flats with (Dg4.81) and (Dg4.41) soils on sandy flats. Other soils include: (Gn2.14) on higher rises; (Uc2.35) and (Uc2.22) on sand stringers and old sandy stream lines; (Dy5.41) and (Dy2.41) on sandy flats; and (Dy3.41)on some flats. Occurs on sheet(s): 4"
"MT4"
"Gently undulating plains: dominant soils are sandy or loamy leached grey earths (Gn2.94) with a strongly developed ironstone nodule horizon at 18-24 in. depth; often this may be cemented to form blocks of massive nodular laterite. Closely associated are other grey earths (Gn2.95), (Gn2.81), (Gn2.82), and (Gn2.85) and various yellow earths (Gn2.21), (Gn2.22), (Gn2.24), (Gn2.35), and (Gn2.61). Throughout the unit there may also be low rises of sandy or loamy red earths (Gn2.12 and Gn2.11). Better-defined drainage depressions have loamy duplex soils, chiefly (Dy3.42), (Dy3.43), and (Dy2.43). Occurs on sheet(s): 4"
"MT5"
"Gently undulating fan deposits: chief soils are acidic and neutral grey leached earths (Gn2.94 and Gn2.95) on the fine sandy (bull-dust) flats. Associated are (Dy3.41 and Dy3.42) soils along the toe of the fan, with (Uc2.31) soils on sandy banks, 3-4 ft high, above the flats. Minor soils include (Uc2.21), (Uc4.2), and others. As mapped, small areas of unit Mb13 are included, as are trachyte dykes with (Uc2.12) soils and bare rock. Occurs on sheet(s): 4"
"MT6"
"Gently undulating fan deposits: chief soils are acidic grey leached earths (Gn2.94) with (Gn2.95) and (Gn2.75) on the slightly depressional (bull-dust) flats. Associated are (Dy2.43) soils on flats of the fan toe and gravelly (Um2.21) and (Um4.1) soils on sandy gravelly banks, 1-4 ft above the flats in apex and medial fan positions. Minor soil occurrences include gravelly (Gn2.14) and (Gn2.24) on the sandy banks and some (Um2.12) over iron-manganese hard-pans. As mapped, areas of unit P16 are included. Occurs on sheet(s): 4"
"MT7"
"Plain: chief soils are acid Fey earths (Gn2.94) often in fairly intimate association with leached sands (Uc2.22) that have a clay D horizon at depths of 3-8 ft. Associated are small areas of (Dy3.81) soils containing ironstone gravels. Occurs on sheet(s): 5"
"MT8"
"Gently undulating terrain of broad shallow valleys and low ridges with moderate amounts of laterite and lateritic (ironstone) gravel: chief soils of the broad shallow valleys are acid grey earths (Gn2.94) sometimes containing ironstone gravels and possibly with some (Dy5.81) and/or (Dy5.41) soils also. Associated are leached sands (Uc2.2 and Uc2.3) in valley deposits and outwash areas; (Dy3.61) and (Dr2.61) soils containing ironstone gravels on ridges and their slopes and areas of block laterite; and minor areas of various soils such as (Um4.2), (Dr2.21), and (Dy3.21) on river terraces. As mapped, areas of unit Tc5 may be included. Occurs on sheet(s): 5"
"MT9"
"Undulating with long ridges: chief soils of the undulating areas are acid Fey earths (Gn2.94) sometimes containing ironstone gravels. Associated are ridges and knolls of (Dy3.61) and (Dr2.61) soils containing ironstone gravels and areas of block laterite; and smaller areas of other soils. Occurs on sheet(s): 5"
"MT10"
"Extensive level plains: dominant soils are loamy mottled bleached grey earths (Gn2.91), with (Gn2.94) closely associated. Ironstone nodules may occur at depth and in some soils a cemented hardpan may occur at relatively shallow depths. Associated are very similar mottled earths (Gn2.95), (Gn2.81, Gn2.82, Gn2.84, Gn2.85), (Gn2.71, Gn2.74), (Gn2.51, Gn2.54), (Gn2.64, Gn2.61), and less commonly (Gn2.34) and (Gn2.25). Adjacent to small drainage lines loamy mottled duplex soils of unit Vd8 occur. Throughout the unit there are small low sandy rises of unit MT11, and occasional small islands of sandy red earths (Gn2.14). Occurs on sheet(s): 7"
"MT11"
"Gently undulating slightly elevated sandy rises and old sand-filled stream channels: dominant soils are deep sandy bleached grey earths (Gn2.94), with associated sandy bleached yellow earths (Gn2.74) and (Gn2.34, Gn2.35). Higher sandy areas have deep bleached sands (Uc2.21, Uc2.22). Associated marginally are plains with loamy grey earths of unit Mc5. Occurs on sheet(s): 7"
"MT12"
"Gently undulating plains consisting of low sandy rises and broad shallow drainage depressions; small isolated dissected sandstone or lateritic mesas occur in parts of the unit: dominant soils of the rises are sandy bleached mottled grey earths (Gn2.94), with associated sandy grey earths (Gn2.81), sandy yellow earths (Gn2.34), (Gn2.24), (Gn2.64), and (Gn2.74), and bleached sands (Uc2.21). Most of these soils are underlain by weathered sandstone at moderate depths. Occasional higher rises have sandy red earths (Gn2.14). The shallow drainage depressions have loamy bleached grey earths (Gn2.94, Gn2.95) and loamy duplex soils (Dy2.41, Dy2.42) and (Dy3.43). Adjacent to

larger streams are small levees of loamy or sandy red earths (Gn2.14). The small dissected mesas are remnants of unit Bz17. Occurs on sheet(s): 7"
"MT13"
"Gently undulating lands, some higher ridges have large granite tor outcrop: dominant soils are moderately deep sandy bleached grey earths (Gn2.94). Closely associated are moderately deep bleached sands (Uc2.12) and (Uc2.21, Uc2.22), with lesser (Uc4.2). Sandy or loamy duplex soils (Dy3.43, Dy3.42) are common on lower slopes. Occurs on sheet(s): 7"
"MT14"
"Very gently undulating plains with some massive laterite outcrop: dominant soils are loamy bleached mottled grey earths (Gn2.94), with associated mottled yellow earths (Gn2.74). Loamy red earths (Gn2.14), with lesser (Gn2.15), are common on the low rises, while loamy duplex soils (Dy2.42) and (Dy3.42, Dy3.43) occur in drainage depressions and on narrow stream flood-plains included in the unit. Shallow bleached sands (Uc2.12) occur adjacent to laterite outcrop or where it is within about 24 in. of the surface. Occurs on sheet(s): 7"
"MT15"
"Gently undulating plains: dominant soils are loamy or, less commonly, sandy bleached mottled grey earths, chiefly (Gn2.94) but occasionally (Gn2.95, Gn2.91); similar bleached mottled yellow earths (Gn2.74) are usually associated. The grey or yellow earths commonly have ironstone nodules at depth. Slightly higher rises on the plain and narrow stream levees have loamy or sandy red earths (Gn2.14). In lower sites and in drainage depressions loamy duplex soils occur, chiefly (Dy3.43) and (Dy2.43), occasionally (Dy3.41) and (Dy3.81). In some areas there are low rises of gravel-strewn gilgaied soils with clays (Ug5.5) and (Ug5.24) on the puffs and brown friable earths (Gn3.51) in the depressions. Occurs on sheet(s): 7"
"MT16"
"Undulating lands with broad ridge crests: dominant soils on slopes are probably sandy or loamy bleached grey earths (Gn2.94), with bleached yellow earths (Gn2.74) associated on the slopes and (Gn2.95) soils on the valley floors. The broad ridge crests have deep sandy red earths (Gn2.14). Associated with minor streams are small areas of loamy duplex soils (Dy3.43). Data are extremely limited. Occurs on sheet(s): 7"
"MT17"
"Gently undulating plains with many low sandy rises: dominant soils are probably loamy bleached grey earths (Gn2.94), with associated (Gn2.95). The low sandy rises are small remnants of unit Mr11 with sandy yellow earths (Gn2.24) and (Gn2.74). Adjacent to drainage lines are loamy duplex soils (Dy3.43) of unit Va87. Data are very limited. Occurs on sheet(s): 7"
"MT18"
"Undulating or gently undulating plains: dominant soils are deep sandy bleached grey earths (Gn2.94), with sandy yellow earths (Gn2.74), (Gn2.34), and (Gn2.24) often associated. The soils are usually strongly nodular at depth. On slightly higher broad ridge crests sandy red earths (Gn2.14) or yellowish red earths (Gn2.24) commonly occur. In some drainage depressions sandy or loamy duplex soils (Dy3.42, Dy3.43) occur. In the northern occurrences of the unit there may be small lower plains with the slightly gilgaied brown friable earths (Gn3.51) of unit MW1. Data are limited. Occurs on sheet(s): 7"
"MT19"
"Very gently undulating or level plains: dominant soils are deep sandy bleached mottled grey earths (Gn2.94) with similar yellow earths (Gn2.74) commonly associated. Less common are areas of deep bleached sands (Uc2.21) or deep-surfaced sandy duplex soils (Dy3.81) and (Dy5.81). On slightly higher rises and on stream levees are deep sandy red earths (Gn2.14). In shallow drainage depressions throughout the unit there are loamy duplex soils (Dy3.42), or occasionally (Dy3.43). Occurs on sheet(s): 7"
"MT20"
"Moderately undulating lands with some high-level old surfaces now strongly dissected by streams; near the marginal high hills the landscape is strongly undulating: dominant soils are deep sandy bleached grey earths (Gn2.94), with lesser similar bleached yellow earths (Gn2.74). Associated are some areas of deep bleached sands (Uc2.32) and (Uc2.21) and gleyed sandy duplex soils (Dg2.41) and (Dg4.41). Adjacent to the marginal granite hills are sandy red earths (Gn2.14, Gn2.11), deep sandy duplex soils (Dy2.61) and (Dy2.51), or shallow sands (Uc2.21), (Uc2.12), and (Uc4.21) adjacent to rock outcrop. Occurs on sheet(s): 7"
"MT21"
"Undulating high-level plains bounded by the steep hilly scarps of unit Mx2 on the east and the high hills of unit JK35 on the west: dominant soils are probably deep sandy bleached grey earths (Gn2.94), with other sandy earths (Gn2.74), (Gn2.64), (Gn2.24), and (Gn2.14) associated. Adjacent to drainage lines are gently undulating plains with deep bleached sands (Uc2.21). Data are extremely limited. Occurs on sheet(s): 7"
"MV1"
"Very gently undulating alluvial plains with many old stream channels and levees: dominant soils are deep sandy mottled yellow earths (Gn2.63), with other sandy earths (Gn2.23), (Gn2.83), and (Gn2.43) associated. Lesser neutral sandy earths (Gn2.62) and (Gn2.82) also occur; occasionally these have ironstone nodules in the profile. On

the sandy rises are deep yellow earthy sands (Uc5.22), with lesser (Uc5.23), (Uc5.21), and (Uc5.11). Occurs on sheet(s): 7"
"MW1"
"Gently undulating or undulating plains: dominant soils of the slopes and lower sites are slightly gilgaied (6 12 in.) brown friable earths (Gn3.51), with less commonly (Gn3.71). The soils are usually underlain at depth by very dense pedal alkaline heavy clays. In many depressions sink-holes are present to a depth of 18 in. Some puffs have a gravel-strewn surface. Closely associated, particularly in lower sites, are small areas of slightly gilgaied cracking clays (Ug5.26), (Ug5.33), and (Ug5.22). On upper slopes and on broad ridge crests throughout the unit loamy yellow earths (Gn2.61), (Gn2.64), and (Gn2.21) are common. Occurs on sheet(s): 7"
"MX1"
"Strongly undulating to low hilly high plateaux with very steep scarped margins, occasional isolated high hilly ranges; granite outcrop is often prominent: dominant soils are probably yellow friable earths (Gn3.71) of shallow to moderate depth. Closely associated are shallow loams (Um5.41) and (Um5.51), or occasionally sands (Uc4.2). Other friable earths also occur, chiefly (Gn3.74), (Gn3.14), (Gn3.21), and (Gn3.51, Gn3.54). Data are limited. Occurs on sheet(s): 7"
"MX2"
"High hilly to hilly lands with some mountainous areas, slopes are very steep with much massive granite rock outcrop on the mountains: dominant and associated soils are probably the same as unit MX1 but there may be greater areas of shallow stony sands on the mountainous parts. Data are extremely limited. Occurs on sheet(s): 7"
"MY1"
"Gently undulating plateau elements sometimes sharply incised by narrow valleys. The boundary of this unit is frequently formed by breakaways but it may at times merge beneath the adjacent plain. These areas are capped by the Robe pisolite iron ore formation. The chief soils are gravelly acid red earths (KS-Gn2.11) with (Dr2.33) soils on the pediments. Occurs on sheet(s): 6"
"MY2"
"Gently sloping to flat plateaux or plains with laterites (bauxitic in places) and lateritic boulders and gravels; narrow stream valleys: chief soils are probably ironstone gravels in a red earth matrix (KS-Gn2.11 and KS-Gn2.12) together with red earths (Gn2.12 and Gn2.11) and yellow earths, such as (Gn2.21). Other soils include (Uc5.22 and Uc5.21) in sandy areas; and some (Gn2.14) soils in locally moist valley side slope situations. As mapped, areas of units My84, MY3, AC13, and BY1 are included. Occurs on sheet(s): 8"
"MY3"
"Flat to gently undulating plateaux characterized by lateritic gravels and boulders that are highly bauxitic: narrow valleys: chief soils are ironstone (bauxitic) gravels in a red earth matrix (KS-Gn2.11 and KS-Gn2.12), often with bouldery bauxitic ridges and seams on the plateaux. Other soils marginal to the plateaux include (Gn2.21) on valley side slopes; (Uc5.21) in sandy fill areas; and (Gn2.14) in locally moist valley side slope situations. As mapped, areas of units MY2 and AC13 are included. Occurs on sheet(s): 8"
"MY4"
"Low lateritic residuals: chief soils are probably ironstone gravels in a red earth matrix (KS-Gn2.11, KSGn2.12) with (KS-Uc4.12) also. Small areas of other soils may occur. Occurs on sheet(s): 10"
"MZ1"
"Ranges and their slopes on granites, gneisses, and allied rocks: chief soils seem to be ironstone gravels with earthy (KS-Gn2.21) and (KS-Gn2.1) and sandy (KS-Uc2.12) matrices. Other soils may occur. Occurs on sheet(s): 5"
"Ma1"
"Montane region at moderate elevation: steep hill slopes of red earths (Gn2.11) with areas of other soils including hard acidic red soils (Dr2.21) and hard acidic yellow mottled soils (Dy3.21). Occurs on sheet(s): 2"
"Ma2"
"Mountainous at moderate elevation: small areas of organic loamy soils (Um7.11) at the highest altitude passing to red earths (Gn2.11 and Gn2.14) on the slopes, and with hard acidic yellow mottled soils (Dy3.41) on the drier slope positions. Occurs on sheet(s): 2"
"Ma3"
"Low hills and ridges of red earths (Gn2.15) and other undescribed soils, together with soils of the unit CC11 on the small areas of undulating plain between the ridges and low hills. Occurs on sheet(s): 2"
"Mb1"
"Hills and hill slopes: yellow leached earths with whole-coloured subsoils (Gn2.34) and mottled subsoils (Gn2.74) in association with leached sands (Uc2.2 and Uc2.3); minor areas of other soils common to adjacent map units. Mb1 is the same as unit EE1 of Sheet 1. Occurs on sheet(s): 2"
"Mb2"
"Dissected sandstone plateau of moderate to strong relief with sandstone pillars, ledges, and slabs-level to undulating ridges, irregularly benched slopes, steep ridges, cliffs, canyons, narrow sandy valleys: chief soils are (i) on areas of gentle to moderate relief, acid yellow leached earths (Gn2.74) and (Gn2.34) and acid leached yellow

earths (Gn2.24)-sometimes these soils contain ironstone gravel; and (ii) on, or adjacent to, areas of strong relief, siliceous sands (Uc1.2), leached sands (Uc2.12) and (Uc2.2), and shallow forms of the above (Gn2) soils. Associated are: (i) on flat to gently undulating remnants of the original plateau surface, leached sands (Uc2.3), siliceous sands (Uc1.2), sandy earths (Uc5.22), and (Gn2) soils as for (i) above (these areas are in part comparable with unit Cb29); (ii) on flat ironstone gravelly remnants of the original plateau surface, (Gn2) soils as for unit Mb5 (i); (iii) on gently undulating ridges where interbedded shales are exposed, shallow, often stony (Dy. Occurs on sheet(s): 3"
"Mb3"
"The same as unit Mb2 but with numerous small remnants of units Mg20 and Mm1 generally on the crests and upper slopes of mountains. Occurs on sheet(s): 3"
"Mb4"
"Coastal complex: chief soils are acid yellow leached earths (Gn2.74) and (Gn2.34), hard acidic yellow mottled soils (Dy3.41), and hard acidic red soils (Dr2.21). This unit includes headlands and rugged coastal areas of unit Mb2; ridges and slopes of unit Tb35; low-lying coastal areas of unit Cb27; and some swampy areas. Occurs on sheet(s): 3"
"Mb5"
"Dissected sandstone plateau--"terraced"ridges with flat to hilly crests and steep side slopes, scarps, canyons, rock walls, pillars, and slabs of sandstone: chief soils are acid yellow leached earths and acid yellow earths as follows: (i) flat to undulating areas of the original plateau surface--yellow leached earths (Gn2.74) and yellow earths (Gn2.21) and (Gn2.24) all containing large amounts of ironstone gravels and/or boulders; (ii) gently undulating ridge tops of leached sands (Uc2.12) and (Uc2.3) with open (treeless) areas of acid peats (O) and yellow leached earths (Gn2.74) and (Gn2.34), these areas are in part comparable with unit NZ1; (iii) hilly areas of the (Uc) soils and shallow forms of the (Gn2) soils; (iv) areas of (Dy3.41) and (Dy2.41) soils sometimes containing ironstone gravels on some ridge slopes; and (v) steep slopes with pockets of soil materials from the above soils. The unit has many features comparable with those of unit Mb2. Data are limited. Occurs on sheet(s): 3"
"Mb6"
"Rolling to low hilly--moderately dissected remnant of earlier coastal plain about 200 250 ft above sea level: chief soils are acid yellow leached earths (Gn2.74) and yellow earths (Gn2.64) and (Gn2.24) on the flat to very gently sloping crest areas. Associated are: (Gn3.11) soils on flat-topped crests generally above 200 ft; (Dy3.41), (Dy3.31), and (Dd1.41) soils on lower dissection slopes and some valley floors; (Gn2.94) soils on poorly drained flats; (Gn2.25) soils on some stream levees; and (Gn3.81) soils on some upper dissection slopes. Occurs on sheet(s): 4"
"Mb7"
"Rolling terrain--weakly dissected remnant of earlier coastal plain about 200 250 ft above sea level: chief soils are acid yellow leached earths (Gn2.74) and yellow earths (Gn2.64) on the broad gently sloping crest areas. Associated are: red earths (Gn2.14) on the gently sloping high river terraces generally above 200 ft; (Gn3.84) and (Dy3.41) soils on crests and slopes of rounded rises; (Dy3.42) soils on the second terrace and (Gn2.72) soils on the first terrace of the incised streams; and (Gn2.94) soils on poorly drained flats. Occurs on sheet(s): 4"
"Mb8"
"Gently sloping inclined plateau, at about 400 ft above sea level on the western side and about 200 ft on the eastern side--a remnant of an old coastal plain: chief soils are acid yellow leached earths (Gn2.74) on the lower portions of the plateau, with leached sands (Uc2.31 and Uc2.36) on the mid-plateau areas, and red earths (Gn2.14) on the higher plateau areas. Other soils include (Dy3.81) around the head of re-entrant drainage-ways, (Dy3.41) and (Dr2.41) on dissected scarp edges, and (Gn2.54) on lower plateau surfaces. Occurs on sheet(s): 4"
"Mb9"
"Rolling to low hilly terrain of a weakly dissected sedimentary basin, with gently sloping convex hills below 350 ft above sea level and fairly flat platforms above 350 ft; some significant stream flats: chief soils are acid yellow leached earths (Gn2.74) and acid yellow earths (Gn2.64) on crests and slopes generally below 350 ft. Associated are (Gn2.91) and (Gn2.94) soils on broad stream flats, and (Gn2.14) soils on platforms (above 350 ft) and lower slopes. Other soils include: (Dy3.41) on lower hill slopes; (Gn3.81) and (Gn3.84) on some crests; (Gn2.21) on some stream terraces; and (Uc2.33) on low mounds along some stream flats. Occurs on sheet(s): 4"
"Mb10"
"Gently to strongly undulating portions of old dissected coastal plain, generally less than 150 ft above sea level but with some old platform remnants at 200 ft and isolated sandstone inselbergs to 400 ft: chief soils are acid yellow leached earths (Gn2.74 and Gn2.71) with acid yellow earths (Gn2.64) containing ironstone gravels in some places. Associated are (Dy3.41) soils on mid slopes, (Dy5.81) and (Dg4.81) soils on lower hill slopes and flats, and (Uc2.33 and Uc2.34) soils in sandy areas. Small areas of (Gn2.14) soils on platform remnants, (Uc4.1) and (Uc1.2) soils on sandstone inselbergs, and a variety of other soils of local significance are included. Occurs on sheet(s): 4"
"Mb11"
"Low hilly land of shales and soft sandstones, with broad gently sloping to flat crests and gentle to moderate side slopes to shallow valleys with narrow alluvial flats: chief soils are acid yellow leached earths (Gn2.74) and acid

yellow earths (Gn2.64) on intermediate crests and upper slopes. Associated are red earths (Gn2.14) on the higher crests and upper slopes, and (Dy3.41) on mid and lower slopes and crests of low rises. Other soils include (Dr2.41) and (Dr3.41) on upper slopes, and (Dy2.21), (Dy2.41), and (Gn2.94) on creek flats. Soils are generally of good depth and contain small amounts of ironstone gravels, especially the (Gn2.74) and (Gn2.64) soils. Occurs on sheet(s): 4"
"Mb12"
"Low tilted and dissected coastal plateaux, less than 200 ft above sea level, of flat to gently undulating relief but with some steeper slopes on scarps: chief soils seem to be acid yellow leached earths (Gn2.74) and (Gn2.34), acid yellow leached friable earths (Gn3.84), and some yellow earths (Gn2.24) all often containing some ironstone gravels and/or red hard oxidic nodules. The (Gn3.84) soils tend to be more common on the inland portions of the plateaux. Associated are: red earths (Gn2.14) on slightly higher portions of the plateaux; various (Dy) and (Dr) soils such as (Dy3.21), (Dy3.41), (Dr2.21), and (Dr3.41) on the scarps; and other soils such as (Gn4.64), (Db1.41), (Db2.42), and (Dy3.81) on the gentle back slopes (dip slopes) of the plateaux. This unit has similarities with unit Mw22. As mapped, small areas of units Tb87, Tb88, and Sk5 are included. Occurs on sheet(s): 4"
"Mb13"
"Rolling to low hilly terrain on sandy metamorphic rocks; gently rounded hill crests with gentle side slopes to narrow alluvial flats along poorly defined drainage-ways: chief soils are extremely gravelly acidic yellow leached earths (Gn2.34) with similar (Gn2.54) soils, both underlain by mottled clay D horizons at depths of 2-40 in. or rock at depths of 20-30 in. Associated are (Dy3.41) soils on lower slopes and flats. Minor occurrences include complexes of (Um2.12) and gravelly (Dy3.41) soils on crests and upper slopes, gravelly (Gn2.14) soils on fans, (Gn2.94) soils on flats, and (Dr3.41) soils on hill slopes. Occurs on sheet(s): 4"
"Mb14"
"Rolling to low hilly lands as for unit Mb13 of extremely gravelly (Gn2.34) soils interspersed with broad alluvial flats of (Gn3.04) soils as for unit MF8. Occurs on sheet(s): 4"
"Mb15"
"Flood-plains and adjacent side slopes: chief soils are probably acid yellow leached earths (Gn2.74 and Gn2.71), and (Gn2.34), with yellow and brown earths (Gn2.61 and Gn2.64) and (Gn2.41 and Gn2.42). Other soils include (Dy3.4), (Ug5.5), (Ug5.6), and (Ug5.2). As mapped, small areas of units CC57, JJ31, and My76 may occur, and possibly some (Um6.21), (Uf6.32), and (Gn3.4) soils where small limestone plains have been included. Occurs on sheet(s): 8"
"Mb16"
"Flood-plains with numerous channels and some swampy areas: chief soils are probably acid yellow leached earths such as (Gn2.74 and Gn2.71) and (Gn2.34) in association with cracking clays such as (Ug5.5) and (Ug5.2). Other soils include the undescribed soils of swampy areas. Occurs on sheet(s): 8"
"Mb17"
"Undulating to gently undulating lands with occasional low lateritic scarps and some small level plains: dominant soils of the undulating areas are loamy nodular bleached mottled yellow earths (Gn2.74), with very similar (Gn2.64) soils closely associated, mostly on the better-drained sites. Massive nodular laterite often occurs at shallow depths in the profile. The low lateritic scarps have shallow gravelly and nodular loams (Um5.51), with small areas of loamy nodular red, yellow, or brown earths (Gn2.14), (Gn2.24), (Gn2.44), and (Gn2.54) occurring away from the crest of the scarp. Small level plains occurring throughout the unit have loamy yellow-grey duplex soils (Dy3.13) and (Dy3.23), with lesser (Dy3.33), (Dy3.43), and (Dy3.83). Closely associated on some plains are small areas of deep grey cracking clays (Ug5.24, Ug5.28). Near the coast and adjacent to tidal streams, salt-pan soils of unit Io1 are common, and fringing the coast there may be narrow sand dunes of unit A20. Occurs on sheet(s): 7"
"Mb18"
"Gently undulating outwash fan plains, often bounded by steep sandstone scarps with moderately undulating foot slopes; occasional high stony ridges may also occur: dominant soils are sandy or rarely loamy bleached mottled yellow earths (Gn2.74), but other earths are commonly associated, chiefly (Gn2.64), (Gn2.54), (Gn2.75), (Gn2.94), (Gn2.91), (Gn2.34), and (Gn2.24). Red earths (Gn2.14) are common adjacent to streams. In lower sites loamy grey duplex soils (Dy3.41), (Dy3.42), and (Dy3.82) occur. Where the unit is adjacent to the sand dunes of unit B36 small plains of deep bleached sands (Uc2.33, Uc2.31) occur. The stony ridges are small remnants of unit Tb141. Occurs on sheet(s): 7"
"Mb19"
"Gently undulating or undulating lands with broad ridge crests and shallow drainage depressions: dominant soils are loamy or sandy bleached mottled yellow earths (Gn2.74), with similar (Gn2.64) and (Gn2.94) soils often closely associated. Most soils have a prominent ironstone nodule horizon at depth and some are nodular throughout the profile; massive nodular laterite may occasionally outcrop. On the higher ridge crests sandy or loamy red earths (Gn2.14) are common. In the better-defined drainage depressions are sandy or loamy grey duplex soils (Dy3.43,

Dy3.42), and similar (Dy2) soils. Occasionally in lower sites there may be small areas of slightly gilgaied friable yellow or brown earths (Gn3.71) and (Gn3.51). Occurs on sheet(s): 7"
"Mb20"
"Gently undulating plains: dominant soils are sandy bleached mottled yellow earths (Gn2.74), which usually have a prominent ironstone nodule horizon at depth. Closely associated are similar nodular sandy earths, chiefly (Gn2.94), (Gn2.34), (Gn2.24), (Gn2.64), and (Gn2.21). On some low ridge crests massive nodular laterite may outcrop. In narrow well-defined drainage depressions loamy grey earths (Gn2.94, Gn2.95) and loamy duplex soils (Dy3.42, Dy3.43) occur. Occurs on sheet(s): 7"
"Mb21"
"Gently undulating to undulating plains with well-defined drainage depressions: dominant soils are deep sandy bleached mottled yellow earths (Gn2.74), with similar bleached grey earths (Gn2.94) closely associated. On higher ridge crests small areas of deep sandy red (Gn2.14) or yellow (Gn2.24) earths occur. On some slopes there are areas of deep bleached sands (Uc2.21) or deep sandy duplex soils (Dy4.81). The drainage depressions have sandy or loamy duplex soils (Dy3.43, Dy3.42), or occasionally deep bleached sands (Uc2.21). Occurs on sheet(s): 7"
"Mb22"
"Undulating lands with occasional high linear strike ridges or low hills: dominant soils are loamy or occasionally sandy bleached mottled yellow earths (Gn2.74), with other earths (Gn2.64), (Gn2.94), and (Gn2.24) closely associated; occasionally red earths (Gn2.14, Gn2.11) occur on higher broad ridge crests. All earths have a prominent ironstone nodule horizon at depth and massive nodular laterite often outcrops on slopes. Occurring throughout the unit, particularly in more dissected areas, are gravel-strewn ridges which are small inclusions of unit Sd3. The low hills have shallow stony loams (Um4.12) or sands (Uc4.12) and (Uc2.12). In lower sites and on small alluvial plains loamy duplex soils (Dy3.43) and (Dy3.83, Dy3.81) occur. In parts of the unit where basic rocks are exposed there may be small areas of red friable earths (Gn3.12, Gn3.11). Occurs on sheet(s): 7"
"Mb23"
"Gently undulating plains; the unit is similar to unit Mb22 but with lesser relief: dominant and associated soils are as for unit Mb22 but there are very few inclusions of unit Sd3 and no areas of red friable earths. Loamy nodular red earths (Gn2.11, Gn2.14) are more important associated soils. Data are fairly limited. Occurs on sheet(s): 7"
"Mb24"
"Gently undulating plains: dominant soils are deep sandy bleached mottled yellow earths (Gn2.74), usually with a prominent ironstone nodule horizon at depth. On slightly higher broad ridge crests there are important areas of deep sandy red earths (Gn2.14, Gn2.11), or occasionally deep bleached sands (Uc2.21). In some areas there are low gravel-strewn ridges with the loamy yellow duplex soils of unit Sd3. Occurs on sheet(s): 7"
"Mb25"
"Moderately undulating lands: dominant soils are deep sandy bleached mottled yellow earths (Gn2.74), with deep sandy red earths (Gn2.14) occurring on the ridge crests. On some higher ridges loamy nodular red earths (Gn2.11) occur, with some outcrops of massive nodular laterite. Occasional low sandstone hills have shallow stony sands (Uc4.12). Occurs on sheet(s): 7"
"Mc1"
"River floodplains and terrace remnants: floodplains with high seasonal water-table, largely of undescribed soils, but including wet earths (Gn2.8), other undescribed soils on terrace remnants. Occurs on sheet(s): 2"
"Mc2"
"River flood-plains and levees: chief soils on flood-plains and levee back slopes are acid grey earths (Gn2.81) and (Gn1.84). Associated are levee banks of dark porous loamy soils (Um6.11) and/or other loamy soils, such as (Um5.2); and present flood-plain deposits of (Uc) soils and (Um) soils. As mapped, areas of units J3 and Tb43 are included. Occurs on sheet(s): 3"
"Mc3"
"River flood-plains and levees: chief soils on flood-plains and levee back slopes are acid grey earths (Gn2.81) and (Gn3.91), and/or deep, dark cracking clays (Ug5.16), and/or friable acidic yellow mottled soils (Dy5.11). Associated are: levee banks of dark porous loamy soils (Um6.11) and/or (Um6.12); and various (Uc) and (Um) deposits of the present flood-plain. As mapped, areas of unit Mc4 are included. Dominant soil is not clearly known. This unit has similarities with units Mc2, NY2, and Kf1. Occurs on sheet(s): 3"
"Mc4"
"River flood-plains and swamps: chief soils on flood-plains are acid grey earths (Gn2.81) and (Gn3.91), and/or deep, dark cracking clays (Ug5.16), and/or friable acidic yellow mottled soils (Dy5.11). Associated are swamps and swampy areas of various undescribed soils. As mapped, areas of unit Mc3 are included. Dominant soil is not clearly known. This unit has similarities with units J3, NY1, and NN1. Occurs on sheet(s): 3"
"Mc5"
"Level plains with numerous small swampy depressions and occasional slightly elevated sand-filled old stream channels and levees: dominant soils of the plains are loamy mottled grey earths (Gn2.81, Gn2.84); similar bleached loamy grey earths (Gn2.94, Gn2.91) are closely associated. Also occurring locally are similar mottled yellow earths

(Gn2.74) and (Gn2.61). Ironstone nodules are prominent in some soils. Adjacent to the small swamps are loamy duplex soils (Dy3.33) and (Dy3.43), with similar neutral and occasionally acid forms associated. The low sandy rises and filled old stream channels are areas of unit MT11 too small to map separately. Occurs on sheet(s): 7"
"Md1"
"Gently undulating plateau remnants with some steep slopes: red friable earths (Gn3.12) in association with dark friable earths (Gn3.43) and hard neutral dark soils (Dd1.12) and minor areas of red friable porous earths (Gn4.11) on the plateau tops and upper slopes; some areas of dark cracking clays (Ug5.15 and Ug5.16) and other soils such as (Gn3.91) on lower slopes. Occurs on sheet(s): 2"
"Md2"
"Undulating to low hilly plateau remnants: low hills and knolls of red friable soils (Gn3.12) and red friable porous earths (Gn4.11) with other soils such as (Gn3.43) and (Dd1.12) and also at their base some hummocky areas of hard alkaline dark soils (Dd1.23) on mounds and dark cracking clays (Ug5.15) in depressions; sandsheets of leached sands such as (Uc4.31) and other soils; dune and terrace remnants at intermediate levels of sandy neutral and alkaline yellow mottled soils (Dy5.42 and Dy5.43) with hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43); narrow stream valleys of dark cracking clays (Ug5.16) some of which are saline. Occurs on sheet(s): 2"
"Md3"
"Undulating to hilly dissected tableland with some rounded hills, flat-topped ridges, and small valley plains; a multicyclic erosional landscape: upper slopes generally and ridge tops of red and brown friable earths (Gn3.12 and Gn3.22) with friable neutral red soils (Dr4.12) in association with cracking clays (Ug5.1, especially Ug5.12, Ug5.13, and Ug5.15) on mid and lower slopes, and also some dark friable earths (Gn3.41) on lower slopes, and in association with valley plains of various cracking clays (Ug5.1); hard neutral red soils (Dr2.12) occur on the crests of some hills; stony dark porous loamy soils (Um6.21) occur on some lower hill slopes; also other soils described from the area apparently code as (Dd3.11 and Dd3.12), (Um6.1), and (Ug5.2). Occurs on sheet(s): 2"
"Md4"
"Hills with some gentle slopes and flats: moderately steep to gentle hill slopes of red friable earths (Gn3.12 and Gn3.13), grading, down slope, to gently sloping to flat areas of hard alkaline red soils (Dr2.23) and, up slope, to stony hill-tops of shallow soils, possibly friable loamy soils (Um6); also in association with deep dark cracking clays (Ug5.15) and small areas of brown cracking clays (Ug5.3) on gentle to moderate slopes where conditions are relatively moist and drainage is relatively restricted. Occurs on sheet(s): 2"
"Me1"
"Hilly with some steep slopes and small graded valleys: moderately steep rounded hills of brown and red friable earths (Gn3.21, Gn3.22, Gn3.11, Gn3.12, and Gn3.14) in association with less rounded hill slopes of hard acidic yellow mottled soils (Dy3.41) and (Dy3.21), hard acidic red soils (Dr2.21), and yellow leached friable earths (Gn3.54), and also other hill slopes of loamy soils having an A2 horizon (Um4.2) with yellow-brown earths (Gn2.44); stream valleys of various soils including (Dy4.41) (Dy5.41), and (Um6.11). This unit is a broad one. In some areas the (Dy) and (Dr) soils with the (Um4.2) and the (Gn2.44) soils are.dominant rather than the (Gn3) soils. Occurs on sheet(s): 2,3"
"Me2"
"Steep hilly to mountainous with incised stream valleys: steep but more or less rounded hill slopes of brown friable earths (Gn3.21 and Gn3.22) and possibly some (Gn4) soils, in association with: at the higher altitudes, steep hill slopes of sandy soils (Uc4.2), loamy soils having an A2 horizon (Um4.2) with yellow-brown earths (Gn2.44), and possibly (Uc6.11) and (Um5.41) soils; and at the lower altitudes, moderate to steep slopes of hard acidic yellow mottled soils (Dy3 21 and Dy3.41), hard acidic red soils (Dr2.21), and yellow leached friable earths (Gn3.54); and narrow incised stream valleys of various soils including (Um6.11) and (Dy) soils. This unit is a broad one. In some areas the (Um4.2) and (Gn2.44) soils and in others the (Dy) and (Dr) soils rather than the (Gn3) soils could be dominant. Occurs on sheet(s): 2,3"
"Me3"
"Undulating to hilly basaltic ridge: chief soils are brown friable earths (Gn3.22) with (Um6) soils, such as (Um6.21), and with dark cracking clays (Ug5.15) in the lower-lying situations. Occurs on sheet(s): 3"
"Me4"
"Undulating or occasionally low hilly lands with some residual mesas: dominant soils are brown friable earths (Gn3.23 and Gn3.22) with also some red friable earths (Gn3.13). Other gradational soils occur, chiefly (Gn2.12), (Gn2.13), (Gn2.41),and (Gn2.81), together with smaller areas of uniform clays (Uf6.31). Small areas of cracking clays (Ug5.22 and Ug5.24) occur in some lower sites and high ridge crests have shallow red or brown duplex soils (Dr2.12), (Dr2.13), and (Db1.13). The occasional sandstone mesas have shallow sands (Uc1.21) or loams (Um1.41) both of which are often stony. Occurs on sheet(s): 4"
"Me5"
"Moderately hilly country on conglomerate, sandstone, and mudstones with steep slopes grading down to moderate and gentle colluvial slopes: chief soils are brown friable earths (Gn3.22) with other friable earths including

(Gn3.92) on the slopes. Associated are various (Uf) and (Um) soils such as (Uf6.3) and (Um6.4) on the steeper slopes. Minor soil occurrences include (Gn3.11) and (Dr2.41) on scarps adjoining the lateritic plateau, some (Dy) and (Db) soils, and some (Ug5.1) soils. Occurs on sheet(s): 4"
"Me6"
"Close pattern of hills with rounded crests and short moderate to steep slopes below the scarp of the adjacent (Gn3.11) plateau; sedimentary and igneous rocks; some outcrop on crests: chief soils are brown friable earths (Gn3.22) on mid to lower slopes. Associated are (Um4.1) soils on ridge crests and upper steep slopes, (Gn3.42 and Gn3.41) on mid to lower slopes, and some (Ug5.16 and Ug5.14) on low broad crests and lower slopes. Minor soil occurrences include (Um4.2 and Um4.3) soils on ridges. Several small plateau areas of units Mp4 and/or Mz12 are included. Occurs on sheet(s): 4"
"Me7"
"Low hilly granitic lands with tor clusters on upper slopes grading into long gentle slopes and broad concave sloping depressions: chief soils are brown (Gn3.22) and dark (Gn3.42) friable earths. Associated are (Ug5.15) soils on concave drainage floors and depressions, (Um5.1) soils on crests, and (Ug5.12) soils on inclusions of basic rocks. Minor soil occurrences include (Dy3.41), (Dr3.22), and (Dy3.2). Occurs on sheet(s): 4"
"Me8"
"Low hilly area of tertiary sediments and igneous rocks: chief soils are brown (Gn3.22) and dark (Gn3.42) friable earths and shallow dark cracking clays (Ug5.12) on the deeply altered igneous rocks; with (Dr2.41), (Dy3.41), and probably (Dd1.41) soils on siltstones. Other soils include (Db4.11) and (Gn3.91) on shales, (Uc4.1) and (Uc2.12) on hard sandstone hills, and (Gn3.74) and (Dr3.41) on soft sandstones. Occurs on sheet(s): 4"
"Me9"
"Gently undulating to level basalt plains and plateaux with a few very low flow scarps and occasional low conical hills; throughout the unit there are low to moderate amounts of large basalt boulders on the surface and through the solum of all soils. Most soils also contain variable to high amounts of small ironstone nodules throughout the B horizons: dominant soils are shallow to moderately deep brown friable earths (Gn3.22), with slightly acid (Gn3.21) and alkaline (Gn3.23) variants occurring locally. Dark cracking clays (Ug5.13, Ug5.12) and occasionally (Ug5.23) occupy the numerous small stony grassy plains. Loamy red friable earths (Gn3.12) are common on slightly elevated areas and flow scarps. Occasional loamy yellow friable earths (Gn3.72) occur associated with the brown friable earths. Occurs on sheet(s): 7"
"Mf1"
"Hilly to steep hilly: moderate to steep slopes of yellow leached friable earths (Gn3.54, Gn3.74, and Gn3.84) in association with shallow sand soils (Uc4.11) and red friable earths (Gn3.14 and Gn3.24), minor areas of sandy acidic yellow mottled soils (Dy5.41, Dy5.61, and Dy5.81) and leached sands (Uc2.3); dissected by streams with narrow valley plains of varied soils including (Um6.32), (Ug6.1), and acid peaty (O) soils. Occurs on sheet(s): 2"
"Mf2"
"Hilly to steep hilly with some flat-topped ridges and terraces in the valleys: slopes as for Mf1 but with some ridge tops of red friable porous earths (Gn4.11); valley plains as for Mf1 but with terraces of hard acidic yellow mottled soils (Dy3.41) and other undescribed soils. Occurs on sheet(s): 2"
"Mf3"
"Rugged mountain terrain at moderate to high elevation: ridges and slopes (1) where the parent soil materials are highly siliceous there are leached sands (Uc2.3) in association with shallow sandy soils (Uc4.11)--both these have highly organic (peaty) surface horizons--and minor areas; of (Dy5.61), (2) where the parent soil materials are not highly siliceous there are yellow leached friable earths (Gn3.54, Gn3.74, and Gn3.84) and red friable earths (Gn3.14); dissected by many streams with narrow valley plains of acid peaty (O) soils often flanked by slopes of various leached sands (Uc2.3); numerous rock outcrops. Occurs on sheet(s): 2"
"Mf4"
"Mountainous--steep to very steep ridges generally with narrow crests and thickly colluviated in places, ravines, gorges, rock outcrops, and hilly valleys along major streams: chief soils are acid yellow leached friable earths (Gn3.54), (Gn3.74), and others (undescribed) with red friable earths (Gn3.14) often co-dominant. Associated are soils such as (Gn4.14) in the more sheltered sites; (Um4.2), (Gn2.24), and (Gn2.44) soils on the more exposed sites; areas of (D) soils as for unit LL4 on lower and mid side slopes; and some (Uc) and (Um) soils, often bouldery, along the stream valleys. As mapped, areas of adjoining units may be included, especially unit LL4. Occurs on sheet(s): 3"
"Mf5"
"Hilly to steep hilly with narrow valleys along the streams: moderate to steep slopes of yellow leached friable earths (Gn3.74 and Gn3.84) with red friable earths (Gn3.14) often co-dominant. Associated are shallow soils, such as (Um4.1 and Um4.2) and (Uc4.1), on hill crests and upper slopes; (Dr2.21), (Dy3.21), and related soils on the drier, more exposed, mid to lower slopes; some areas of (Gn2.14) soils; and minor occurrences of other undescribed soils. The whole area is traversed by narrow valleys of variable soils, largely undescribed, but

including (Um6.11) on terraces and (Dg4) and (Dy5) on flood-plains. As mapped, small but significant areas of unit Mg24 are included in the N.S.W. occurrences. Compare units Mj3 and Mj4. Occurs on sheet(s): 3,4"
"Mf6"
"Old coastal plain or plateau about 200 ft above sea level, of rolling relief and generally shallow open valleys: chief soils are acid yellow friable earths (Gn3.51 and Gn3.54), (Gn3.71 and Gn3.74) on crests and upper slopes. Small areas of other soils include: (Gn3.81 and Gn3.84) on some upper slopes; (Gn2.71), (Gn2.74), and (Gn2.94) on high sandy platforms; (Dy3.41) on dissection slopes; and (Gn3.91), (Gn3.94), and (Dy3.31) along stream valleys. Occurs on sheet(s): 4"
"Mf7"
"Steep hilly terrain of generally convex hills with steep side slopes, marked local fan development, and narrow creek flats: chief soils are acid yellow friable earths (Gn3.71) and (Gn3.54) on slopes and fans. Associated are (Um4.1) soils on hill crests and (Gn3.14) soils on fans and lower slopes. Other soils include: (Gn3.11), (Ug5.14), and (Gn3.91) on basalt caps on the highest hill crests; (Um6), (Gn2.91), and (Gn2.94) on valley flats; and (Um2.12) on some hill crests. Occurs on sheet(s): 4"
"Mf8"
"Hilly dissected plateau remnants about 600 ft above sea level with included higher granitic peak at 1400 ft--generally convex hills with moderate slopes and marked fan development, narrow creek flats: chief soils are acid yellow friable earths (Gn3.71) and (Gn3.54) on slopes and fans. Associated are (Gn3.14) soils on fans and (Um4.1) soils on hill crests. Other soils include (Dy5.81) and (Gn3.81) along stream flats, probably (Uc2.12), (Gn2.14), and/or (Dr2.21) on granite, and (Gn3.11), (Ug5.14), and (Gn3.91) where remnants of basalt remain. Occurs on sheet(s): 4"
"Mf9"
"Hilly terrain on phyllites at 40-450 ft above sea level--convex hills with moderate slopes, marked fan development, and narrow stream flats: chief soils are acid yellow friable earths (Gn3.71) on lower slopes and fans and (Gn3.54) on mid slopes. Associated are (Um4.1) soils on crests and (Dr2.21) and (Dr2.41) soils on upper slopes. Other soils included are (Dy3.21) and (Um4.12) on hill crests, (Gn3.14) and (Dr4.21) on mid slopes and basic dykes, and (Gn2.91), (Gn2.94), (Gn2.74), and (Gn2.22) along stream valleys. Occurs on sheet(s): 4"
"Mf10"
"Generally a stepped undulating to low hilly landscape on andesitic tuffs and related rocks at about 200 250 ft above sea level, with flat-topped platforms at an elevation of about 100-150 ft; occasional hills to over 250 ft; narrow valleys: chief soils are acid yellow friable earths (Gn3.74), (Gn3.51), (Gn3.54), and possibly (Gn3.84) on the flatter areas and side slopes. Associated are (Gn3.41) and related soils on side slopes. Other soils include: (Gn3.91 and Gn3.94) on stream flats with (Gn2.64) on the levees; ridges and knolls of (Gn2.14) soils of unit Mw22; and the soils of units Tb70 and Tb71 on included portions of those units. Buried soil materials such as pedal red clays and also lateritic gravels may underlie the (Gn2.14) soils locally. Occurs on sheet(s): 4"
"Mf11"
"Low hilly terrain on sandstones--probably a dissected old coastal plain; elevations between 100 and 180 ft above sea level; slopes are gentle to moderate: chief soils are acid yellow friable earths (Gn3.54) and (Gn3.74) on the slopes and crests of hills. Associated are (Gn2.14) soils on flat-topped crests. Small areas of many other soils occur throughout. Small "valleys"of unit MF4 are included locally. Occurs on sheet(s): 4"
"Mf12"
"Low hilly landscape on sandstone generally below 300 ft above sea level and characterized by trachyte plugs rising abruptly to heights of 950 ft with debris aprons between 300 and 500 ft and mostly vertical bare rock above the aprons: chief soils are acid yellow friable earths (Gn3.74, Gn3.54, and Gn3.84) on crests and slopes of convex hills and (Gn2.14 and Gn2.44) soils on flat-topped crests of hills and ridges. Associated are the dominant soils of unit Mt3 (Gn2.64, Gn2.24, and Gn2.74) on low platforms and terraces along streams. Other soils include (Uc2.12), (Dy3.41), (Db4.21), and (Dy5.41) on trachyte; and (Dy3.41) and (Dy5.21) on sandstone hills. Occurs on sheet(s): 4"
"Mf13"
"Low hilly to hilly dissected plateau above 1400-1600 ft above sea level with crests to 2400 ft; waterfalls and rapids along marginal scarps; rocks are chiefly phyllites and related metamorphics with some greenstones, andesites, and granites: chief soils are acid yellow friable earths (Gn3.74 and Gn3.71) on phyllites on all the gentle to moderate slopes. Associated are: (Gn3.54) soils on upper phyllite slopes; (Gn3.84 and Gn3.81) on lower slopes, fans, and the less well-drained low hilly parts of the plateau; and (Dy3.41) soils on some hill slopes. Minor soil occurrences include: (Gn3.11) and (Gn3.41 and Gn3.42) soils on greenstones and andesites; (Um4.1), (Dr3.21), and (Dy3.41) on phyllitic hill crests and slopes; (Gn2.14) soils on gravelly fans associated with andesites and jasper rocks; and (Uc2.12), (Uc4.2), and (Dy3.41) soils on granite. Occurs on sheet(s): 4"
"Mf14"
"Low hilly to hilly plateau on tuffs, trachyte, and ash generally above 1000 ft above sea level; convex hills with gentle to moderate side slopes to narrow drainage-ways; some narrow stony ridge crests; soils are moderately deep

to deep: chief soils are acid yellow friable earths (Gn3.74). Associated are (Gn3.81) soils on mid and lower slopes and (Um4.1) soils on trachyte crests and steep slopes. Minor soil occurrences include (Gn3.11) on basalt caps, and many others. Occurs on sheet(s): 4"
"Mf15"
"Flat to gently sloping portion of elevated coastal plain (less than 250 ft above sea level): chief soils are acid yellow leached friable earths (Gn3.84 and Gn3.81) on the flat to gently sloping plain. Associated are: (Gn2.74) soils on low crests and along some drainage-ways on the plain; some (Gn2.14) soils adjacent to major dissection scarps; some (Dy3.41), (Dy3.82), and related soils on dissected slopes adjacent to drainage-ways; and (Gn3.04), (Gn3.05), and (Gn2.94) soils on lower slopes of the old plain surface. Occurs on sheet(s): 4"
"Mf16"
"Low hilly land on sandy and clayey alluvia--gentle broad ridge crests at about 20-250 ft above sea level broken by sandstone inselbergs to 400-500 ft; side slopes are gentle to moderate, valleys shallow and narrow: chief soils are probably acid leached friable earths (Gn3.81 and Gn3.84) with (Gn3.74). Associated are (Dy3.41), (Dy5.41), and (Dg4.41) soils on ridge slopes. Other soils include (Uc2.21) on sandstone ridges, yellow (Gn2) soils such as (Gn2.74), and small areas of (Gn2.14). Data are very limited. Occurs on sheet(s): 4"
"Mf17"
"Moderately to strongly undulating or occasionally low hilly plateaux forming the drier western margins of the coastal ranges: dominant soils are moderately deep to deep loamy yellow friable earths (Gn3.74) with lesser (Gn3.84), (Gn3.94), and (Gn3.54). Also closely associated are red friable earths (Gn3.14, Gn3.11). Loamy red earths (Gn2.14, Gn2.17) and deep bleached sands (Uc2.21), (Uc2.12), and (Uc4.2) occur where the unit lies adjacent to unit Ca31. Towards the northern extent of the unit friable loams (Um4.4) and (Um6.34) occur where there is a common boundary with unit LN1. Occurs on sheet(s): 7"
"Mf18"
"High hilly to mountainous lands with much acid or intermediate volcanic rock outcrop: dominant soils are moderately deep to deep loamy friable yellow earths (Gn3.74), with lesser (Gn3.94). Closely associated are other gradational soils including (Gn3.14), (Gn2.44), (Gn2.14), and possibly (Gn2.24) or (Gn2.54). Shallow gravelly loams (Um4.2) and (Um4.12) and sands (Uc2.12) and (Uc4.12) are common on the steeper slopes and ridge crests. Occurs on sheet(s): 7"
"Mf19"
"Strongly undulating to low hilly plateaux: the soils are as for unit Mf18 with the inclusion of small areas of deep red friable earths (Gn3.11) of units Mp19 and Mp20. Occurs on sheet(s): 7"
"Mf20"
"Strongly undulating to low hilly lands with some granite outcrop; ridge and hill crests are mostly rounded: dominant soils are shallow to moderately deep yellowish red friable earths (Gn3.74), but other friable earths (Gn3.71), (Gn3.84), and (Gn3.14) also occur. Shallow Fitty duplex soils (Dr2.61), (Dr2.21), (Dy2.21), (Dy3.41), and (Dy2.41) are commonly associated, particularly on lower slopes. Small alluvial terraces fringing streams have deep red friable earths (Gn3.14) or deep loams (Um4.23) and (Um6.34). Included in the unit, as mapped, are small areas of basic rocks with neutral red (Gn3.12) or brown (Gn3.22) friable earths. Occurs on sheet(s): 7"
"Mg1"
"Broken terrain with some rounded hills: moderate to steep slopes of red friable porous earths (Gn4.11); other soils in variety but not described. Occurs on sheet(s): 2"
"Mg2"
"Hilly: rounded, moderate to steep hill slopes of red friable porous earths (Gn4.11) with small areas of other soils including friable acidic red soils (Dr4.21) on some ridges and friable yellow soils (Dy4.1) on hill slopes in non-basaltic areas, and dissected by narrow, often swampy stream valleys of undescribed soils; small areas of the Rg1 unit occur in the south-eastern portion of this unit also. Occurs on sheet(s): 2"
"Mg3"
"Moderate to steep lower hill slopes in the montane region with basalt boulders and red friable porous earths (Gn4.11) and minor areas of other undescribed soils in the stream valleys. Occurs on sheet(s): 2"
"Mg4"
"Rounded hills with moderate to steep slopes of red friable porous earths (Gn4.11) and other undescribed soils. Occurs on sheet(s): 2"
"Mg5"
"Rounded hills with moderate to steep slopes of red friable porous earths (Gn4.11) dissected by small, often swampy, stream valleys of undescribed soils; also with small areas of other friable earths (Gn4.3 and Gn4.5) around the margins of the unit. Occurs on sheet(s): 2"
"Mg6"
"Low, rolling and rounded hills separated by numerous small valley plains: hills and hill slopes of red friable porous earths (Gn4.11), possibly with small areas of other undescribed soils; small valley plains of various yellow

mottled soils (Dy5) and possibly (Dy3) and with other undescribed soils adjacent to the creeks, high seasonal water-table in the valley plains. Occurs on sheet(s): 2"
"Mg7"
"Undulating to low hilly: rounded hills with gentle to moderate slopes of red friable porous earths (Gn4.11 and Gn4.14) with smaller areas of red and brown friable earths (Gn3.11, Gn3.14, and Gn3.24) and yellow leached earths (Gn3.54, Gn3.74, and Gn3.84), generally on the lower to middle slopes, and with hard acidic brown soils (Db1.11) on rounded slopes above the incised creeks; in association with other low hills of hard acidic yellow mottled soils (Dy3.21, Dy3.41, and Dy3.61) on gentle to moderate slopes, and traversed by shallow, generally ill-drained, valley plains of hard yellow mottled soils (Dy3) and other undescribed soils. Occurs on sheet(s): 2"
"Mg8"
"Montane region at low to moderate elevation: moderate to steep hill slopes of red friable porous earths (Gn4.11), also with a small area of organic loamy soils (Um7.11) on the top of Mt. Macedon.. Occurs on sheet(s): 2"
"Mg9"
"Mountainous: moderate to steep hill slopes of red friable porous earths (Gn4.11) and possibly other related soils. Occurs on sheet(s): 2"
"Mg10"
"Basalt ridges generally with moderate slopes sometimes crumpled by slumping and dissected by streams with small often marshy valley plains: ridges and slopes of red friable porous earths (Gn4.11) with smaller areas of brown friable porous earths (Gn4.31), especially towards the southern limits of the units, minor areas of plastic clay soils (Uf6.41) in poorly drained situations and also dark friable earths (Gn4.41); small inclusions of soils of unit Mf1; unclassified soils in the narrow valley plains. Occurs on sheet(s): 2"
"Mg11"
"Rounded hills: gentle to moderate slopes of red friable porous earths (Gn4.11); small areas of red earths (Gn2.11) on hill tops; unclassified soils on slump benches; small inclusions of soils of units Mf1 and R. Occurs on sheet(s): 2"
"Mg12"
"Rounded hills, undulating peneplains, and small valley plains: rounded hills with gentle to moderate slopes of red friable porous earths (Gn4.11); smaller areas of undulating peneplain remnants of sandy yellow mottled soils (Dy5); and small valley plains of hard yellow mottled soils (Dy3) on terraces, and dark cracking clays (Ug5 and Ug6), probably with (Um) and (Uf) soils on floodplains. Occurs on sheet(s): 2"
"Mg13"
"Rounded hills and hill slopes of red friable porous earths (Gn4.11). Occurs on sheet(s): 2"
"Mg14"
"Ridges and hills: ridge tops and upper slopes of shallow forms of red friable porous earths (Gn4.11) in association with red porous loamy soils (Um6.13); intermediate and lower slopes showing some slumping of soils and features of wetness. Occurs on sheet(s): 2"
"Mg15"
"Ridges and hills with a valley plain: ridge tops and upper slopes as for Mg14 but including an area as for R and flanked by a valley plain of hard yellow mottled soils (Dy3.4) on terraces and dark cracking clays (Ug5.16) on the floodplain. Occurs on sheet(s): 2"
"Mg16"
"Undulating with rounded hills, some with steep slopes, and broad undulating stream valleys, some with gorges in places: undulating areas and rounded hill slopes of red friable porous earths (Gn4.11 and Gn4.14) in association with friable red soils (Dr4.1) and other undescribed soils especially in the lower-lying situations; small areas of red earths (Gn2.14) occur on some hill slopes towards the southern margin of the unit. Occurs on sheet(s): 2"
"Mg17"
"Undulating to hilly country flanked by mountain ranges: rounded hill slopes and ridge tops of red friable porous earths (Gn4.11) surrounded by undulating to hilly areas of brown friable porous earths (Gn4.31) and smaller areas of other soils including hard acidic yellow soils (Dy2.41 and Dy3.41); and dissected by narrow creek valleys of undescribed soils but including dark cracking clays (Ug5.1). Occurs on sheet(s): 2"
"Mg18"
"Gently undulating areas of red friable porous earths (Gn4.11). Data are limited. Occurs on sheet(s): 3"
"Mg19"
"Gently rolling to rounded hilly country occasionally with some steep slopes dissected remnants of the old basaltic plateau: chief soils are red friable porous earths (Gn4.11). Associated are small areas of various soils, including (Um6.21) on the steeper slopes. As mapped, areas of units Tb28, Gd3, and Mb2 are included. Occurs on sheet(s): 3"
"Mg20"
"Mountainous--plateau remnants at moderate to high elevations (2000 ft to >4500 ft)--undulating to hilly with some steep slopes and scarps: chief soils are red and brown friable porous earths (Gn4.11) and (Gn4.31), often

shallow stony or bouldery. Associated are small areas of various soils such as (Gn2.14), (Gn3.1), (Um7.11) on small areas at high elevation, shallow (Um) soils on serpentine, and (Uc) soils on granite. Data are limited. As mapped, soils of units Mm1, Mw6, Pb14, and Mb2 may be included where these units adjoin unit Mg20. Occurs on sheet(s): 3"
"Mg21"
"Plateau remnants at low elevation (~1000 ft): chief soils on the rolling to hilly areas are red friable porous earths (Gn4.11). Associated are (Gn3.11), (Gn3.14), and other (Gn3) soils on rounded hill slopes; shallow (Gn4.31) soils on steep slopes; small swampy valleys of undescribed soils; and on steep scarps of the plateau remnants, (Gn4.14) soils and other soils common to unit LL3. Occurs on sheet(s): 3"
"Mg22"
"Flat to low rolling hills at low elevation (< 1000 ft): chief soils are red friable porous earths (Gn4.11) sometimes with hard ferruginous material below the solum. Data are limited. Occurs on sheet(s): 3"
"Mg23"
"Plateau remnants at moderate elevation (>2000 ft): smooth rounded hills, some with slump slopes, of red friable porous earths (Gn4.11). Stream channels are very narrow. Occurs on sheet(s): 3"
"Mg24"
"Plateaux and plateau remnants at low elevation (< 1000 ft): low rolling hills of red friable porous earths (Gn4.11) generally on moderate to gentle but occasionally steep slopes, and in association with small areas of many different soils, including (Gn4.31). Small areas of units Mf5 and Ml2 are included around plateau edges. In some of the small headland occurrences of the unit, (Gn3.1) soils are present to an unknown extent. Occurs on sheet(s): 3"
"Mg25"
"Plateau remnants: moderate to steep slopes (sometimes modified by slumping) of red and brown friable porous earths (Gn4.11 and Gn4.31) in association with areas of unit Ml2 and sometimes rugged elements of unit Mg27. As mapped, minor areas of adjacent soil units are included. Occurs on sheet(s): 3"
"Mg26"
"Plateaux and plateau remnants in mountainous country at moderate to high elevation (>1000 ft): rolling hills of red friable porous earths (Gn4.11) and/or brown friable porous earths (Gn4.31). Associated are dark friable porous earths (Gn4.41 and Gn4.42), sometimes red earths (Gn2.1), and other soils, largely unknown but including (Uf6.21) on the steep, bouldery, stony slopes and scarps flanking the plateau remnants. Occurs on sheet(s): 3,4"
"Mg27"
"Mountainous--rugged plateau remnants and mountain peaks at moderate to high elevation (> 1000 ft): soils almost unknown, available data suggest a complex soil population with (i) red and brown friable porous earths (Gn4.11) and (Gn4.31 and Gn4.34) on moderate slopes and broader ridge tops; (ii) dark friable porous earths (Gn4.41 and Gn4.42) on the steeper slopes and narrow ridge tops, (iii) shallow soils such as (Uc4), (Um4), and (Um6) on steep slopes with rock outcrops and bare rock walls; and (iv) a variety of other soils including (Dr4), (Dy4), and (Gn3.2) on moderate slopes. (iii) and (iv) are more common on the less basic rock types. Occurs on sheet(s): 3"
"Mh1"
"Gently undulating ridges and almost flat plateau residuals at moderate elevation: moderate to steep slopes some slumping, and some areas of valley fill, all covered by brown friable porous earths (Gn4.31)--usually with a thick surface organic accumulation in natural areas, and in association with smaller areas of red friable porous earths (Gn4.11) and dark friable porous earths (Gn4.41); dissected by streams with narrow valley plains of undescribed soils. Occurs on sheet(s): 2"
"Mh2"
"Hilly to mountainous at moderate elevation, steep-sided valleys with narrow floodplains, some gently undulating plateau remnants divided by gorges: brown friable porous earths (Gn4.31) with brown friable earths (Gn3.21), yellow leached earths (Gn2.34), and other (Gn2), (Gn3), and (Gn4) soils predominate, and also with some areas of red friable porous earths (Gn4.11), hard acidic red mottled soils (Dr3.41), sandy soils with yellow or brown clay subsoils (Dy4) and (Db4), and leached sands (Uc2.34). Occurs on sheet(s): 2"
"Mh3"
"Gently undulating plateau remnants at moderate elevations, with a few monadnocks: (Gn) soils of the surrounding unit Mh2, together with shallow Uc2 and Uc5 soils, some of which have peaty A horizons; some acid organic soils (O) in small open plains and soils of unit KL1 on monadnocks and some slopes. Occurs on sheet(s): 2"
"Mh4"
"Mountainous: steep hill slopes of brown friable porous earths (Gn4.31) in association with mottled friable porous earths (Gn4.51) and minor, localized, areas of red friable porous earths (Gn4.11) and other (Gn) soils; dissected by narrow, incised, stream valleys of undescribed soils. Occurs on sheet(s): 2"
"Mh5"
"Rugged mountainous country at moderate to high elevation; soil variation is considerable with a general order as follows, moderate to steep mountain slopes of brown and red friable porous earths (Gn4.31, Gn4.34, and Gn4.14) with smaller areas of (Gn4.11) and/or red earths (Gn2.11 and Gn2.14) with smaller areas of yellow earths (Gn2.21

and Gn2.24); in association with (1) at the relatively higher altitudes, small areas of organic loamy soils (Um7.11) or shallow grey-brown sandy soils (Uc6.11) or loamy soils with an A2 horizon (Um4.2); and (2) at the relatively lower altitudes, moderate areas of friable acidic red soils (Dr4.21) and friable acidic yellow soils (Dy4.21, Dy4.61, Dy5.21) or friable brown soils (Db3.11); and (3), in the drier situations at the relatively lower altitudes, small areas of hard acidic red soils (Dr2.21) and hard acidic yellow mottled soils (Dy3.21); and (4) narrow stream valleys with small floodplains of variable soils, largely undescribed, but including (Um5.5), (Ug6.1), a. Occurs on sheet(s): 2"
"Mh6"
"Plateau remnants at high elevation (>3500 ft)--gently undulating with some deeply dissected valleys and also swampy flats in the headwaters of some streams: chief soils are shallow brown friable porous earths (Gn4.31) with shallow red friable porous earths (Gn4.11). Associated are acid peats (O) and various (Um) soils in the swampy flats. Occurs on sheet(s): 3"
"Mh7"
"Plateau remnants at high elevation (>4000 ft)--generally steep slopes with some benches: chief soils are shallow brown friable porous earths (Gn4.31). Associated soils include (Db3.12) and (Dd3.12). Data are limited. Occurs on sheet(s): 3"
"Mh8"
"River flood-plains and adjoining steep valley slopes: well-drained flood-plains of brown friable porous earths (Gn4.31) often with relatively impermeable D horizons below the solum. Small areas of (Ug5.4), (Ug5.16), and (Dy5.1) soils occur on poorly drained portions of the flood-plains. Associated are steep, valley-side slopes of dark friable porous earths (Gn4.41 and Gn4.42) with small patches of red friable porous earths (Gn4.11) on ridge crests as described for unit Ml2; minor areas of unit Mf5 soils also occur on some slopes. Occurs on sheet(s): 3"
"Mi1"
"Rounded hills with moderate to steep slopes and outcropping limestones: slopes of shallow forms of brown and red friable porous alkaline earths (Gn4.33 and Gn4.13) with smaller areas of shallow forms of dark and red loamy soils (Um6) and shallow forms of hard alkaline red soils (Dr2.23), also with minor areas of (Gn4.11) on the middle and upper hill slopes, and hard acidic red soils (Dr2.31), and others not described, on lower hill slopes; dissected by streams with small floodplains of undescribed soils. Occurs on sheet(s): 2"
"Mj1"
"Mountainous at moderate elevation: lower, mid, and upper mountain slopes of red and brown friable earths (Gn3.14, Gn3.24) and yellow leached friable earths (Gn3.54); and on upper slopes some loamy soils with an A2 horizon (Um4.2) with small areas of organic loamy soils (Um7.11) at the highest altitudes; and on lower slopes friable acidic yellow soils (Dy4.21) and friable acidic red soils (Dr4.21); narrow stream valleys with small floodplains of variable soils, largely undescribed, but including (Um5), (Um6), and (Uc). Soils other than those recorded are likely also. Occurs on sheet(s): 2"
"Mj2"
"Dissected river terraces and adjoining undulating to low hilly slopes: chief soils in a complex soil situation seem to be acid red friable earths (Gn3.14), generally as follows: high terraces of acid red friable earths (Gn3.11 and Gn3.14), and/or friable acidic red and red mottled soils (Dr4.21) and (DrS.21) with hard acidic yellow mottled soils (Dy3.41), sometimes with hard pans below the solum, and possibly other (undescribed) soils on the flatter and often less well-drained areas. Lower terraces, in descending order, have dark porous loamy soils (Um6.11 and/or Um6.12), which may be extensive, locally; other loamy soils such as (Um5.2); present flood-plain deposits of (Uc1.2) and/or (Um1.21) soils. Adjoining slopes have soils of units Tb43 and to a lesser extent Ta7. As mapped, small areas of unit Mc2 are included. Note that the full sequence of terraces and therefore of soils is rarely expressed in any given locality. Occurs on sheet(s): 3"
"Mj3"
"Hilly with deep dissection but with some remnants of the old gently undulating landscape, some hillside creep: chief soils are acid red friable earths (Gn3.14) in the relatively wetter sites, and hard acidic red soils (Dr2.21) in the relatively drier sites--it is not clear which of these soils is the more common. Associated are: various (Dy) soils such as (Dy5.51) and (Dy4.11) in the wetter areas and (Dy3.21) and (Dy3.41) in the drier areas; some yellow (Gn) soils such as (Gn3.84) in the wetter areas; and some (Um4) soils on steep slopes. As mapped, small areas of other units, notably Mj5, Mg23, and Rh3, are included. Occurs on sheet(s): 3"
"Mj4"
"Mountainous--steep hilly to rugged terrain but with some remnants of the old undulating landscape, rock outcrops, hillside creep: chief soils are acid red friable earths (Gn3.14) and hard acidic red soils (Dr2.21)--generally the former seem dominant in the western and wetter portions* of the unit and the latter in the eastern and drier portions, but no clear boundary is evident and much of the unit covers rather inaccessible country. Associated soils are (Um4.2), (Dy3.21), and (Dy3.41) in the eastern and drier portions; and (Dy5.51) and (Dy4.11) in the western and wetter portions, where other soils such as (Gn4.14), (Gn3.5), (Gn3.7), and (Gn3.8) may occur also. As mapped, areas of unit Pb15 are included. Occurs on sheet(s): 3"
"Mj5"

"Rounded hills with some steep-sided valleys, granitic tors: chief soils are acid red friable earths (Gn3.14); small areas of other soils occur, including (Dy) soils. Occurs on sheet(s): 3"
"Mj6"
"Mountainous with some steep scarps, granitic tors: steep slopes of acid red friable earths (Gn3.14) and acid leached red earths (Gn2.14). Associated are plateau remnants of unit Sj2; hilly areas of unit Wa9; and areas of unit Cb30 along the western side of the unit. Data are limited. Occurs on sheet(s): 3"
"Mj7"
"Strongly dissected hilly lands with short moderate slopes; rock outcrop is locally prominent: dominant soils are sandy to loamy red friable earths (Gn3.14); the A horizons usually contain stones but the B horizon clay is often stone-free; solum depth ranges from 20 to 40 in. Associated are similar brown and yellowbrown friable earths (Gn3.24), (Gn3.54), and (Gn3.74) and also some sandy earths (Gn2.14), (Gn2.24), and (Gn2.44). On lower slopes and marginal (drier) areas sandy to loamy duplex soils (Dr2.21), (Dr2.41), (Dy3.21), and (Dy3.41) are common. In more stony sites small areas of shallow loams (Um1.43) and (Um4.2) are always present. Occurs on sheet(s): 4"
"Mj8"
"Hilly high plateaux often bounded by precipitous scarps: dominant soils are deep to moderately deep red friable earths (Gn3.14) with associated yellow friable earths (Gn3.74). Small areas of deep red earths (Gn2.14) occur and also small areas of (Gn3.11). Other friable earths that may occur include (Gn3.24), (Gn3.21), and (Gn3.54). All soils have a strong finely structured organic A1 horizon. Occurs on sheet(s): 4,7"
"Mj9"
"High hilly or mountainous lands, mostly with steep slopes; rock outcrop is often prominent: dominant soils are fairly shallow and nearly always stony friable earths with a dark loamy surface Fading to red clay subsoils (Gn3.14). A wide variety of other shallow stony soils occur, chiefly (Um1.43), (Um4.2), (Gn3.24), (Gn3.11), (Db1.11), (Dr2.11), (Dr2.12), and (Dy2.11). Data are fairly limited. Occurs on sheet(s): 4,7"
"Mj10"
"High hilly or mountainous lands, often with very steep slopes and precipitous scarps; rock outcrop is often prominent. A complex range of moderately deep to shallow soils occur, mostly friable earths with strongly structured organic A1 horizons. Red friable earths (Gn3.14) are probably most common but important areas of other friable earths (Gn3.24), (Gn3.21), (Gn3.11), (Gn3.91), (Gn3.54), and (Gn3.74) occur. In some areas earths (Gn2.44), (Gn2.24), and (Gn2.14) are more common; and there are limited areas of red porous earths (Gn4.11). Shallow stony loams are common in more stony sites, chiefly (Um6.2), (Um6.4), and (Um1.43). At the drier margins of the unit loamy duplex soils occur, chiefly (Dy3.21), (Dy3.41), (Dy3.81), similar (Dr2) soils, and occasionally (Dr4.11). Occurs on sheet(s): 4,7"
"Mj11"
"High hilly to mountainous lands with very steep slopes and precipitous scarps and much acid igneous rock outcrop: moderately deep red friable earths (Gn3.14) are probably dominant, but there are many areas of shallow stony sands and loams including (Uc4.22), (Uc4.12), (Uc2.12), (Um6.2), and (Um6.4). Other associated soils are as for units Mj8 and Mj10. Occurs on sheet(s): 7"
"Mj12"
"Hilly to low hilly lands with short steep slopes: dominant soils are moderately deep to deep red friable earths (Gn3.14), with lesser (Gn3.11). Other friable earths (Gn3.74, Gn3.71) and (Gn3.54) occasionally occur. In some moderately undulating drier sites there are loamy duplex soils (Dr2.21), (Dy2.21), and (Dy3.21). Adjacent to streams there are small alluvial plains with deep loams (Um4.23) and (Um6.34). Occurs on sheet(s): 7"
"Mk1"
"Montane region at low to moderate elevation: moderate to steep hill slopes of red friable porous earths (Gn4.14), possibly with (Gn4.11) also; narrow stream valleys of undescribed soils; and also small areas of soils from adjoining units. Occurs on sheet(s): 2"
"Mk2"
"Mountainous to sub-mountainous at moderate to low elevations: moderate to steep slopes at the relatively higher elevations of red and brown friable porous earths (Gn4.14 and Gn4.34) with smaller areas of (Gn4.11 and Gn4.3 1); and gentle to steep slopes at the relatively lower elevations of red friable earths, such as (Gn3.14), and yellow leached earths, such as (Gn3.84), in the relatively drier portions, other undescribed soils probably occur also.. Occurs on sheet(s): 2"
"Mk3"
"Montane region--dissected tableland and its escarpment: moderate to steep hill slopes of red friable porous earths (Gn4.14) in association with yellow porous earths (Gn4.64) and yellow leached earths (Gn3.74 and Gn3.84)--D horizons are evident bow the sola of all these soils in some situations at least; incised streams with narrow valleys of undescribed soils; the steep scarps to the tableland have shallow stony forms of hard yellow mottled soils (Dy3) and porous earths (Gn4). Occurs on sheet(s): 2"
"Mk4"

"Mountainous country with some steep, narrow, undulating ridges: red friable porous earths (Gn4.14) on middle and lower ridge and hill slopes in association with red deep porous loamy soils (Um6.13) on upper, stony, ridge slopes, other soils on the slopes include red earths (Gn2.11) and friable acidic red soils (Dr4.21); dissected by narrow incised stream valleys of undescribed soils. Occurs on sheet(s): 2"
"Ml1"
"Hilly: gently sloping hill-tops and steep upper hill slopes of shallow forms of dark friable porous earths (Gn4.41), some basalt boulders, and with friable neutral dark soils (Dd3.12) and possibly dark cracking clays (Ug5.1) on middle and lower hill slopes; in association with moderate to steep hill slopes of friable red earths (Gn3.1), [Gn2.11 - errata] and friable red soils (Dr4.1); small areas of unit Tb4 are included. Occurs on sheet(s): 2"
"Ml2"
"Rounded hilly to very steep and narrow-topped plateau scarps with steep, often slumped, slopes and small flood-plains along the incised stream valleys: moderate to very steep slopes and narrow ridge tops of dark friable porous earths (Gn4.41 and Gn4.42) and sometimes brown friable earths (Gn3.22), commonly with scattered basalt stones and boulders. Associated are dark cracking clays (Ug5.12) on mid to lower slopes and alluvial cones; deep dark cracking clays (Ug5.16) on lower slopes and in the small valley plains; and very small areas of (Gn4.11) soils on the broader ridge tops, especially in the more easterly occurrences of the unit. Minor areas of other soils such as (Uf6.21) and (Gn2.1) occur in specific sites, the latter often being associated with ironstone materials and/or mottled and pallid clays. As mapped, minor areas of adjacent units are included. Occurs on sheet(s): 3"
"Ml3"
"Plateau remnants: rounded hilly to very steep slopes of dark friable porous earths (Gn4.41 and Gn4.42) as for unit Ml2 but with a greater proportion of red and brown friable porous earths (Gn4.11 and Gn4.31) on moderate to steep rounded slopes sometimes modified by slumping, and with areas of other soils such as (Gn3.22), (Gn2.1), and (Db3.1) which may be prominent locally. As mapped, minor areas of adjacent soil units are included. Occurs on sheet(s): 3"
"Ml4"
"Steep-sided and narrow-topped plateau remnants often stone-strewn: chief soils are dark friable porous earths (Gn4.41 and Gn4.42) and sometimes other soils such as (Gn3.22). Associated are very small areas of (Gn4.11) soils on broader ridge tops; flanking hill slopes of soils of unit Tb55; and some areas of (Ug5.12) soils on lower slopes and alluvial cones. Occurs on sheet(s): 3"
"Mm1"
"Steep to very steep hills and ridge tops of somewhat benched form, with bluffs and cliffs, and traversed by narrow, steep-sided valleys: chief soils seem to be neutral and alkaline dark friable earths (Gn3.4, and Gn3.43). Associated are friable red and brown soils (Dr4.12) and (Db3.12); shallow porous loamy soils (Um6.2); and shallow dark cracking clays (Ug5.12 and Ug5.13). Surface rubble and boulders are common. Small areas of units Mg20 and Mf4 occur at the higher elevations, especially in the Liverpool Range area. The full range of soils is not known and therefore the dominant soil is doubtful. Occurs on sheet(s): 3"
"Mm2"
"Strongly rolling to hilly country on calcareous sediments with some steep-sided basaltic residuals: chief soils are alkaline dark friable earths (Gn3.43) and (Gn3.92) soils with weak gilgai formation. Associated are dark clays (Uf6.32) on steep colluviated slopes and shallow brown friable earths (Gn3.22) on basalt. As mapped, small terraced valleys of unit MM9 are included in places. Occurs on sheet(s): 4"
"Mm3"
"Undulating to rolling land on granodiorite and diorite with shallow open valleys and moderately wide alluvial flats in places: chief soils are neutral dark friable earths (Gn3.42) and hard neutral yellow soils (Dy2.32) on crests and slopes. Associated are (Gn3.12) and (Dr2.32) soils on crests and slopes. Other soils include: (Dy2.52) on hill crests; (Gn3.72) and (Dy2.12) on slopes; (Dd2.32) on lower slopes; (Dr2.62) on stream levees; and (Dd1.33) on stream flats. Occurs on sheet(s): 4"
"Mm4"
"Undulating to low hilly land on serpentine with fairly broad creek flats: chief soils are neutral dark friable earths (Gn3.42) on mid and lower hill slopes. Associated are an intimate complex of (Gn3.42), (Dr2.12), and (Um6.21) soils on stony knolls throughout the area, and (Uf6.32) soils on upper slopes and crests. Other soils include (Gn3.45), (Ug5.16), (Dy2.42), and (Dd1.33) on creek flats. Occurs on sheet(s): 4"
"Mm5"
"Steep hilly terrain on volcanic rocks and shales with steep slopes to V-valleys, and some alluvial flats in the foothills: chief soils are neutral and acid dark friable earths (Gn3.42 and Gn3.41) on the volcanic rocks and (Dy3.41) soils on the shales. Associated are (Db1.12), (Um4.1), and (Gn3.11) soils on volcanic rocks, and (Um2.12) and (Dr3.41) soils on shales. Other soils include: (Dy2.41) and (Uc2.12) on granite; (Gn2.14) on granodiorite; (Gn3.22) on andesite; (Um6.21) and (Uf6.32) on ultrabasic rocks; and (Dd1.33) soils on minor creek flats. Occurs on sheet(s): 4"
"Mm6"

"Hilly land on andesite and related rocks with gentle to moderate side slopes to open valleys with fair stream flats in places: chief soils are neutral dark friable earths (Gn3.42) with dark plastic clays (Uf6.32) on crests and upper slopes. Associated are (Gn3.12) soils. Other soils include (Ug5) on stream flats and (Dy3.41) and (Um2.12) on shale. As mapped, small areas of unit Pb20 may be included. Occurs on sheet(s): 4"
"Mm7"
"Low hilly to hilly terrain on volcanic rocks and appearing as open valleys in steep hilly to mountainous land, gentle to moderate side slopes to shallow streams with significant flats: chief soils are neutral dark friable earths (Gn3.42) and yellow friable earths (Gn3.72), with friable brown soils (Db3.12) on crests and slopes. Associated are (Gn3.12) and (Um6.12) soils. Other soils include: (Gn3.14) and (Dy3.41) on slope fans; (Dy3.41), (Dd1.33), (Gn2.4), and (Gn2.34) soils on stream flats; (Uc1.4) on new stream terraces; (Uc1.23) on new stream flood-plains; and (Um4.1) on new flood-plains. As mapped, small areas of unit Mp9 are included. Occurs on sheet(s): 4"
"Mm8"
"River terraces, levees, and flood-plains: chief soils are neutral and alkaline dark friable earths (Gn3.42 and Gn3.43) with brown friable earths (Gn3.22, Gn3.23, and Gn3.25) on the broad middle terrace. . Associated are: (Gn2.42), (Gn2.45), (Um6.12), and (Uc1.2) soils on the low terraces and levees; (Gn2.14) on high terrace remnants; and (Dr2.12 and Dr2.22) on some middle terrace areas. Small areas of a wide variety of other soils occur in special localities. Buried soils also occur. As mapped, small areas of units Cd7, Fu6, and Mp9 are included. Occurs on sheet(s): 4"
"Mm9"
"Steep hilly eastern scarp of basaltic plateau, including steep hills, scarp slopes and platforms between 500 and 1200 ft above sea level and all lower basaltic hills down to 250 ft above sea level; soils are shallow and bouldery; some sandstones, shales, tuffs, and trachyte are included: chief soils are neutral and acid dark friable earths (Gn3.42 and Gn3.41). Associated are (Um6.23) soils on steep scarp slopes and (Dy5.11) soils on low platforms and lower hill slopes. A number of other soils occur including: (Gn3.11) on some basalt hills; (Um4.1 and Um4.3) on hill tops of frothy lavas; (Dy5.21), (Dr5.21), and (Dg4.21) in complex on lava; and (Gn3.22) on creek flats. Occurs on sheet(s): 4"
"Mm10"
"Low hilly basaltic plateau ranging from 400 to 1000 ft above sea level; low rounded hills with gentle to moderate slopes to narrow alluvial flats along clearly defined drainage-ways: chief soils are neutral dark friable earths (Gn3.42). Associated are shallow and often bouldery variants of (Gn3.11 and Gn3.12) soils. Minor soil occurrences include: (Gn3.92) and (Ug5) soils in alluvial flats; (Gn3.41) and (Um6.23) soils on steep slopes; and various (Uc), (Um), and (Dy) soils on included sandstones and rhyolite. Occurs on sheet(s): 4"
"Mm11"
"Rolling to rounded low hilly plateaux on deeply weathered mixed parent rocks including lithic sandstones and basalts; some low hilly dissected areas with small mesas adjacent to higher lateritic plateaux: dominant soils are alkaline dark friable earths (Gn3.43) with neutral and acidic red friable earths (Gn3.12, Gn3.11, and Gn3.10). Associated are dark (Ug5.12), brown (Ug5.37), and grey (Ug5.24) cracking clays. Other soils include a range of (D) soils such as (Dy5.33), (Dr3.23), and (Dy3.43) and (Uf6.31) soils on basalt knolls. Occurs on sheet(s): 4"
"Mm12"
"Low hilly country on altered sedimentary rocks with smooth round slopes generally but some abrupt scarps in lateritic materials: chief soils seem to be alkaline dark friable earths (Gn3.43) with dark cracking clays (Ug5.15). Associated are: (Gn2.11) soils on flat-topped areas above scarps and on gentle slopes from these; some (Ug5.37) soils on upper convex slopes; (Gn3.12 and Gn3.13) soils on upper slopes, especially of diorite rocks; and some (Dy2.12) and (Db1.13) soils on lower slopes. Minor soils include (Dr2.21) and (Dr2.41) below scarps and (Um4.1) and (Um5.51) on scarps. The (Gn3.13) soils are dominant in some localities. Occurs on sheet(s): 4"
"Mm13"
"Generally low rounded hilly country on lithic sandstones with concave slopes to broad depressions; some outcrops of mottled rock, some low scarps: chief soils are alkaline dark friable earths (Gn3.43). Associated are: (Ug5.14 and Ug5.15) soils from upper slopes to depressions; (Dr4.13), (Dr2.41), and (Dr2.23) on some rises; (Gn3.13) on rises; and (Um5.51) with (Gn2.11) on crests of mottled rock areas. Minor soil occurrences include (Gn3.71) and (Gn3.11). Occurs on sheet(s): 4"
"Mm14"
"Valley plains with minor levees, slightly depressed areas, and concave to flat floors of minor side valleys: chief soils are alkaline dark friable earths (Gn3.43) with (Gn3.42). Associated are (Ug5.16) soils in depressed broad flats; (Gn3.43), (Gn3.49), and (Ug5.15) soils in flats showing a gilgai microrelief; (Ug5.24) in drainage-ways; (Ug5.15) soils on terraces; and (Um6.23) soils on flats. Minor soil occurrences include (Um6.21) and (Db2.32). Occurs on sheet(s): 4"
"Mm15"
"Slightly depressed alluvial plaiDs with some low stream levees and shallow stream channels: dominant soils are loamy dark friable earths (Gn3.43) with lesser (Gn3.42) and similar earths (Gn2.42). Chief associated soils are

various deep uniform sands including (Uc1.23, Uc1.22), (Uc5.22), and (Uc1.12) on the low levees. Loamy dark duplex soils (Dd1.33) and (Dd1.13) occur in the seasonally inundated relic stream channels and where the unit adjoins the marine plains of unit HG7. Occurs on sheet(s): 7"
"Mn1"
"Basaltic ridges and knolls with some steep rocky slopes and in places some gentle convex slopes: chief soils seem to be alkaline red friable earths (Gn3.13) and friable neutral red soils (Dr4.12). Associated are neutral red earths (Gn2.12). Data are limited. Occurs on sheet(s): 3"
"Mn2"
"Undulating terrain broken by occasional hills and ridges: chief soils are alkaline and neutral red friable earths (Gn3.13 and Gn3.12). Associated are dark cracking clay soils, such as (Ug5.13 and Ug5.15). As mapped, soils of both units Oc17 and Ro1 may be interspersed through this little-known area. Occurs on sheet(s): 3"
"Mn3"
"Moderate or occasionally strongly undulating lands: dominant soils are red friable earths (Gn3.13) with lesser brown friable earths (Gn3.23). Closely associated are red, brown, or grey cracking clays (Ug5.38), (Ug5.34), (Ug5.13), (Ug5.22), and (Ug5.24), or uniform clays (Uf6.31 and Uf6.32). Adjacent to drainage lines there may be small areas of loamy duplex soils (Dd1.33) and (Dy2.43). Occurs on sheet(s): 4"
"Mn4"
"Undulating valley plain bounded by high hills: dominant soils are red-brown or brown friable earths that usually contain gravel at depth. The chief form is (Gn3.13), but (Gn3.12) and (Gn3.23) also occur. The lower slopes of the marginal hills have loamy red duplex soils (Dr2.12) and red friable earths (Gn3.12). Occurs on sheet(s): 4"
"Mn5"
"Gently undulating stepped limestone plain with limestone benches and outcrops: chief soils are shallow alkaline red friable earths (Gn3.13) often in complex with a variety of shallow loamy soils (Um6.21), (Um6.43), (Um6.23), and (Um6.24) on slopes, and/or (Ug5) soils such as (Ug5.26) in depressions and on broader slopes. Small areas of other soils include (Gn2.42) and (Gn2.12). Some areas may have similarities. Occurs on sheet(s): 8"
"Mn6"
"Broadly undulating lands with granite tor outcrop on some ridge crests: dominant soils are quartz-gravelstrewn moderately deep loamy red friable earths (Gn3.13), with lesser (Gn3.12). Associated on some slopes are gravel-strewn loamy red duplex soils (Dr2.12, Dr2.13) and gravel-strewn red clays (Uf6.31). On some lower areas are deep brown or red-brown cracking clays (Ug5.32, Ug5.37). Shallow to moderately deep Fitty red earths (Gn2.11, Gn2.12) and shallow gravelly loams (Um5.51) occur near rock outcrop. Occurs on sheet(s): 10"
"Mo1"
"Almost flat to gently undulating: chief soils on the flatter areas are neutral and alkaline red friable earths (Gn3.12, Gn3.13) and/or hard alkaline red soils (Dr2.13) and/or red and yellow earths (Gn2.12) and (Gn2.2). Associated are soils of units Ke11 and Kb2 on the more undulating areas; soil dominance is not clearly defined. Data are limited. Occurs on sheet(s): 3"
"Mo2"
"Dissected basaltic plateau at moderate elevation (> 3000 ft): undulating country of neutral red friable earths (Gn3.12) with some flanking slopes of acid leached red earths (Gn2.14). Data are limited. Occurs on sheet(s): 3"
"Mo3"
"Rolling with some broad gentle slopes and with basaltic knolls and ridges: chief soils are neutral and alkaline red friable earths (Gn3.12 and Gn3.13). Associated are basaltic knolls and ridges with a variety of soils, including (Dr4.12), (Um6), and (Ug5) soils; and some (Dr2) soils. Occurs on sheet(s): 3"
"Mo4"
"Gently to strongly undulating with some basaltic knolls and ridges: chief soils are neutral red friable earths (Gn3.12) and neutral red earths (Gn2.12). Associated are basaltic knolls and ridges with a variety of soils, including (Dr4.12), (Um6), and (Ug5) soils. Occurs on sheet(s): 3"
"Mo5"
"Strongly undulating to hilly: chief soils on the sloping land are neutral red friable earths (Gn3.12). Associated are shallow friable soils, such as (Db3.12) and (Dr4.12), on the tops of hills and knolls; and dark cracking clays such as (Ug5.13, Ug5.14, and Ug5.16) on slopes and in the relatively lowerlying situations. As mapped, small areas of soils of unit Mz1 are included. Occurs on sheet(s): 3"
"Mo6"
"Stepped basaltic plateau remnants at elevations generally greater than 4000 ft--undulating to hilly: chief soils are: on hilltops and slopes, neutral red friable earths (Gn3.12); and on lower slopes and in valleys, (Dy3.2) and (Db1.2) soils, both often containing much ironstone gravel and some ironstone blocks. Associated are a wide variety of soils including: on ridges and knolls, (Db3.12) or (Dr4.1) or (Um6.2) and less commonly shallow forms of (Gn4) soils, such as (Gn4.32) and (Gn4.12); on undulating areas, deep forms of (Gn3.12) and (Uf6.31) and less commonly (Gn2.11) soils; slopes below basalt ridges and knolls may have various (Ug5) soils, such as (Ug5.14) and (Ug5.4). As mapped, areas of unit Kd4 may be included. Occurs on sheet(s): 3"

"Mo7"
"Dissected basaltic plateau--gently to strongly rolling terrain with hills, knolls, and flat-topped ridges: chief soils are neutral red friable earths (Gn3.12) and structured red clays (Uf6.31), together with various dark cracking clays (Ug5.13, Ug5.14, Ug5.15, Ug5.16) and red-brown cracking clays (Ug5.37, Ug5.38). These soils may cover relatively large individual areas as separate entities or may occur in various soil complexes. Associated are: red earths (Gn2.11) containing ironstone gravels on residuals, sometimes flat-topped, of bauxitized basalt; other red earths (Gn2.14) on rolling terrain and hill slopes, (Um6.2) and (Db3.12) soils on crests and upper slopes of knolls and ridges which are often flanked by cracking clays (Ug5) as recorded above; and minor areas of (Dy3.4) soils. As mapped, small areas of unit Kd4 are included. Occurs on sheet(s): 3"
"Mo8"
"Dissected basaltic plateau--generally low hilly: chief soils are neutral red friable earths (Gn3.12). The area is generally similar to unit Mo7 although the cracking clays (Ug5) are not so extensive; also, soils of unit Ub56 are commonly associated throughout. Occurs on sheet(s): 3"
"Mo9"
"Steep hilly to mountainous land on diorite, moderate to steep slopes, fringing pediment, some rock outcrop, narrow stream valleys: chief soils are neutral red friable earths (Gn3.12) on crests, slopes, and some pediments. Other soils include (Dr4.21), (Dy3.31), and (Gn2.41) on slopes and (Gn2.84), (Gn3.92), (Um1.43), and (Ug5) along stream valleys. Occurs on sheet(s): 4"
"Mo10"
"Hilly to steep hilly land mainly on greenstones, along the erosion scarp of the headwaters of coastal streams; steep to very steep side slopes to V-valleys; some cliffs with much rock outcrop: chief soils are neutral red friable earths (Gn3.12), both shallow and deep variants, on slopes, platforms, and spurs. Associated are (Um6) soils on crests and upper slopes, some (Gn3.11) soils, some (Gn3.42) soils and (Dr3.41) soils on phyllites. Minor soil occurrences include (Um4.2) on mass movement material on slopes, (Gn3.54) and (Gn3.15) on lower slopes and fans, and (Um4.1) on phyllite. Occurs on sheet(s): 4"
"Mo11"
"Strongly rolling to low hilly country on basic rock; broad convex crests with some rock outcrop passing to long gentle concave colluvial slopes with strong linear gilgai and thence to depressions: chief soils are neutral red friable earths (Gn3.12). Associated are: (Ug5.16) soils in the depression of gilgais and (Ug5.24) soils in banks of gilgais on the colluvial slopes; (Ug5.15) soils in depressions; and (Dr2.12) soils on crests. Occurs on sheet(s): 4"
"Mo12"
"Undulating basaltic valley plains with some stony rises: dominant soils are neutral red friable earths (Gn3.12). Associated are shallow stony and bouldery (Gn3.12) soils and shallow (Uf6.21) soils on the stony rises. Occurs on sheet(s): 4"
"Mo13"
"Low hilly country on diorite and other basic rocks: chief soils seem to be neutral friable earths (Gn3.12) with hard neutral red soils (Dr2.12). Associated are (Ug5.33) and (Gn3.43) soils and some (Uf6.31) soils. Small areas of other soils occur also. Occurs on sheet(s): 4"
"Mo14"
"Rolling to hilly country: chief soils seem to be neutral friable earths (Gn3.12) with (Gn3.11) and smaller areas of (Gn3.13). Associated are (Ug5.38) soils, (Gn3.75) soils, (Gn2.12) soils, (Db1.12) soils, and others. Small mesas of unit Mz5 are included. Occurs on sheet(s): 4"
"Mo15"
"Moderately undulating lands: dominant soils are red friable earths (Gn3.12) that are often gravelly. Closely associated are shallow gravelly red duplex soils (Dr2.12), (Dr2.13), (Dr2.32), (Dr2.33), (Dr2.43), and some similar (Dr3) soils. Small areas of uniform red clays (Uf6.31) also occur, and on ridge crests there may be small occurrences of shallow gravelly loams (Um1.43). In lower landscape sites gravelly duplex soils (Dy2.43) and (Dd1.43) are associated with small areas of gilgaied grey clays (Ug5.24). included in the unit as mapped are small areas of loamy red earths (Gn2.12). Occurs on sheet(s): 4"
"Mo16"
"Mountainous or high hilly areas with precipitous slopes; hilly or low hilly lands may occur marginally: dominant soils are loamy often stony friable earths (Gn3.12) with lesser (Gn3.11). Important areas of loamy red duplex soils (Dr2.12) occur on lower flatter slopes, together with occasional (Dy3.42) soils. Throughout the unit rock outcrop is common on steep slopes and shallow (Um) soils are also probably present. Data are limited. Occurs on sheet(s): 4"
"Mo17"
"Hilly or low hilly lands, usually with rounded crests; a range of soils is present but most are shallow and stony: dominant are red friable earths (Gn3.12) but other friable earths (Gn3.22), (Gn3.25), and (Gn3.42) are also common. Some steeper slopes have shallow stony uniform clays (Uf6.31 and Uf6.32), with lesser (Ug5.12). Also occurring are small areas of loamy duplex soils (Dr2.12) and (Dy3.42). Occurs on sheet(s): 4"
"Mo18"

"Hilly to steep hilly lands on serpentine and associated metamorphic rocks; narrow ridge crests; steep stony slopes passing to fairly wide valleys with low hilly or rolling topography: chief soils are shallow and gravelly variants of neutral red friable earths (Gn3.12). Associated are (Um6.21), (Uf6.31), and (Um6.43) soils, often stony, on the lower slopes and on the hills of the valleys. Minor soil occurrences include (Gn3.42) and (Ug5.13) on lower slopes and flats. As mapped, small areas of soils as for units Va60 and Kb22 are included. Occurs on sheet(s): 4"
"Mo19"
"A composite landscape of low hills on metamorphic rocks as for unit Tb126 and higher hills on serpentine as for unit Mo18, which occupies the larger area. Small areas of soils other than those recorded for these two units may occur. Occurs on sheet(s): 4"
"Mo20"
"Low to moderate and broadly rounded hills and ridges with narrow valley floors: chief soils seem to be neutral red friable earths (Gn3.12) and friable red clays (Uf6.31); they range from very shallow (less than 12 in.) to moderately deep (more than 30 in.). Associated are (Ug5.33) soils on some crests. Minor soil occurrences include (Dd3.42) on upper slopes and (Ug5.1 and Ug5.2) soils in the valleys. Occurs on sheet(s): 4"
"Mo21"
"Gently undulating country developed on basalt with widely separated low hilly interfluves: main soils are neutral, and also acid, red friable earths (Gn3.12 and Gn3.11) together with some gravelly (Dy3.42) and (Dy2.61) soils. Rock outcrop is common on elevated country with some shallow stony (Um6.1) soils. Small areas of (Ug5.15) soils occur along valley floors. Occurs on sheet(s): 9"
"Mo22"
"Hilly and mountainous country developed on basalt; extensive valley plains: chief soils are neutral red friable earths (Gn3.12) on plains of moderate to gentle slopes together with (Gn2.12) soils and lesser areas of (Dy2.22) and (Gn2.22) soils. Interfluves have much rock outcrop and some shallow stony (Um6) soils on upper slopes. There are some quite extensive cracking clay plains of (Ug5) soils such as (Ug5.38). Occurs on sheet(s): 9"
"Mo23"
"Undulating to low hilly country on intermediate and basic igneous rocks with some rock outcrops and boulders: chief soils are neutral red friable earths (Gn3.12) on moderate to gentle slopes. Associated are various (Ug5) soils, such as (Ug5.24), (Ug5.34), and (Ug5.37), on gentle slopes and flat areas; and shallow (Um6) soils such as (Um6.24 and Um6.23) on steeper slopes. Minor occurrences of other soils are possible. This unit merges with units Gg5, CC55, and CC56. Occurs on sheet(s): 8,9"
"Mo24"
"Undulating terrain with rounded low hills, mainly on basalts but with some sandstones: chief soils are neutral red friable earths (Gn3.12) on slopes together with cracking clays (Ug5.2) and possibly (Ug5.1) on flats in basaltic areas. Other soils are red and yellow earths such as (Gn2.12) and (Gn2.24) on slopes and flats in sandstone areas. The surface of the (Gn3.12) soils is often stone-covered. Occurs on sheet(s): 8"
"Mo25"
"Low rounded basaltic hills with ridges of sandstones: chief soils are probably neutral red friable earths (Gn3.12) on slopes with cracking clays (Ug5.2) on flats. Other soils are (Uc4.1) and (Uc1.4) with rock outcrop on sandstones. Some valley plains similar to unit Mb15 are included. Occurs on sheet(s): 8"
"Mo26"
"Basaltic valleys with dolomites, siltstones, and conglomerates between ridges of sandstones and greywackes: chief soils are probably neutral red friable earths (Gn3.12) on slopes with cracking clays such as (Ug5.2) on flats. Other soils including red and yellow earths (Gn2.1) and (Gn2.2) are likely. Occurs on sheet(s): 8"
"Mo27"
"Low rounded basaltic hills with some undulating portions: chief soils are probably neutral red friable earths (Gn3.12). Associated are probably (Uf6.22) soils on upper slopes, (Ug5.1) soils on lower slopes, and (Ug5.2) soils on flats. A surface stone cover occurs in places. Occurs on sheet(s): 8"
"Mo28"
"Basaltic plateau of a stepped ridge relief; surface is boulder-strewn; soils are shallow; some minor sandstone outcrop: chief soils are shallow varieties of neutral red friable earths (Gn3.12) on the plateau crests. Associated are elongate depressions of (Ug5) soils. Other soils include (Um6) soils such as (Um6.24) and (Uf6) soils such as (Uf6.31) on the ridges and their slopes. Occurs on sheet(s): 8"
"Mo29"
"Moderately to strongly undulating lands with broad rounded crests and some low hilly areas and low plateaux; basic rock outcrop may be common on higher sites: dominant soils are moderately deep strongly structured red friable earths, chiefly (Gn3.12) but occasionally (Gn3.13). Associated on some slopes and on areas of more acid parent material are loamy red duplex soils (Dr2.12) and (Dr2.22) with extremely gravelly A horizons. In some areas there are small occurrences of cracking clays (Ug5.14) and (Ug5.32). Occurs on sheet(s): 7"
"Mo30"

"Gently undulating basalt plains or plateaux with many low stony flow scarps and occasional low conical hills. Most areas have surface stone and all soils have stone within the profile: dominant soils are loamy friable red earths (Gn3.12), which are shallow to moderately deep over most of the unit but may occasionally be deep. Slightly acid forms (Gn3.11) also occur. Commonly associated are small stony plains of dark cracking clays (Ug5.12, Ug5.13) of units Kb24 and Kc1O, and areas of brown friable earths (Gn3.22) of unit Me9. The latter occur in slightly depressed sites, chiefly towards the eastern margin of the unit. Shallow very stony friable loams (Um6.33) or clays (Uf6.31) are common on the low flow scarps. Occurs on sheet(s): 7"
"Mo31"
"This unit is an association of unit Mo30 of Sheet 7 and unit Kb24 of Sheet 7. Overall, the loamy friable red earths (Gn3.12) of unit Mo30 (the gently undulating basalt plains or plateaux) are dominant, but the pattern is very complex. Although there are only a few larger areas, there are numerous small occurrences of the dark cracking clays (Ug5.12) of unit Kb24 (level to gently undulating stony plains). Minor associated soils of both units also occur. Occurs on sheet(s): 7,10"
"Mo32"
"Dissected basalt plateaux with very stony slopes and many flat plateau remnants: dominant and associated soils are similar to those of unit Mo30, but shallow stony loams (Um6.33) and clays (Uf6.31) are the major associated soils. The unit may also include small areas of a range of loamy duplex soils (Dy2) and (Dy3) where streams have cut through the basalt and exposed other underlying rocks. Occurs on sheet(s): 7"
"Mo33"
"Undulating lands with occasional higher linear strike ridges: dominant soils are probably moderately deep red friable earths (Gn3.12, Gn3.11), with gravelly red duplex soils (Dr2.11) and (Dr2.21) associated. On the higher ridges yellow duplex soils (Dy2.21) and (Dy2.81) and shallow sands (Uc4.12) and (Uc2.12) occur. Data are very limited. Occurs on sheet(s): 7"
"Mo34"
"Gently undulating lands with some areas of stronger relief and occasional low hills: dominant soils are shallow to moderately deep loamy red friable earths (Gn3.12), with lesser acid and alkaline forms (Gn3.11, Gn3.13). Associated soils include moderately deep to deep loamy red duplex soils (Dr2.12, Dr2.13) and occasional loamy red earths (Gn2.12, Gn2.15). Shallow gravelly loams (Um5.41) and (Um5.51) are common on higher sites in areas of stronger relief. Deep crusty loamy red duplex soils (Dr1.33, Dr1.32) and (Dr1.43) are common on the alluvium of major streams, particularly towards the southern extent of the.unit. All sedentary soils have much quartz gravel on the surface and through the A horizons. Occurs on sheet(s): 10"
"Mp1"
"Undulating basaltic plateau remnant, flanked by steep slopes: chief soils are red friable earths (Gn3.11). Other soils are likely. Occurs on sheet(s): 3"
"Mp2"
"Hilly to steep hilly with some rounded slopes: chief soils are red friable earths (Gn3.11 and Gn3.12). Associated are friable brown soils (Db3.21 and Db3.23), the latter in seepage sites; and shallow dark. Occurs on sheet(s): 3"
"Mp3"
"Plateaux and plateau remnants of lateritized basalts, and basalts at high elevation (about 2000 ft above sea level): chief soils on long straight to slightly concave slopes and over low ridges of the central portions of these plateaux are acidic red friable earths (Gn3.11) with variable amounts of laterite, and yellow friable earths (Gn3.71 and/or Gn3.74) with variable amounts of laterite in the broad valleys. Associated are: shallow to deep forms of acidic red earths (Gn2.11) with variable amounts of laterite on low convex rises, knolls, and ridges (some of cuesta form), particularly in the eastern portions of these plateaux; and neutral red friable earths (Gn3.12) on broad ridges and gentle slopes generally at a lower level than the two previous soil formations, and particularly in the western portions of these plateaux. Small areas of other soils are likely, notably shallow (Um) soils. The full range of soils described above may not be present in each individual occurrence, especially the smaller. Occurs on sheet(s): 4"
"Mp4"
"Plateaux and plateau remnants of lateritized basalts, and basalts, at moderate elevations (less than 2000 ft above sea level)--generally pedimented lateritic landscapes of undulating to rolling relief with flat-topped ridges (some cuestas) and knolls: chief soils on the long smooth but uneven slopes are acidic red friable earths (Gn3.11) with variable amounts of laterite. Associated are shallow to deep forms of acidic red earths (Gn2.11); in some areas of these soils smooth peds become apparent from a depth of 3 ft. Other soils include: yellow earths (Gn2.2) and shallow (Um) soils all with variable amounts of lateritic materials on or around the ridges, cuestas, knolls, and low convex rises; some (Gn3.71), (Gn3.74), and (Gn3.51) soils with variable laterite content on floors of the broad shallow valleys; some (Gn3.12) soils on slopes; and some (Uf6.21) soils on escarpments. Some local variations between different areas of this unit are to be expected. Occurs on sheet(s): 4"
"Mp5"
"Moderately steep uneven slopes below adjacent plateau rim and leading down to major drainage lines; derived from basalts and with drifts of lateritic materials: chief soils are acid red friable earths (Gn3.11) . Associated are:

moderate areas of (Gn2.11 and Gn2.14) soils on all slopes; stony (Um2.12) and (Um4.1) on some knolls; (Ug5.12, Ug5.13, and Ug5.14) soils on lower slopes and small rises on slopes; and some (Gn3.23), (Gn3.43), and (Ug5.3) on low benches and rises. Minor soil occurrences include (Dr2.42), (Dy2.42), (Dy2.43), (Ug5.16), and (Db1.13). Occurs on sheet(s): 4"
"Mp6"
"Low coastal basaltic plateaux and islands of Moreton Bay (about 50 ft above sea level): chief soils are red friable earths (Gn3.11) on the gently undulating to flat ridge tops with (Gn3.14) soils on the bevelled slopes of the ridges. Occurs on sheet(s): 4"
"Mp8"
"Dissected basaltic plateau (less than 450 ft above sea level) of rounded low hilly relief: chief soils are red friable earths (Gn3.11) on all hill crests and slopes, underlain by laterite in places. Other soils include (Gn3.74) containing black nodular material below 2 ft on stream flats, (Dr4.21) soils on some slopes, and (Gn3.22) soils on basalt in some places. Occurs on sheet(s): 4"
"Mp9"
"Steep hilly to mountainous land on volcanic rocks with some gentler foothills--very steep slopes generally but moderate slopes in places; narrow deep valleys with terraces along small streams: chief soils are red friable earths (Gn3.11). Associated are (Db3.12) and (Gn3.42) soils on slopes and crests and (Uc4.1) on jasper outcrops. Other soils include: (Dr4.12) on slopes; (Db 1.23), (Gn3.12), and (Dr4.12) on terraces and fans; (Gn4.52) on very steep slopes; and (Gn3.74) on phyllites. As mapped, there are inclusions of units Mm8 and X13. Occurs on sheet(s): 4"
"Mp10"
"Low hilly basaltic plateau more than 1200 ft above sea level with crests to 1450 ft in places; the smoothly convex low hills with their gentle slopes to narrow swampy drainage-ways are characteristic of the less dissected parts; low hilly areas with moderate slopes and some hilly areas are included; some stony knolls of metamorphic rocks occur and some phyllites are exposed: chief soils are acid red friable earths (Gn3.11). Minor soil occurrences include: (Gn3.92) in the swampy drainage-ways; (Gn3.41) and (Db3.12) soils on plateau margins; and (Gn3.74) and (Gn3.84), with (Dy3.41) on phyllites. Occurs on sheet(s): 4"
"Mp11"
"Low hilly basaltic plateau between 400 and 500 ft above sea level; smooth convex low hills with gentle slopes and ill-defined depressions on the plateau top but with steep scarp slopes around the margin: chief soils are acid red friable earths (Gn3.11). Minor soil occurrences include shallow and bouldery variants of (Gn3.11), (Gn3.21), and (Gn3.41) on steep slopes; (Gn3.91) in seepage sites; and (Uc4.1) and (Dy5.41) on sandstone. Occurs on sheet(s): 4"
"Mp12"
"Rolling plateau surface at 150-1700 ft above sea level, surrounded by cliff, scarp, and steep slopesthe basalts and clay laterites of this plateau are weathered to depths of 200 ft: chief soils are acid red friable earths (Gn3.11 and Gn3.10). Associated are red earths (Gn2.11), often gravelly. There are probably many similarities to unit Mp4, but data are very limited. Occurs on sheet(s): 4"
"Mp13"
"Strongly to moderately hilly country on mixed and variable basic to acidic rocks; slopes are steep to moderate and crests rounded; some marginal ridges: chief soils are acidic red friable earths (Gn3.11 and Gn3.10). Associated are (Gn3.13 and Gn3.12) soils on lower slopes. Minor soil occurrences include (Um4.1)on ridge crests, (Uc2.12) on trachyte, and (Dr4.41) on granitic rocks. Other soils are likely locally. Occurs on sheet(s): 4"
"Mp14"
"High mountains with precipitous scarps and very steep slopes, flatter areas are confined to scarp margins and narrow valley floors; rock outcrop may be frequent: dominant soils are loamy red friable earths (Gn3.11), with associated (Gn3.14) and brown friable earths (Gn3.21 and Gn3.24). Also occurring are shallow stony duplex soils (Dr2.11) and (Dr2.21) and similar (Dr4), (Dy2), and (Db1) soils. Shallow stony loams (Um1.43) and (Um2.12) occur on many steep rocky spurs and slopes. In the narrow alluvial valley floors loamy duplex soils (Dy3.42) occur on the older terraces and uniform loams (Um5.5) on younger terraces. Other soils are also likely to occur within the unit. Occurs on sheet(s): 4"
"Mp15"
"Hilly high plateaux often bounded by precipitous scarps: dominant soils are deep to moderately deep red friable earths (Gn3.11), with associated red porous earths (Gn4.11). Also occurring are other friable earths (Gn3.14), (Gn3.21), and (Gn3.24). On lower, flatter (and drier) slopes, shallower dark earths (Gn3.41) and (Gn3.21) are common, with some dark clays (Ug5.16) on alluvial valley floors. Occurs on sheet(s): 4"
"Mp16"
"Low hills with broad gently sloping crests and gentle to moderate side slopes to narrow alluvial flats: chief soils are red friable earths (Gn3.11) containing moderate amounts of lateritic gravel and fragments. Minor soil occurrences are (Gn3.14) on side slopes, (Gn2.14) on fans, and (Gn3.7) on basal hill slopes. Occurs on sheet(s): 4"
"Mp17"

"Steep hilly to mountainous land as for unit Mp9 associated with steep hilly lands as for unit Rh12: chief soils are red friable earths (Gn3.11). Associated are friable brown soils (Db3.12). Occurs on sheet(s): 4"
"Mp18"
"Moderately undulating lands with some low hilly areas: dominant soils are deep red friable earths (Gn3.11), with some areas of red porous earths (Gn4.11) overlying strongly structured deep subsoils. Other associated soils include moderately deep or deep friable loams (Um6.34, Um6.33) and (Um4.43, Um4.41) of units LN2 and Gh1. Occurs on sheet(s): 7"
"Mp19"
"Low hilly to hilly basalt plateaux with some low conical peaks: dominant soils are deep red friable earths (Gn3.11), with areas of red porous earths (Gn4.11) overlying strongly structured deep subsoils. Chief associated soils are deep mottled brown friable earths (Gn3.51). Included in the unit are small areas of moderately deep friable loams (Um4.43, Um4.41) and (Um6.33), with lesser friable earths (Gn3.14) and (Gn3.74) on inclusions of metamorphic rocks. Small areas of deep friable earths (Gn3.14), (Gn3.74), and (Gn3.84) also occur on small inclusions of acid igneous rocks. Occurs on sheet(s): 7"
"Mp20"
"Gently undulating to undulating plateaux with fairly long gentle slopes: dominant and associated soils are as for unit Mp19. Occurs on sheet(s): 7"
"Mp21"
"Gently undulating basalt plains and low plateaux with some very stony dissected flow scarps: dominant soils are moderately deep to deep red friable earths (Gn3.11), with variable amounts of residual basalt gravel on the surface and throughout the profile. The chief associated soils are deep brown friable earths (Gn3.21), with lesser (Gn3.22, Gn3.23) and (Gn3.51) occupying the lower depressed areas. There are also small areas of moderately deep to deep dark cracking clays (Ug5.13, Ug5.12). Shallow stony friable loams (Um6.33) and clays (Uf6.31) are common on the flow scarps. Occurs on sheet(s): 7"
"Mp22"
"Undulating plains with occasional low hilly areas: dominant soils are moderately deep to deep red friable earths (Gn3.11), which usually have basalt boulders in variable amounts and size throughout the profile. In some less well-drained sites brown friable earths (Gn3.21) and (Gn3.51) occur, together with strongly nodular brown earths (Gn2.41). The low hills or plateau remnants have shallow stony soils, chiefly red or dark clays (Uf6.31, Uf6.32) and (Ug5.12), together with some red friable earths (Gn3.11). Throughout the unit are small areas of deeper dark cracking clays (Ug5.12). Occurs on sheet(s): 7"
"Mq1"
"Very gently undulating plains with some dunes: extensive flat areas with occasional sink-holes, of sandy to loamy alkaline grey earths (Gn2.83) associated with yellow earths (Gn2.23 and Gn2.22) and possibly red earths (Gn2.13 and Gn2.12). Associated are: dunes of siliceous sands (Uc1.23) or (Uc1.43); clay pans of (Dr1.33) and cracking clays (Ug5.2 and Ug5.3); and brown calcareous earths (Gc1.22) on some dunes in the N.S.W. areas of this unit. Layered soil materials often evident below depths of 45 ft. Occurs on sheet(s): 3,4"
"Mq2"
"Plains with mostly moderate to strong gilgai microrelief or numerous sink-hole depressions: chief soils are sandy to loamy alkaline grey earths (Gn2.83) in the inter-depression areas and cracking clays (Ug5.2 and Ug5.3) in most depressions. Associated are red earths (Gn2.13 and Gn2.12). As mapped, small gilgai clay areas of unit CC20 are included. Layering of soil materials is likely. Occurs on sheet(s): 3"
"Mq3"
"Gently undulating plains with low rises and broad shallow depressions; occasional small low outcrops of massive secondary limestone occur: dominant soils are moderately deep to deep sandy grey earths (Gn2.83). Associated in lower areas are very shallow sands (Uc5.13) overlying an indurated earthy pan. Deep sands (Uc5.22, Uc5.23), often with ironstone nodules and quartz gravel at depth, occur on the low rises. Occurs on sheet(s): 7"
"Mr1"
"Mountainous ranges with some narrow undulating ridge crests: steep, sometimes rocky, slopes of acid leached yellow earths (Gn2.24 and Gn2.44). Associated are red earths (Gn2.14), loamy soils having an A2 horizon (Um4.2), and possibly undescribed soils especially on the undulating range crests. Data are limited. Occurs on sheet(s): 3"
"Mr2"
"Mountainous--ridge and slope country: narrow undulating to hilly ridge crests of shallow, often stony and/or rocky, acid leached yellow earths (Gn2.24) and probably other (Gn2) soils; steep to rugged side slopes of shallow soils, including (Gn2.4), (Um4.1), and (Um4.2); and minor areas of various soils, including (Uf6.31), where particular parent materials are exposed. Data are limited. Occurs on sheet(s): 3"
"Mr3"
"Subdued ridge and slope country: undulating to low hilly ridge crests of acid leached yellow earths, including (Gn2.24) and (Gn2.74). Associated are: basins and other low-lying areas of hard neutral and acidic yellow mottled

soils (Dy3.42 and Dy3.41); steep side slopes and scarps of (Gn2.4) and (Um4.1) soils; and small areas of (Um6.13) and (Dr4.1) soils on basaltic knolls and ridges. Minor areas of units Mu5 and Ub39 may be included. Data are limited. Occurs on sheet(s): 3"
"Mr4"
"Subdued ridge and slope country: undulating to low hilly terrain of acid and neutral leached yellow and red earths, such as (Gn2.24), (Gn2.75), (Gn2.15), (Gn2.14). Associated are hard neutral and acidic yellow mottled soils (Dy3.42 and Dy3.41); and less commonly (Dr2) and (Um4) soils on the steeper slopes. Data are limited. Occurs on sheet(s): 3"
"Mr5"
"Mountainous--stepped ranges with some undulating ridge crests and undulating to hilly valleys: chief soils seem to be acid leached yellow earths (Gn2.24, Gn2.74) often of shallow depth on the slopes, with (Dy3.61) and possibly other soils on the ridge crests. Associated are: (Dr3.41), (Dr2.41), (Dr2.21), (Dy3.41), and (Um4.1) soils on steeper slopes generally, in hilly valleys, and on hilly areas which flank the main mass; and other soils, including (Uc) soils, occur, as do slabs of sandy ironstone. Data are limited. Occurs on sheet(s): 3"
"Mr6"
"Undulating to strongly undulating weakly dissected old coastal plain about 200 ft above sea level with some flat-tops and convex ridge crests above 200 ft, long gentle slopes to shallow open terraced valleys; some high sandstone inselbergs rise abruptly to over 450 ft: chief soils are acid yellow earths (Gn2.24), (Gn2.64), and (Gn2.74) on the broad crests. Associated are (Gn2.94) soils on slopes and creek flats, and (Uc2.2), (Uc2.33), and sometimes (Uc2.35) soils in treeless flat-bottomed valleys. Other soils include: (Gn2.14) on higher ridge crests (above 200 ft) and on the third terrace along major streams; (Gn3.52) on second terrace of major streams; (Dy5.51) and (Dy5.11) with hummocky microrelief along some stream flats; and (Uc2.12) and (Dr2.41) with (Dy2.41) on crests and slopes, respectively, of the inselbergs. As mapped, small areas of mountainous basaltic country with (Gn3.14), (Uf6.32), (Um6.21), and (Gn3.11) soils are included. Occurs on sheet(s): 4"
"Mr7"
"Undulating plains with some strongly dissected areas adjacent to incised drainage lines: dominant soils are slightly acid sandy yellow earths (Gn2.24) with lesser (Gn2.21, Gn2.22, and Gn2.25). In most soils a prominent ironstone nodule horizon occurs at relatively shallow depths (20 30 in.). Associated are areas of nodule-free earthy sands (Uc4.2) and (Uc5.22), together with some areas of sandy or loamy red earths (Gn2.11 and Gn2.12). Occurs on sheet(s): 4"
"Mr8"
"Undulating plains and their sloping margins: chief soils are yellow earths (Gn2.24 and Gn2.25) and (Gn2.74) and grey earths (Gn2.81), all typically containing much ironstone gravel and sometimes with block laterite at shallow depths. Associated are ironstone gravels and sands (KS-Uc4.11) and (Uc4.11) on marginal slopes together with colluvial red and yellow earths (Gn2.15) and (Gn2.2); some shallow valleys and drainage depressions of (Uc1.21), (Uc5.2), and (Dy5.41) soils; and small areas of other soils such as (Dy3.41) and (Dr2.41) on flanking slopes. As mapped, small areas of units Mw32, JY2, and AB32 may be included. Occurs on sheet(s): 8"
"Mr9"
"Gently undulating plains with low moderately steep-scarped margins: dominant soils are loamy yellow earths (Gn2.24) with a prominent ironstone nodule horizon at approximately 30 in. Associated are sandy yellow earths (Gn2.24) and some red earths (Gn2.14, Gn2.11). In lower sites are loamy and sandy mottled yellow earths (Gn2.61) and (Gn2.74). Occurs on sheet(s): 7"
"Mr10"
"Gently undulating to undulating lands occupying broad shallow valleys: dominant soils are moderately deep loamy and sandy yellow earths (Gn2.24), usually with prominent ironstone nodules at depth. Associated are shallow sands (Uc4.2) and sandy and loamy grey earths (Gn2.81). On scalded areas are moderately deep bleached loamy grey earths (Gn2.95) and shallow bleached sands (Uc2.3); usually these overlie a prominent ironstone nodule horizon. Small stream levees have loamy red or yellow earths (Gn2.11, Gn2.14) and (Gn2.21). Occurs on sheet(s): 7"
"Mr11"
"Gently undulating plains consisting of low very broad sandy rises and many sharply defined shallow drainage depressions that become less prominent in the northern parts of the unit. Well-defined swamps are also a feature. The dominant soils of the rises are sandy yellow earths (Gn2.24), with lesser (Gn2.25), (Gn2.34), and (Gn2.74). Other sandy earths (Gn2.84, Gn2.85), (Gn2.54), and occasionally (Gn2.94) are commonly associated. Some soils have ironstone nodules at depth. On higher ridges there may be areas of sandy red earths (Gn2.14, Gn2.15) or deep sands (Uc4.22) and (Uc5.22). On some lower slopes adjacent to the drainage depressions deep sandy duplex soils (Dy5.81) or deep bleached sands (Uc2.21) occur. The drainage depressions have sandy to loamy grey duplex soils (Dy3.43, Dy3.42) and (Dy2.43, Dy2.42) and bleached grey earths (Gn2.94, Gn2.95). Small areas of units TM1 and Va87 are included. Occurs on sheet(s): 7"
"Mr12"

"Gently undulating outwash slopes and fans: dominant soils are deep loamy yellow earths (Gn2.24), with lesser (Gn2.21) and very occasional loamy red earths (Gn2.14). Loamy duplex soils (Dy2.23), (Dy2.43), (Dy3.23), and (Dy3.43) occur in slight depressions and in the minor drainage lines. Data are limited. Occurs on sheet(s): 7"
"Mr13"
"Gently undulating lands with short even slopes to the drainage lines: dominant soils are deep loamy yellow earths (Gn2.24), with lesser red earths (Gn2.14, Gn2.11) on the higher broad ridge crests. Some bleached loamy yellow earths (Gn2.34) occur on the lower slopes; loamy duplex soils, chiefly (Dy2.33), (Dy2.43), (Db1.33), and (Dy3) equivalents, occur in the minor drainage lines. Included also are small areas of shallow leached sands of unit Cd29. Occurs on sheet(s): 7"
"Mr14"
"Very gently undulating low lateritic plateau with long gentle slopes to drainage lines: loamy yellow earths (Gn2.24) are the dominant soils but there are also large areas of loamy red earths, chiefly (Gn2.14) but with some (Gn2.11), on the broad ridge crests and higher slopes. Loamy or occasionally sandy duplex soils (Dy3.41), (Dy3.42), and (Dy2) equivalents occur adjacent to drainage lines and in localized internal drainage depressions. Shallow gravelly loams (Um4.12) and (Um4.21) occur on the low lateritic scarps bordering the unit. Occurs on sheet(s): 7"
"Mr15"
"Strongly undulating to low hilly lands with some large granite tor outcrop: moderately deep to deep loamy yellow earths (Gn2.24) are probably dominant, but associated are important areas of red earths (Gn2.14) lesser (Gn2.11), and occasional (Gn2.74). Loamy duplex soils (Dy3.41), (Dy3.21), and (Dr3.21) occur on lower slopes, while shallow bleached sands (Uc2.21, Uc2.22) and (Uc2.12), and other shallow sands (Uc4.21 Uc4.22) are common on higher slopes and adjacent to rock outcrop. Loamy red or yellow earths (Gn2.14) and (Gn2.24) occur on the occasional small lateritic mesas, while friable earths (Gn3.12), (Gn3.22), and shallow friable loams (Um6.33) are common on small basalt mesas that are also included in the unit. Occurs on sheet(s): 7"
"Mr16"
"Moderately to strongly undulating elevated plateau: dominant soils are probably deep loamy yellow earths (Gn2.24) but deep yellow friable earths (Gn3.74) also occupy large areas. Minor associated soils include other loamy earths (Gn2.44), (Gn2.84), and (Gn2.14) and also friable earths (Gn3.84), (Gn3.94), and (Gn3.04). Small areas of red friable earths (Gn3.11) occur on basic rocks. Occurs on sheet(s): 7"
"Mr17"
"Slightly elevated old beach ridges inland from the coastline: dominant soils are slightly compacted sandy yellow earths (Gn2.24), with bleached forms (Gn2.34) also occurring. At moderate depths the soils Fade to loose sands. Associated are small areas of salt pans of unit Io1 and deep grey cracking clays of unit 1112. Data are limited. Occurs on sheet(s): 7"
"Mr18"
"Very gently undulating plains, occasionally with low scarped margins. The unit is similar to and grades into unit Mr11 but the drainage depressions are much fewer and less well defined; small well-defined swamps are again a feature in parts of the unit: dominant soils are deep sandy yellow earths (Gn2.24), often with yellowish red subsoils. The chief associated soils are sandy or occasionally loamy red earths (Gn2.14) on slightly higher level surfaces, and sandy bleached grey or yellow earths (Gn2.94), (Gn2.74), and (Gn2.34) on weakly dissected slopes to the drainage depressions. The earth soils may occasionally have ironstone nodules at depth. The drainage depressions have similar soils to those occurring in unit Mr11. Occurs on sheet(s): 7"
"Mr19"
"Gently undulating alluvial plains associated with major streams. The unit is often dissected by many stream channels and parts are subject to seasonal flooding: dominant soils are probably sandy or loamy yellow earths (Gn2.24), which occur on low rises, but also common are slightly higher rises of similar red earths (Gn2.14). In areas subject to flooding adjacent to the stream channels stratified loams (Um4.23) usually occur. On the broader flood-plains small drainage depressions have loamy duplex soils (Dy3.42) and (Dd2.32). Data are very limited. Occurs on sheet(s): 7"
"Mr20"
"Strongly undulating lands with some low hilly areas: a complex pattern of soils is present but dominant are probably sandy or loamy yellowish red earths (Gn2.24), which occur on the middle and upper slopes. Associated with them are (Gn2.25) and (Gn2.74) soils. On broad high ridge crests sandy or loamy red earths (Gn2.14, Gn2.11, Gn2.15, and Gn2.12) are common, and on lower slopes and valley floors loamy mottled yellow earths (Gn2.74) and (Gn2.64) are common. Included in the unit are low hilly areas of granite or gneiss with (Dr2.61), (Dr2.21), (Dy2.21), and (Uc4.22) soils. Data are limited. Occurs on sheet(s): 7"
"Mr21"
"Moderately to occasionally strongly undulating lands, often with long gentle slopes; the strongly undulating areas may have low laterite or sandstone scarps: dominant soils are deep sandy yellowish red earths (Gn2.24), with sandy red earths (Gn2.14) and, less commonly, (Gn2.11), usually occurring on ridge crests. All soils normally have a

prominent ironstone nodule horizon below approximately 30 in. and massive nodular laterite may occur at variable depths within the profile. On lower slopes deep sands (Uc4.21, Uc4.22) often occur and shallow gravelly or nodular sands (Uc4.21) and (Uc4.12) occur near the low scarps. Throughout the unit there are small plains fringing drainage lines; these have deep bleached sands of unit Ca43, or occasionally deep sandy bleached earths (Gn2.74) and (Gn2.94). Occurs on sheet(s): 7"
"Mr22"
"Gently undulating plains: dominant soils are deep loamy or sandy yellow earths (Gn2.24), but there are important areas of deep coarse sands (Uc4.21, Uc4.22, and Uc4.24) and lesser red earths (Gn2.14). Associated soils include other sandy and loamy yellow earths (Gn2.64) and (Gn2.14) and deep sands (Uc5.22), (Uc4.24), (Uc2.12), and (Uc2.31, Uc2.34). Loamy red or brown earths (Gn2.12, Gn2.15) and (Gn2.45) occur on levees of major streams. Occurs on sheet(s): 10"
"Ms1"
"Undulating to hilly with some fairly broad flat areas, often broken by rocky knolls and ridges, some of which may be steep: chief soils are sandy acid yellow earths (Gn2.21), sandy acid and neutral red earths (Gn2.11 and Gn2.12), and shallow sand soils (Uc4.1 and Uc4.2) on the ridges and their slopes where ferruginized rock and ironstone gravels are common. Associated are: flatter and lowerlying areas generally of various hard-setting (D) soils, such as (Db2.32 and Db2.42), (Dy3.41 and Dy3.42); some sandy (D) soils, such as (Dy5.42); some slopes and flatter areas especially in northern expressions of the unit of (Dr2.43) and (Dy3.43) soils sometimes with cracking clays (Ug5); small areas of (Uc5.2) soils; and small areas of soils, such as (Dr4.12), associated with small basaltic flat tops and ridges. As mapped, small areas of units Mz1, Mo5, Kb2, Ke11, and Kc5 may be included. This is a broadly defined and complex unit which may be capable of further division when further data are available. Occurs on sheet(s): 3"
"Ms2"
"Very gently undulating or level plains: dominant soils are slightly acid sandy yellow earths (Gn2.21) with lesser (Gn2.22). Ironstone nodule layers often occur at moderate depths. Closely associated are yellow earthy sands (Uc5.22) and areas of deep sandy red earths (Gn2.11 and Gn2.12). Small areas of loamy red and yellow earths also occur and broad shallow drainage depressions have sandy-surfaced duplex soils (Dy3.32, Dy3.42, and Dy3.43) or other earth soils (Gn2.95) and (Gn2.35). Small low hilly areas of unit Fz7 may be included. Occurs on sheet(s): 4"
"Ms3"
"Level or very gently undulating plains: dominant soils are slightly acid sandy yellow earths (Gn2.21) with associated (Gn2.22, Gn2.24, and Gn2.25). A prominent ironstone nodule horizon is normally present by 36 in. In slightly lower sites and particularly in broad shallow drainage lines leached earths (Gn2.34) and (Gn2.94) are common, again often with an ironstone nodule horizon. Also occurring in the unit are smaller areas of earthy sands (Uc5.22) and sandy and loamy red earths (Gn2.11 and Gn2.12). In better-defined drainage lines duplex soils are common, chiefly (Dy2.43), (Dy2.32), (Dy3.42), and (Dy3.43). Occurs on sheet(s): 4"
"Ms4"
"Moderate to gently undulating lands with some low lateritic scarps: dominant soils on higher landscape sites are loamy yellow earths (Gn2.21), (Gn2.24), and (Gn2.62) with occasional areas of red earths (Gn2.11). In valley floors and lower slopes loamy duplex soils occur, chiefly (Dy3.42). The low lateritic scarps have shallow stony loams (Um1.41) or sands (Uc2.12). Occurs on sheet(s): 4"
"Ms5"
"Gently undulating extensive plateau surface with dissected low scarped margins: dominant soils are slightly acid loamy yellow earths (Gn2.21) with lesser (Gn2.61). A prominent ironstone nodule horizon is often present at moderate depths. In some areas a sink-hole type gilgai microrelief is present, with (Dy2.43) and (Dy3.43) soils occurring in the depressions. Adjacent to shallow drainage lines are loamy duplex soils (Dy3.43 and Dy3.42); these are often underlain by mottled rock. The dissected margins of the plateau include soils of units Tb119 and Cd14. Occurs on sheet(s): 4"
"Ms6"
"Undulating lands with broad shallow depressions: dominant soils of the higher landscape sites are loamy yellow earths (Gn2.21) and (Gn2.61). On lower slopes loamy mottled duplex soils (Dy3.42) occur and in the broad depressions (Dy2.43) soils are most common. Included in the unit, as mapped, are small inclusions of unit Cd17 and small areas of loamy red earths (Gn2.12). Occurs on sheet(s): 4,7"
"Ms7"
"Gently sloping to gently undulating plateau areas with long and very gentle slopes and, in places, abrupt erosional scarps: chief soils are (i) on gently convex slopes of the plateau, sandy yellow earths (Gn2.21) containing ironstone gravels and with clay D horizons; (ii) on depositional slopes flanking erosional sites, yellow earthy sands (Uc5.22) sometimes with ironstone gravels at depth; (iii) on erosional ridges and slopes, leached sands (Uc2.12) containing ironstone gravels and overlying mottledor pallid-zone clays; and (iv) sandy depressions of leached sands (Uc2.22) with some (Dy) soils. Soil dominance tends to vary locally between (i) and (iii). As mapped, areas of unit Uf1 are included. Occurs on sheet(s): 5"

"Ms8"
"Gently sloping to gently undulating plateau areas or uplands with long and very gentle slopes and, in places, abrupt erosional scarps: chief soils are (i) on depositional slopes, sandy yellow earths (Gn2.21 and Gn2.22) containing some ironstone gravels, and yellow earthy sands (Uc5.22) often with ironstone gravels at depths below 6-7ft; and (ii) on erosional ridges and slopes, ironstone gravels (KS-Uc4.11) together with (Uc4.11) and (Uc2.12) (both containing ironstone gravels), all underlain by hardened mottled-zone material by depths of 12-24 in. Soil dominance tends to vary locally between (i) and (ii) but overall the soils of (i) seem to have a slight dominance over the soils of (ii). Associated are smaller areas of other soils, such as (Dy3.82) containing ironstone gravels in its surface horizons. As mapped, small areas of units JJ16, Va66, DD9, X17, and possibly Sl28 are included. Occurs on sheet(s): 5"
"Ms9"
"Undulating terrain of a succession of plateau areas as for unit Ms8 and relatively narrow valley side slopes as for unit Oc35 with some small flats of (Dr2.33) soils: generally the sandy yellow earths (Gn2.21 and Gn2.22) and yellow earthy sands (Uc5.22) of unit Ms8 seem to be dominant but there are areas of soils common to both units mentioned above. Occurs on sheet(s): 5"
"Ms10"
"Gently sloping to gently undulating plateau areas or uplands with long and very gentle slopes and, in places, abrupt erosional scarps: chief soils on depositional slopes are sandy, acidic, and neutral yellow earths (Gn2.21, Gn2.22, Gn2.25, and Gn2.35) and yellow earthy sands (Uc5.22), all containing some ironstone gravels or underlain by indurated ironstone gravel pans. Associated on erosional ridges and slopes are (Uc2.12), (Uc2.21), and (Uc4.11) soils all containing some ironstone gravels and underlain by indurated ironstone gravel pans or hardened mottled-zone materials. This unit is similar to unit Ms8 but seems to have a greater variety of yellow earth soils which, however, could be more extensive in some areas of unit Ms8 than present data indicate. Occurs on sheet(s): 5"
"Ms11"
"Undulating areas with granitic and gneissic outcrops, ridges, and escarpments: chief soils seem to be sandy yellow earths (Gn2.21 and Gn2.22) and yellow earthy sands (Uc5.22). Associated are shallow (Uc) soils such as (Uc4.11); various shallow (Dy) and (Dr) soils such as (Dr2.31); and small flats of (Gn2.13) soils. Small areas of units Fa4 and My45 may be included. Occurs on sheet(s): 5"
"Ms12"
"Undulating plateau area with some low dunes; ironstone gravel pavement: chief soils are acidic yellow earths (Gn2.21) often containing much ironstone gravel and underlain by a red-brown hardpan. Associated usually on low dunes are yellow earthy sands (Uc5.22) sometimes underlain by a red-brown hardpan. Other soils include (KS-Uc5.22) on erosional sites and (Gn2.12, Gn2.13) in small flats. The red-brown hardpan may be present from depths of 18 in.. Occurs on sheet(s): 5,6"
"Ms13"
"Low-lying alluvial plains: chief soils are acid yellow earths (Gn2.21 and Gn2.24) with lesser areas of (Gn2.34), all often containing some ironstone gravels and occurring on gentle slopes. Associated are areas of a wide variety of soils including (Uc2.2) sands on gentle sandy slopes; (Dy3.42), (Dy2.42), and similar soils in low sites; (Uc1.2) sands fronting sandstone hills; (Dy5.42) and (Uc1.2) soils in sandy low sites; and (Um5.52) and (Gn2.1) soils on levees. Occurs on sheet(s): 8,9"
"Ms14"
"Gently sloping plain: chief soils are probably acid, and also neutral, yellow earths (Gn2.21 and Gn2.22). Associated are cracking clays such as (Ug5.28). Other soils include (Gn2.12) and (Uc5.2). Occurs on sheet(s): 8"
"Ms15"
"Variable terrain--steeply to gently undulating country with some mesas and developed on siltstones, sandstones, and conglomerates; some lateritic remnants: chief soils are acid yellow earths (Gn2.21) and (Gn2.61) containing slight to large amounts of ironstone gravels and occurring on moderate to steep slopes. Associated are cracking clays (Ug5.22) and (Ug5.5) on moderate to gentle lower slopes where they may form complexes with the yellow earths and with (Db), (Dy), and (Dr) soils such as (Dr3.71); some such areas have gilgai microrelief. The soils of unit Mt6 occur along the larger stream valleys; and the soils of unit BY3 occur on mesas and the steeper slopes generally, together with areas of the soils of unit My79. Minor areas of other units such as unit JJ34 may be included. Occurs on sheet(s): 8"
"Ms16"
"Gently undulating to undulating outwash plains; occasional low rises with massive nodular laterite on margins, and some areas of channels, levees, and flats associated with streams: dominant soils are deep sandy and loamy yellow earths (Gn2.21 and Gn2.22) usually with ironstone nodules at depth. On lower areas are sandy and loamy grey earths (Gn2.81), (Gn2.94), and some massive yellow mottled duplex soils (Dy3.81). On the low rises are shallow sands with ironstone nodules (Uc5.22), (Uc4.21), (Uc4.1), (Uc4.22), overlying massive nodular laterite. Adjacent to streams are deep loamy brown and red earths (Gn2.42), (Gn2.12), and occasionally deep red sands (Uc5.21) on the levees. Occurs on sheet(s): 7,8"

"Ms17"
"Gently undulating to undulating plains with massive nodular laterite occurring near low scarp margins: dominant soils are shallow lo moderately deep sandy or loamy nodular yellow earths (Gn2.21, Gn2.22). Associated near the marginal scarps are sandy red earths (Gn2.11, Gn2.12) and shallow nodular loams (Um5.51). Occasional sandy grey earths (Gn2.81, Gn2.82) occur in lower sites. Occurs on sheet(s): 7"
"Ms18"
"Gently undulating plains: dominant soils are deep sandy yellow earths (Gn2.21), with lesser (Gn2.64) and (Gn2.74). Some sandy red earths (Gn2.11) are associated. On small scalded areas are quartz-gravel-strewn loamy-surfaced brown duplex soils (Db1.33). Less commonly, grey duplex soils (Dy2.31) with ironstone nodules in the profile also occur. Occasionally near old stream channels are deep sands (Uc4.2) and (Uc5.22, Uc5.21). Occurs on sheet(s): 7,10"
"Ms19"
"Gently undulating to undulating plains with low laterite scarps: dominant soils are shallow to moderately deep loamy yellow earths (Gn2.21) with many ironstone nodules in the profile. Associated are other strongly nodular earths (Gn2.61), (Gn2.74), and (Gn2.11, Gn2.14). Shallow extremely nodular loams (Um5.51) and (Um4.22) are common near the scarped margins. On the lower slopes of scarps are loamy duplex soils (Dy3.13), (Dy2.13), (Dr2.13), and (Db1.13), with some yellow earths (Gn2.23) and (Gn2.62) also occurring. Occurs on sheet(s): 7"
"Ms20"
"Gently undulating plains with some narrow well-defined drainage depressions: dominant soils are sandy yellow earths (Gn2.21), with occasional (Gn2.24) and (Gn2.34). Associated low rises have sandy red earths (Gn2.14, Gn2.11) and occasionally extremely nodular earthy sands (Uc5.21) or grey earths (Gn2.81) overlying massive nodular laterite. Bleached sands (Uc2.21) may also occur. In the shallow drainage depressions sandy or loamy grey earths occur, chiefly (Gn2.81, Gn2.82) and (Gn2.94), and occasionally grey duplex soils (Dy2.42, Dy2.43). Occurs on sheet(s): 7"
"Mt1"
"Old coastal plain or plateau, about 100 ft above sea level, of undulating to rolling relief, shallow open valleys: chief soils are acid yellow earths (Gn2.64) and acid yellow leached earths (Gn2.74) and (Gn2.34) on the broad ridges. Small areas of other soils include: (Gn2.91 and Gn2.94) on lower slopes and along stream valleys; (Dy3.41) soils on slopes and some crests where sesquioxidic nodular sheets may underlie the soil; (Dy3.31) soils along stream valleys; and (Dg4.81) soils in depressions. As mapped, small areas of unit Tb75 are included. Occurs on sheet(s): 4"
"Mt2"
"Generally undulating to rolling terrain of weakly dissected coalescing sandy and clayey fans; broad convex to flat-topped crests are cut by shallow streams with narrow flats and broken by occasional sandstone inselbergs: chief soils are acid yellow earths (Gn2.64) with acid yellow leached earths (Gn2.74) on the crests. Associated are red earths (Gn2.14) on the higher crests. Other soils include: (Gn2.24) and (Gn3.64) on some crests; (Gn2.91 and Gn2.94) on alluvial flats, (Uc1.22) along creeks; (Dy3.41) on some alluvial flats; and (Uc2.12) on crests and (Dr2.41) with (Dy3.41) on slopes of sandstone inselbergs. Patches of siliceous tertiary gravels are present. Occurs on sheet(s): 4"
"Mt3"
"Rolling weakly dissected coastal plain with broad gently convex ridge crests and gentle side slopes to flat wet valley bottoms, generally below 100 ft above sea level; commonly most of the (Gn) soils contain moderate to large amounts of hard nodules and lumps of ironstone 1-2 in. across. Chief soils are acid yellow earths (Gn2.64), (Gn2.24), and (Gn2.74) on ridge crests, slopes, and some stream terraces. Associated are (Dy3.41) and related soils on lower ridge slopes and flats. Small areas of many other soils occur including (Gn2.14) on stream terraces. As mapped, distinct "valleys"of unit MF4 are included, as are small areas of soils of the adjoining units. Occurs on sheet(s): 4"
"Mt4"
"Gently undulating plains developed on sandstones, limestones, and shaly sediments: chief soils seem to be acid yellow earths (Gn2.64) and (Gn2.24) containing some ironstone gravels. Associated are probably smaller areas of (Gn2.12) and (Dy5.81) soils. Occurs on sheet(s): 8"
"Mt5"
"Gently undulating plain on sandstones and siltstones with some small areas of rocky rises: chief soils are acidic yellow earths (Gn2.64) and (Gn2.24). Associated are some red earths (Gn2.12). Other soils include (Uc5.22) on sandy slopes; (KS-Uc4.12) and (Uc4.1) soils on crests and rocky rises; and (Gn2.9) and (Gn2.7) soils in low-lying sites. Occurs on sheet(s): 8"
"Mt6"
"Gently sloping valley plains with levees, depressions, lagoons, and flat areas; occasional inclusions of rocky hills: chief soils of the flatter areas seem to be acid yellow earths (Gn2.64 and Gn2.61) often containing ironstone gravels. Associated are sandy duplex soils (Dy3.4) in depressions and on back slopes of levees and some flat areas,

together with grey cracking clays (Ug5.5) (more common) and (Ug5.2) (less common) in flat and/or depressed sites of quite variable size and occurrence. The (Ug5) and (Dy3.4) soils may occur in complex and weak (<6 in.) gilgai may be present. Other soils present include (Uc1.43) (commonly) and (Uc4.32) on levees; (Gn2.15 and Gn2.12) on flat areas; and (Um4.23) on flat areas. Minor areas of undescribed soils are likely. As mapped, small areas of unit JJ34 may be included. Occurs on sheet(s): 8"
"Mt7"
"Strongly undulating lands often with granite tor outcrop on higher slopes: a range of loamy mottled yellow or grey earths occur, (Gn2.64) is probably dominant but (Gn2.74), (Gn2.84), and (Gn2.94) are also common. Moderately deep loamy duplex soils (Dy3.41), (Dy3.21), and (Dy2.21) occur on lower slopes, with shallow sands (Uc2.22, Uc2.21), (Uc2.12), and (Uc4.21) common on higher slopes and adjacent to rock outcrop. Minor associated soils include friable yellow earths (Gn3.74) and (Gn3.84) of unit Mf17 and loamy red earths (Gn2.11, Gn2.14), which occur on small lateritic mesa remnants. Occurs on sheet(s): 7"
"Mt8"
"Undulating lands with some granite outcrop occurring adjacent to drainage lines: dominant soils on the broad ridges are loamy mottled yellow earths (Gn2.64), with (Gn2.61) and (Gn2.24) soils associated. On some higher ridges sandy or loamy red earths (Gn2.14) occur. On the small exposures of granite are shallow sands (Uc4.21) and (Uc2.12) and shallow duplex soils (Dy3.42). Data are limited. Occurs on sheet(s): 7"
"Mt9"
"Undulating to moderately undulating or rolling lands with occasional dissected low sandstone scarps: dominant soils are deep sandy mottled yellowish red earths (Gn2.64), mostly without ironstone nodules in the upper 4 ft of the profile. Other sandy earths are often associated, chiefly (Gn2.24), (Gn2.14), (Gn2.61), and occasionally (Gn2.74). These earths often have a prominent ironstone nodule horizon at depth. On some slopes deep sands (Uc4.21) occur, occasionally (Uc4.22), while deep bleached sands (Uc2.21) may occur on lower slopes. The occasional sandstone scarps have shallow gravelly and often nodular sands (Uc2.12) and (Uc4.21). Throughout the unit adjacent to drainage lines are small sandy plains of unit Ca43 with deep bleached sands (Uc2.21). Occurs on sheet(s): 7"
"Mu1"
"Undulating to rolling country with some rounded slopes, broken by ridges and knolls dotted with tors: chief soils are neutral leached red earths (Gn2.15) and hard neutral red soils (Dr2.22) and (Dr2.62), generally as follows: (i) undulating to rolling areas of (Gn2.15) and occasionally (Gn2.16), with (Gn2.25) and (Dy3.42) on mid and lower slopes and (Dy3.43) in valleys--ironstone gravels are present in some areas of the last three soils; (ii) rolling areas of (Dr2.22), (Dr2.42), (Dy3.22), and (Dy3.42); and (iii) ridges and knolls of (Dr2.22), (Dr2.62), and possibly other (D) soils with some areas of siliceous sands (Uc1.2) and tors. Soil dominance varies locally throughout the unit between (i), (ii), and (iii). Data are limited. Occurs on sheet(s): 3"
"Mu2"
"Irregularly stepped, rolling country with some hilly ridges and steep scarps: chief soils throughout the rolling areas are neutral leached red earths (Gn2.15) and neutral red earths (Gn2.12), with hard neutral and alkaline yellow mottled soils (Dy3.42, Dy3.43) in the lower-lying sites. Associated are hilly ridges and steep scarps of (Dr2.22), (Dr3.32), and possibly other (Dr2) soils with (Um4.1) soils and rock outcrops--similar to unit Qb7; and small areas of undescribed soils. Data are limited. Occurs on sheet(s): 3"
"Mu3"
"Undulating to rolling country: chief soils are neutral and acid leached red earths (Gn2.15 and Gn2.14) with hard neutral red and brown soils (Dr2.22) and (Db1.22). Associated are other (Gn2) and also (Dy) soils. Compare units Mu4 and Mu1. Data are limited. Occurs on sheet(s): 3"
"Mu4"
"Gently to strongly undulating plains at moderate to low elevations (<2000 ft) with basins, stream terraces, and low residual hills and ridges; buried, layered soil materials are present: undulating plains of neutral leached red earths (Gn2.15) in the better-drained sites and yellow earths (Gn2.25) in intermediate drainage situations, with yellow leached earths (Gn2.75) often associated with hard neutral and/or alkaline yellow mottled soils (Dy3.42 and Dy3.43) in poorly drained areas, swampy sites, and seepage situations--all often with heavy clay D horizons below the solum. Associated are: low residual hills and ridges of (Dr2.22 and Dr2.42) or (Dy3.22 and Dy3.42) soils, with small areas of (Um4.2) soils and rock outcrops; basins of (Gn2.15 and Gn2.25) or (Dy3.42) soils; and stream terraces of variable width and development with (Um1) soils on present flood-plains, (Um6.11) soils on the youngest terraces, (Gn2.15, Gn2.25, and Gn2.75) in drainage sequence from well-drained to poorly drained sites on. Occurs on sheet(s): 3"
"Mu5"
"Undulating landscape characterized by basaltic knolls and ridges (some of which have scarps) more or less alternating with low, swampy flats: chief soils are neutral and acid leached red earths (Gn2.15 and Gn2.14) and hard, neutral, yellow mottled soils (Dy3.42), generally as follows: (i) undulating slopes of red and sometimes yellow earths (Gn2.14, Gn2.15, and Gn2.25), with (ii) intervening swampy (seasonally waterlogged) flats of

(Dy3.42) soils and (iii) boulder-strewn ridges and knolls of (Gn2.14) or (Dr4.1) or (Um6.12) soils--compare unit Qr2. Soil dominance varies widely with locality. As mapped, areas of unit Mu6 and possibly Rh2 are included. Data are limited. Compare units Tb29, Tb28, and Mu8.. Occurs on sheet(s): 3"
"Mu6"
"Rolling country: chief soils are neutral leached red earths (Gn2.15) and acid and neutral leached yellow earths (Gn2.24) and (Gn2.35). Associated are hilly areas of various (Dy) and (Dr) soils; and basins and low-lying areas generally, of hard, neutral, yellow mottled soils (Dy3.42). Data are limited. Occurs on sheet(s): 3"
"Mu7"
"Gently rolling basins and valleys: chief soils are neutral leached red earths (Gn2.15) with clay D horizons. Associated are various soils including (Dy3.42). Occurs on sheet(s): 3"
"Mu8"
"Dissected and stepped plateau generally of a rolling to rounded hilly terrain with some ranges and steep valley side slopes: chief soils are neutral and acid leached red earths (Gn2.15 and Gn2.14) on the rolling to rounded hilly areas with yellow earths, such as (Gn2.25, Gn2.35, Gn2.34), some containing ironstone gravels, on rolling areas and benched slopes, and hard neutral yellow mottled soils (Dy3.42) and sometimes other (D) soils, such as (Dd1.43), in the flatter, often seasonally wet, areas. Associated are: narrow ranges, also steep side slopes flanking some transit streams (compare unit Tb31), of various (D) soils, including (Dr2.41) and (Dy3.41), and (Um4.1) soils and rock outcrops; some flat hill tops; some terrace-like remnants of (Dr2.42) soils in the broader flatter valleys (?remnants of unit Qd1); and areas of other soils, such as (Dr4.13) and (Um6.43). The area is complex and data are limited. Occurs on sheet(s): 3"
"Mu9"
"Undulating country with some steep slopes, basaltic knolls and ridges, limestone outcrops: chief soils are neutral leached red earths (Gn2.15). Associated are: (i) basaltic areas of (Gn3.13 and Gn3.12) soils on undulating country, (Ug5.1) soils on the flat tops of some ridges, (Dr4.1) and (Db3.1) soils on the slopes of some ridges and knolls; (ii) limestone areas of (Dr4.13) and (Um6.43) soils with outcropping rock; (iii) some steep slopes of shallow (Um4.1) soils; and (iv) (Dr2.4) soils on some moderate slopes. As mapped, areas of units Gb8 and Mu8 are included. Data are limited. Occurs on sheet(s): 3"
"Mu10"
"Undulating dissected lands with occasional low hills: a range of sandy earth soils occurs but (Gn2.15) is probably dominant. Associated are sandy yellow earths (Gn2.22, Gn2.21, and Gn2.25) and smaller areas of grey leached earths (Gn2.94). The occasional low hills have shallow gritty sands with some granite outcrop (Uc2.12) and (Uc2.21). These are inclusions of unit Ca16. Drainage lines occurring in the unit have small alluvial plains of loamy duplex soils (Dy2.43) and (Dy3.43). The latter may also occur on some lower slopes. Data are limited. Occurs on sheet(s): 4"
"Mu11"
"River terraces: chief soils are neutral red earths (Gn2.15) and neutral yellow earths (Gn2.25) on the higher terrace. Associated are (Um6.11) soils on the lower terrace and some areas of (Dy3.4) soils. Occurs on sheet(s): 5"
"Mu12"
"Terraced valley and its steep side slopes: chief soils seem to be neutral and acidic red earths (Gn2.15 and Gn2.14) on upper terraces and mass movement deposits. Associated are flat mid-terrace remnants of acid yellow earths (Gn2.24) in complex with low dunes of (Uc2.22) sands; some deep sand areas (Uc4.2) and (Uc2.2); some areas of (Um6.11) soils on lower terraces; and some (Dr) and (Dy) soils similar to those of unit Qb31 on the steeper side slopes. As mapped, the width of this unit is exaggerated. Occurs on sheet(s): 5"
"Mu13"
"Gently undulating plains with some shallow drainage lines: dominant soils are moderately deep to deep loamy red earths (Gn2.15, Gn2.12, and Gn2.13); the soils may contain some quartz gravel. Associated soils are nodular loamy yellow earths (Gn2.22, Gn2.21) and (Gn2.62). Loamy grey earths (Gn2.82, Gn2.81) and occasional loamy duplex soils (Dy3.42) occur in shallow drainage depressions. Data are limited. Occurs on sheet(s): 7,10"
"Mu14"
"Alluvial plains with old flood channels and small terraces: dominant soils are fine sandy red earths (Gn2.15), with associated (Gn2.11) and (Gn2.25, Gn2.22). On levees close to the stream channels are deep earthy fine sands (Uc5.21, Uc5.22). Occurs on sheet(s): 7,10"
"Mu15"
"Level alluvial plains with numerous old meander channels and terraces, often dissected by many recent small streams: dominant are loamy red earths (Gn2.15), with closely associated (Gn2.14) and (Gn2.24, Gn2.25). Loamy duplex soils, chiefly (Dy2.33), (Dy2.43), (Dy3.33), (Dy3.43), (Dr2.23), (Dr2.43), and occasional (Db1) equivalents, are common on the back slopes of the levees and the higher alluvial plains. In areas where the levee is very narrow the (Dr2.23) soils may be locally dominant. Deep cracking clays (Ug5.24) and (Ug5.16) occur on the lower back slopes of the flood-plain. Occurs on sheet(s): 7"
"Mu16"

"Gently undulating to undulating outwash slopes with some isolated granite outcrops: dominant soils are moderately deep to deep loamy red earths (Gn2.15), with lesser (Gn2.14). Chief associated soils are moderately deep coarse sands (Uc2.22, Uc2.23, and Uc2.21); occasionally these may be locally dominant. Loamy yellow earths (Gn2.25, Gn2.24) and (Gn2.34) are common on poorly drained foot slopes and loamy duplex soils (Dy3.43), (Dy2.42), (Dy3.42), and (Dy5.42) occur on small alluvial plains. Shallow gritty sands (Uc4.21) and (Uc4.11) occur adjacent to rock outcrop. Small areas of loamy red duplex soils (Dr2.21) of unit Pb34 are also included. Occurs on sheet(s): 7"
"Mu17"
"Gently undulating plains with only occasional, very shallow, drainage depressions; the eastern margin of the unit may have low scarps: dominant soils are deep loamy yellowish red earths that are pisolitic (bauxitic) throughout the profile and below approximately 20 in. contain high concentrations of bauxite pisolites in a loose earthy matrix. Occasionally the pisolites are cemented to form irregular bauxite masses. Neutral soils (Gn2.15) are probably most common but acid forms (Gn2.14) are also associated, particularly towards the eastern margins of the unit where bauxite pisolites are less abundant and ironstone nodules tend to be dominant. The soils have a weakly gradational profile and are tending to (Um4.21). Occasionally associated on level sites are similar pisolitic yellow or red earths (Gn2.24, Gn2.25) and (Gn2.12, Gn2.11), while in the shallow drainage depressions nodular or pisolitic yellow or grey earths (Gn2.25), (Gn2.64), (Gn2.74), and (Gn2.94) occur. Occurs on sheet(s): 7"
"Mu18"
"As for unit Mu13 but with small inclusions of unit CC83. Occurs on sheet(s): 10"
"Mw1"
"Flat to undulating range crests flanked by hilly to steep hilly terrain: range crests of acid leached red earths (Gn2.14) and possibly other undescribed soils. Associated are: hill slopes of sandy soils, such as (Uc3.32), with sandy acidic soils with clay subsoils, such as (Dr4.61) and (Dy5.61); and other, contrasting hill slopes of (D) soils with friable surface soils, such as (Dd3.21), (Db4.1), and (Dr4.1), and also yellow-brown earths (Gn2.44). Other soils are likely. Stream valleys are narrow with steep side slopes. This unit is complex. Data are limited. Occurs on sheet(s): 3"
"Mw2"
"Ridge and valley complex, including remnants of the old undulating plateau surface: undulating to hilly plateau remnants at the higher elevations of acid leached red and yellow earths (Gn2.14) and (Gn2.24)--often of shallow depth. Associated are: (Db3.12) soils on serpentine; small wet upland valleys of undescribed soils; very steep slopes and scarps of deep acid leached red earths (Gn2.14), and other soils, such as (Dr4.11), near basalt areas; narrow ridge tops of (Um4.2) soils and rock outcrops; traversed by narrow stream valleys. As mapped, areas of unit Tb49 are included. Occurs on sheet(s): 3"
"Mw3"
"Plateau remnants: undulating to low hilly areas of acid leached red earths (Gn2.14) with small, wet flats and upland valleys of undescribed soils; associated soils may include (Gn4.11). As mapped, areas of unit Rh3 may occur on the north-west flank of this unit. Data are limited. Occurs on sheet(s): 3"
"Mw4"
"Hilly to rugged granitic areas at moderate elevation, with tors and some swampy flats: chief soils are acid leached red and yellow earths (Gn2.14 and Gn2.24) on remnants of the older (deeply weathered) surfaces; and leached sands (Uc2.31 and Uc2.34) on apparently younger surfaces. Associated are: small areas of soils common to units Wa1O and Cb30; occasionally soils common to unit Ub54; and possibly small areas with some similarities to unit KK4 where the elevation exceeds about 4500 ft. Occurs on sheet(s): 3"
"Mw5"
"Rolling terrain of various acid leached red and yellow earths notably (Gn2.14 and Gn2.24) with scattered remnants of unit Rh3, and with some areas of unit Kd4 in the valleys. Occurs on sheet(s): 3"
"Mw6"
"Steep hilly terrain with some rugged areas, rock outcrops: common soils on the steep colluvial slopes are acid leached red earths (Gn2.14)--often gravelly and stony. Associated are: a variety of (D) soils, especially (Dr2.12), (Dr2.22), and (Dy) soils; shallow loamy soils, such as (Um4.1); and undescribed soils associated with serpentine and related rock types. Small areas of soils common to units Rh3 and Mg20 may occur also. Data are limited. Occurs on sheet(s): 3"
"Mw7"
"Steep colluvial slump slopes beneath the sandstone scarp: chief soils are acid leached red earths (Gn2.14). Associated are a variety of soils including (Gn2.44) and (Gn3.21). Occurs on sheet(s): 3"
"Mw8"
"Undulating with slabs of sandy ironstone: chief soils are sandy-surfaced acid leached red earths (Gn2.14). Associated are (Dy3.4) soils. Data are limited. Occurs on sheet(s): 3"
"Mw9"

"Mountainous--rounded hills with steep rocky slopes and incised streams, at moderate elevation (> 3000 ft): chief soils are acid leached red earths (Gn2.14) and red friable porous earths (Gn4.14). Associated are acidic (Dr2) and (Dy) soils on the steeper slopes. Data are limited. Occurs on sheet(s): 3"
"Mw10"
"Hilly to steep and rugged country with some flat to undulating areas: chief soils seem to be acid leached red and yellow earths (Gn2.14, Gn2.24, Gn2.34). Associated are (Dy3.41) and possibly other soils. Compare unit Mr2. Data are limited. Occurs on sheet(s): 3"
"Mw11"
"Strongly undulating to hilly with some milder relief on ridge crests; some basaltic knolls and ridges: chief soils are acid leached red and yellow earths (Gn2.14, Gn2.24, Gn2.44) with some stony hill tops of (Um4) soils. Associated are: some gently undulating ridge crests of (Dy3.41) soils on the flatter sites, and acid (Gn2) soils on low rises (compare unit Tb29); seasonally wet valleys of (Dy3.4) soils; (Um6.11) soils on low terraces along some stream valleys; and basaltic knolls and ridges of (Um6.13), (Dr4.1), and possibly other soils. Data are limited. Occurs on sheet(s): 3"
"Mw12"
"Strongly undulating to hilly with some milder relief on ridge crests; some basaltic knolls and ridges; broken by hilly ranges and steep valley side slopes: chief soils are acid leached red and yellow earths (Gn2.14, Gn2.24, Gn2.44). Associated soils are the same as those for unit Mw11. The whole area is broken by hilly ranges and steep valley side slopes of (D) and (Um4) soils as for unit Pb11. Occurs on sheet(s): 3"
"Mw13"
"Low hilly to rugged hilly terrain with narrow swampy stream valleys: gentle to moderately steep slopes of acid leached red earths (Gn2.14) with acid leached yellow earths (Gn2.24) and other soils, such as (Dy5.8), in less well-drained sites. Associated are: steep to very steep slopes and hilltops of (Um4.2) or (Uc4.11) soils and rock outcrops; undescribed soils in the narrow stream valleys; and minor areas of other soils, such as (Gn3.1). As mapped, areas of units Tb27 and Ub33 may be included. Occurs on sheet(s): 3"
"Mw14"
"Mountainous: chief soils are acid leached red and yellow earths (Gn2.14 and Gn2.24) on the ridge tops and on moderate to steep slopes--some of these soils, especially those at high altitude, have highly organic A horizons. Associated are: other (Gn2) soils, such as (Gn2.94) in low-lying areas and seepage situations; some rock outcrops and boulders; and probably some (Dy) and (Dr) soils but these have not been described. Occurs on sheet(s): 3"
"Mw15"
"Dissected plateau at moderate to nigh elevation (2400-4800 ft): gently undulating plateau-top areas of acid leached red and yellow earths (Gn2.14 and Gn2.24) flanked by steep, often benched, or terraced slopes of (Um4.1), (Um4.2), and (Gn2) soils with various (Dy3) soils on the flatter portions and (Dy5.11) soils in areas of impeded drainage. The whole area is traversed by streams with narrow flood-plains of undescribed soils. As mapped, areas of unit Fa3 are included and may occur as scarps fronting this unit in places. Data are limited. Occurs on sheet(s): 3"
"Mw16"
"Mountainous--dissected plateau at moderate to high elevation (2000 4800 ft): chief soils are acid leached red earths (Gn2.14) with some acid leached yellow earths (Gn2.24), and some areas of basalt boulders. Associated are: shallow, wet, and sometimes peaty upland valleys of undescribed soils; (Dr2.21) soils on steep slopes above deeply incised valleys; and other areas of undescribed soils. This unit merges with unit Mh5 of Sheet 2 in the vicinity of Welumba Creek. Data are limited. Occurs on sheet(s): 3"
"Mw17"
"Rolling to hilly upland country of ridges and long, crumpled, slip and slump slopes: chief soils are acid leached red earths (Gn2.14) probably with other (Gn2) soils, such as (Gn2.24). Associated are small areas of red friable porous earths (Gn4.11), and some low-lying swampy areas of undescribed soils. Occurs on sheet(s): 3"
"Mw18"
"Mountainous dissected plateau at moderate to high elevation (2000-4800 ft): chief soils are probably acid leached red earths (Gn2.14) flanked by steep to rugged slopes similar to unit Pb6. Data are limited. Occurs on sheet(s): 3"
"Mw19"
"Mountainous--generally a ridge-and-valley terrain with undulating to hilly ridge crests; some gorges: chief soils are acid leached red earths (Gn2.14) and loamy soils having an A2 horizon (Um4.2). Associated are small areas of various (D) and (Gn2.2) soils, and other soils such as (Uf6.31) on special parent materials. Data are limited. Occurs on sheet(s): 3"
"Mw20"
"Undulating to rolling country of acid and neutral leached red earths (Gn2.14, Gn2.15), and possibly other earths, such as (Gn2.2) and (Gn2.9) with areas of hard acidic yellow mottled soils (Dy3.41). Areas of unit Pb7 occur where the relief is stronger. Data are limited. Occurs on sheet(s): 3"
"Mw21"

"Low hilly terrain on shales and soft sandstones with gently sloping flat-topped to broadly convex rises, gentle to moderate side slopes, and open shallow valleys: chief soils are acid leached red earths (Gn2.14) on the slopes. Associated are (Dr3.21) and (Dr2.21) soils on upper slopes and (Dy3.41) soils on mid and lower slopes. Other soils include (Gn3.93), (Gn2.94), and (Dy2.41) soils along stream valleys, (Db1.32) and (Um6) soils on andesitic dykes, and possibly (Gn3.11) soils on some of the higher flattop areas. Small areas of unit Tb69 are included. Occurs on sheet(s): 4"
"Mw22"
"Almost flat coastal plain of red and yellow sandy sediments between 50 and 100 ft above sea level: chief soils are acid leached red earths (Gn2.14). Associated are (Gn3.84) soils on the slightly lower portions of the plain. Other soils include (Gn2.94) in depressions, (Dy3.41) on slopes above stream valleys, and (Uc2.21) and (Gn2.74) along the stream valleys. Occurs on sheet(s): 4"
"Mw23"
"Rolling land of red and yellow sandy alluvia with gently sloping to flat crests, and gentle to moderate side slopes to shallow valleys with narrow flats: chief soils are red earths (Gn2.14) on the crests. Associated are (Gn2.64) and (Gn2.74) soils on lower crests and slopes and some (Gn3) soils, such as (Gn3.54), on crests in the eastern portion of the unit. Other soils include (Dy3.41) on slopes, (Dy5.81), (Gn2.91), and (Gn2.94) along stream flats, and (Dy2.41) and (Dr3.41) on shale areas. As mapped, valleys of unit Tb69 are included. Occurs on sheet(s): 4"
"Mw24"
"Hilly to low hilly landscape on sandstone; narrow sharply convex hill crests with moderate to steep slopes to narrow alluvial flats; some rock outcrops; many soils are moderately deep to deep and prone to erosion: chief soils are red earths (Gn2.14) on platforms and mid and lower slopes, and their shallow gravelly variants on ridge crests. Associated are (Uc4.2) soils on ridge crests, (Dy5.21) soils on hill slopes, and (Dr5.21) soils on slopes of high hills. Minor soil occurrences include (Gn2.44) and (Uc4.11) on crests and upper slopes. As mapped, "valleys"of unit MF4 and plateau remnants of unit Mm9 are included. Occurs on sheet(s): 4"
"Mw25"
"Plateau areas between 400 and 1200 ft above sea level: chief soils seem to be acid leached red earths (Gn2.14) and possibly (Gn2.11) with red friable earths (Gn3.11). Some (Uf6.31) soils occur on basalt. Occurs on sheet(s): 4"
"Mw26"
"Strongly undulating lands with some high narrow ridges, low dissected mesaS, and steep-scarped low cuestas: dominant soils are deep sandy red earths (Gn2.14) that are occasionally gravelly. On higher more dissected landscape sites are shallow stony loams (Um1.43), and lower flatter slopes mostly have deep sandy-surfaced duplex soils (Dy3.42) and (Dy5.42). Data are fairly limited. Occurs on sheet(s): 4"
"Mw27"
"Plateaux and mesas with gently undulating surfaces and steep-scarped dissected margins: dominant soils are deep sandy or loamy red earths (Gn2.14), less often (Gn2.11), with some areas of deep red sands (Uc4.2). Also occurring are small areas of sandy yellow earths (Gn2.21). The more eroded mesas have shallow stony sands (Uc4.11) and (Uc2.12) formed on altered sandstone on the higher sites, together with some areas of (Dg2.81), (Um4.1), and (Um2.12). On lower slopes and outwash fans sandy or loamy duplex soils are common, chiefly (Dy5.42) and (Dy3.42). Occurs on sheet(s): 4"
"Mw28"
"Undulating elevated plains with gently sloping margins: dominant soils are deep sandy red earths (Gn2.14). At the margins of the unit sandy yellow earths (Gn2.21 and Gn2.22) occur together with sandy duplex soils (Dy3.42) and leached sands (Uc2.12) and (Uc2.34). Occurs on sheet(s): 4"
"Mw29"
"Strongly rolling lands with broad smooth crests and broad concave depressions: dominant soils are sandy red earths (Gn2.14 and Gn2.11) on broad gently sloping crests and, in places, underlain by water-worn gravel at 3-5 ft in depth. Associated are: (Dy3.41) soils on mid to upper slopes; (Gn2.34), (Gn2.24), (Dr3.21), and (Dr3.41) soils on shoulders of broad rises and some smaller crests; and (Dy3.43) and (Dy2.43) soils in the broad depressions and on lower slopes. Minor soil occurrences include (Dy4.81), (Dy5.41), and (Dr2.61). Occurs on sheet(s): 4"
"Mw30"
"Gently undulating area of tertiary sediments and igneous rocks: chief soils are red earths (Gn2.14) with associated areas of red friable earths (Gn3.11). Other soils are (Ug5.13), (Ug5.14), (Gn3.42), and (Gn3.22) on basalt. Occurs on sheet(s): 4"
"Mw31"
"Deeply incised, steep scarp and valley side slopes of the Darling scarp and its more deeply incised tributary valleys: chief soils of the steep scarp and valley side slopes, on which massive rock outcrops are a feature, seem to be acid red earths (Gn2.14) on the colluvial slope deposits. Associated are (Dr2.21) and (Dy3.21) soils on moderate to steep upper slopes with some (Uc4.11) soils containing ironstone gravel on spurs and ridge tops. Occurs on sheet(s): 5"
"Mw32"

"Flat to gently undulating plains: chief soils are sandy and loamy acid red earths (Gn2.14) often containing ironstone gravels. Associated are yellow earths such as (Gn2.24 and Gn2.25) and (Gn2.74), all often containing ironstone gravels; some colluvial red earths such as (Gn2.15) containing ironstone gravels; some ironstone gravelly sands (KS-Uc4.11) and (Uc4.11); and some shallow valleys with (Uc1.21), (Uc5.2), and (Dy5 41) soils. As mapped, areas of units Mr8, AB32, and JY2 may be included. Occurs on sheet(s): 8"
"Mw33"
"Hilly terrain on sandstones, limestones, and siltstones: chief soils are probably acid red earths (Gn2.14) on the gentler mid slopes. Associated are lower slopes of yellow earths (Gn2.24); slope fans and valley floors of leached yellow earths (Gn2.74) and (Gn2.94); and upper slopes and crests of shallow sandy loam soils such as (Uc4.1). Occurs on sheet(s): 8"
"Mw34"
"Undulating terrain on gabbro and dolerite: chief soils are probably acid red earths (Gn2.14). Associated are variable areas of the soils of unit Va73. Occurs on sheet(s): 8"
"Mw35"
"Dissected low plateaux with flat to undulating plateau crests and dissected sloping margins, with some stepped ridges and breakaways fronting stream valleys, and cliffs along coastal margins; narrow stream valleys with some small swampy areas: chief soils are sandy and loamy red and yellow earths (Gn2.14 and Gn2.12), (Gn2.24 and Gn2.25), and (Gn2.74), containing variable amounts of ironstone gravels and sometimes with block laterite at shallow depths. Associated on areas of gentle topography are yellow and red earthy sands (Uc5.22 and Uc5.21), while ironstone gravels (KS-Uc4.11) and shallow sands (Uc4.1) occur on the dissected margins, ridges, breakaways, and cliffs. Small areas of other soils are likely, including white sands (Uc) and clays (Ug5.4) in swampy sites and the soils of unit LK24 on scarps. Occurs on sheet(s): 8"
"Mw36"
"Dissected plateaux similar to those of unit Mw35 but with numerous small swamps in which a variety of soils including (Ug5.4) may occur. Occurs on sheet(s): 8"
"Mw37"
"Gently undulating to undulating lands with occasional rock outcrop: dominant soils are gravel-strewn loamy red earths (Gn2.14, Gn2.11, and Gn2.15). Associated soils are gravelly grey or yellow earths (Gn2.82) and (Gn2.22), with some small areas of sandy duplex soils, chiefly (Dy3.42). Small areas of grey cracking clays (Ug5.22, Ug5.24) and loamy red duplex soils (Dr2.13, Dr2.12) also occur. Occurs on sheet(s): 7"
"Mw38"
"Slightly elevated lateritic plain with some low scarps and outcrops of massive nodular laterite: dominant soils are nodular loamy red earths (Gn2.14). Associated soils are very nodular shallow loams (Um5.51), (Um4.2), (K-Um5.51), and (K-Um4.2) overlying massive nodular laterite. Loamy grey earths (Gn2.82, Gn2.83) also occur, and where dissected margins have exposed underlying rocks, loamy duplex soils (Dr2.13, Dr2.12) and (Dy2.13, Dy2.12) are developed. Occurs on sheet(s): 7"
"Mw39"
"Gently undulating plains: dominant soils are deep sandy red earths (Gn2.14). Associated in some lower sites are areas of sandy yellow earths (Gn2.21) and (Gn2.34) and, less commonly, sandy grey earths (Gn2.94) and (Gn2.81). Data are fairly limited. Occurs on sheet(s): 7"
"Mw40"
"Slightly elevated old stream terraces, levees, and infilled channels associated with the flood-plains of major rivers; lower terraces occur adjacent to the streams: dominant soils of the old terraces and channels are sandy or loamy red earths (Gn2.14, Gn2.15), occasionally (Gn2.16). Lesser areas of sandy yellow earths (Gn2.24, Gn2.22) and (Gn2.34) also occur. Closely associated on level sites between the channels and levees are the loamy duplex soils of unit Si14. The lower recent stream terraces are subject to flooding and may bc cut by many small channels. The chief soils are uniform loams (Um5.52) and (Um4.2) and sands (Uc5.22, Uc5.21) and (Uc4.2) that are usually stratified at depth. Occurs on sheet(s): 7"
"Mw41"
"Gently undulating to undulating outwash slopes and fans, and including some low hills: dominant soils are sandy red earths (Gn2.14), with lesser sandy yellow earths (Gn2.24), (Gn2.35), and (Gn2.74). Uniform coarse sands (Uc1.22, Uc1.21) and (Uc4.2) occur on the more recent alluvial fans. Sandy or loamy duplex soils (Dr2.42), (Dr2.22), (Dy3.42), (Dy3.43), and (Dy2.43) occur where the outwash slopes merge with the coastal plain. Occurs on sheet(s): 7"
"Mw42"
"High hilly to mountainous lands with very steep slopes and much acid igneous rock outcrop: dominant soils are moderately deep to deep friable-surfaced loamy red earths (Gn2.14), with other loamy earths (Gn2.11) and (Gn2.24) also common. The chief associated soils are deep coarse sands (Uc4.2), (Uc5.11), and (Uc1.21), with some shallow gravelly loams (Um4.1) occurring on steep rocky slopes. Sandy duplex soils, chiefly (Dy3.43) with

some (Dy3.41) and (Dr3.44), occur on lower slopes and in drainage lines. Small areas of unit Mj1O may be included. Occurs on sheet(s): 7"
"Mw43"
"Low lateritic plateaux closely dissected by many small streams: the soils are similar to those of unit Mw44 but shallow gravelly loams are much more common. A range of loamy duplex soils of unit Va83 occur where dissection has exposed underlying rocks. Occurs on sheet(s): 7"
"Mw44"
"Gently undulating to undulating lands with low lateritic scarp margins: dominant soils are loamy red earths, the chief form is probably (Gn2.14) but there are large areas of (Gn2.11) and lesser (Gn2.12, Gn2.15). Chief associated soils are loamy yellow earths (Gn2.24), (Gn2.64), and (Gn2.74). Sandy or occasionally loamy duplex soils (Dy3.41, Dy3.43) occur in the drainage lines. Shallow gravelly loams (Um4.12) and (Um4.21) occur on the low lateritic scarps. Occurs on sheet(s): 7"
"Mw45"
"Gently undulating to undulating lands with many small rocky rises: dominant soils are loamy red earths (Gn2.14), with lesser loamy yellow earths (Gn2.24). Shallow to moderately deep sands (Uc4.22, Uc4.21), (Uc2.12), and (Uc2.22) occur on higher slopes and adjacent to rock outcrop. Data are limited. Occurs on sheet(s): 7"
"Mw46"
"Gently undulating to undulating lands with many low rocky rises that often have large granite tor outcrop: dominant soils are loamy or sandy red or yellow earths; (Gn2.14) is probably dominant but large areas of (Gn2.24) and occasionally (Gn2.15) also occur. Chief associated soils are uniform Fitty sands (Uc2.22, Uc2.21) and (Uc2.12), with other shallow sands (Uc4.12) and (Uc4.22, Uc4.21) common on higher slopes and adjacent to rock outcrop. Moderately deep loamy duplex soils (Dy3.42), (Dy3.22), and (Dr2.22) occur on some lower slopes. Small areas of loamy grey earths (Gn2.94) of unit MT14 are included. Occurs on sheet(s): 7"
"Mw47"
"Hilly to high hilly lands with very steep slopes and much large granite tor outcrop: dominant soils are deep friable-surfaced loamy red earths (Gn2.14), with lesser friable red earths (Gn3.14); the latter are occasionally locally dominant. Areas of other loamy earths including (Gn2.24), (Gn2.74), (Gn2.84), (Gn2.94), and (Gn2.21) are common. Shallow Fitty sands (Uc4.12), (Uc4.21), and (Uc2.12) occur adjacent to rock outcrop, and deep loamy earths (Gn2.14), (Gn2.24), and (Gn2.64) are common on the lower pediment slopes. Small areas of the deep friable loams (Um6.34) of unit Gh1 are included. Occurs on sheet(s): 7"
"Mw48"
"Strongly undulating to low hilly lands with occasional sandstone mesas: dominant soils are deep sandy red earths, chiefly (Gn2.14) with lesser (Gn2.11). On lower more gentle slopes sandy yellow earths (Gn2.34) and (Gn2.74) may occur. On the sandstone hills and mesas are shallow gravelly sands (Uc4.22) and (Uc2.21), and on the dissected scarps and steep upper slopes sandy duplex soils (Dy2.61), (Dy5.41), and (Dr5.41) are often common. Occurs on sheet(s): 7"
"Mw49"
"Gently undulating old stream levees and small alluvial plains, often dissected and eroded by small streams: dominant soils are loamy red earths (Gn2.14), with lesser (Gn2.15). At the margins of the levees loamy red duplex soils (Dr3.41, Dr3.42) occur; the small alluvial plains have alkaline yellow duplex soils (Dy3.43). Occurs on sheet(s): 7"
"Mw50"
"Gently undulating to broadly undulating plains: dominant soils are deep sandy red earths (Gn2.14), with very occasional (Gn2.15, Gn2.11). On the long gentle slopes a catenary sequence of soils is often present; red earths occupy the upper and middle slopes, below these is a narrow zone of sandy yellow earths (Gn2.24), occasionally (Gn2.34), (Gn2.64), or mottled duplex soils (Dy4.81), then a wider zone of sandy mottled yellow or grey earths (Gn2.74) and (Gn2.94). At the base of the slope deep bleached sands (Uc2.21) often occur. Most soils except the red earths have a prominent ironstone nodule horizon at depth. Small valley floors and well-defined drainage depressions have sandy or loamy duplex soils (Dy2.43, Dy2.42) and (Dy3.43, Dy3.42), and occasionally bleached grey earths (Gn2.94, Gn2.95). Adjacent to some larger streams are areas of deep red sands (Uc5.22), and where the unit adjoins unit Ca42 deep bleached sands (Uc2.21) occur. Occurs on sheet(s): 7"
"Mw51"
"Very gently undulating plains forming the surface of an extensive low plateau; small scarps occur at the margins of the plateau. A feature of the unit is the virtual absence of defined drainage channels: dominant soils are deep sandy red earths (Gn2.14), only rarely with ironstone nodules at depth. Occasional (Gn2.11, Gn2.15) soils also occur. Associated in lower landscape sites are small areas of sandy yellow earths (Gn2.24). Occurs on sheet(s): 7"
"Mw52"
"Gently undulating to undulating lands; in some areas the unit occurs as low plateau remnants with strongly undulating dissected marginal scarps: dominant soils on higher landscape sites are loamy or sandy red earths (Gn2.14), occasionally (Gn2.15, Gn2.11). Similar yellowish red earths (Gn2.24) occur on more gentle slopes and

often are locally dominant. Both the red and the yellow earths are strongly nodular at depth, and occasionally pisolitic in some localities; on some slopes there are outcrops of massive nodular laterite. On lower slopes and small level plains loamy nodular mottled yellow earths (Gn2.61, Gn2.64) commonly occur, with bleached yellow or grey earths (Gn2.74) and (Gn2.94) occurring in better-defined drainage depressions. In the north-west parts of the unit some drainage lines have deep bleached sands (Uc2.21), and in the south-west areas loamy duplex soils (Dy3.42) occur in the well-defined drainage depressions. In some areas small circular swampy depressions are common; these have. Occurs on sheet(s): 7"
"Mw53"
"Broadly undulating lands: dominant soils are deep sandy red earths (Gn2.14), occasionally (Gn2.11). The soils often have ironstone nodules at depth and on some slopes or very low scarps there are outcrops of massive nodular laterite. On lower slopes and in drainage depressions deep sandy yellow earths (Gn2.24), (Gn2.34), and (Gn2.74) are common, with occasional bleached grey earths (Gn2.94). On some ridge crests are deep bleached sands (Uc2.21). Occurs on sheet(s): 7"
"Mw54"
"Strongly undulating to low hilly lands with some dissected low sandstone mesas: dominant soils are sandy or loamy deep to moderately deep red earths (Gn2.14), with some areas of (Gn2.11) and occasional (Gn2.24). The soils are often nodular at depth and in some areas massive nodular laterite outcrops. On steeper slopes and on the low mesa scarps shallow gravelly sands (Uc4.22) occur. On small valley plains there are some areas of loamy mottled yellow earths (Gn2.64). Data are limited. Occurs on sheet(s): 7"
"Mw55"
"Undulating or occasionally strongly undulating elevated lands with steep strongly dissected scarped margins: dominant soils are probably sandy or occasionally loamy red earths (Gn2.14), but other sandy earths (Gn2.24), (Gn2.74), and (Gn2.94) are commonly associated. At the scarped margins of the unit, sandstone is exposed with shallow gravelly sands (Uc4.22, Uc4.21). Data are very limited. Occurs on sheet(s): 7"
"Mw56"
"Moderately to strongly undulating lands with some high stony ridges or low hills: dominant soils are sandy or occasionally loamy nodular red earths (Gn2.14), with lesser (Gn2.11). On higher ridges the soils are also gravelly and may have ferruginous sandstone or massive nodular laterite outcrop. On more gentle slopes sandy yellow or yellowish red earths (Gn2.24, Gn2.21) are common, with (Gn2.64) less common. In the numerous shallow drainage depressions deep bleached sands of unit Ca43 occur, chiefly (Uc2.21), but occasionally (Uc2.20) and (Uc2.33, Uc2.31). On some higher stony ridges and low hills shallow gravelly sands (Uc4.21, Uc4.22) occur. Occurs on sheet(s): 7"
"Mw57"
"Gently undulating to undulating plains with occasional stony remnants of unit Fz40: dominant soils are shallow to moderately deep loamy red earths (Gn2.14), with lesser (Gn2.11). Associated near rock outcrop are very gravelly shallow loams (Um5.51), (Um1.43), and (Um2.12). Small areas of loamy red duplex soils (Dr2.13, Dr2.12) also occur. On stream levees and outwash fans are deep loamy red earths (Gn2.15, Gn2.11). Occurs on sheet(s): 10"
"Mw58"
"Gently undulating plains with some stream levees: dominant soils are deep loamy red earths (Gn2.14, Gn2.11), often with quartz gravel throughout the profile. Associated are loamy red duplex soils (Dr2.13, Dr2.12) and occasionally deep cracking clays (Ug5.25, Ug5.24) in depressions. On stream levees are deep loamy or sandy red earths (Gn2.12) and brown earths (Gn2.42). Occurs on sheet(s): 10"
"Mw59"
"Gently undulating outwash slopes and fans: dominant soils are loamy red earths (Gn2.14), also with probably fairly large areas of loamy yellow earths (Gn2.24, Gn2.25) and deep sands (Uc5) and (Uc4) of unit AB35. Included in the unit are areas of cracking clays and uniform clays of unit CC83. Data are very limited. Occurs on sheet(s): 10"
"Mx1"
"Gently undulating plains with low dunes and occasional low stony ridges: extensive level areas of sandy and loamy red earths (Gn2.13 and Gn2.12) with smaller areas of yellow earths (Gn2.22 and Gn2.21), broken by occasional low rises of red earths (Gn2.12 and Gn2.13) mantled with siliceous gravel, or higher ridges with shallow loams (Um1.43). Associated are: dunes of variable frequency of occurrence with sandy red earths (Gn2.13, Gn2.12), red earthy sands (Uc5.21), brown sands (Uc5.1), or siliceous sands (Uc1.2); and drainage lines of cracking clays (Ug5.2 and Ug5.3) with clay pans of (Dr1.33 and Dr1.43) soils. Some areas mapped as this unit in the far north-western portion of New South Wales, Sheet 3, may belong to the unit AB1, but present data are insufficient to determine this. Small stoneand gravel-covered areas of (Dr1.33) soils occur in parts of the unit in the area of Sheet 10. Occurs on sheet(s): 3,4,10"
"Mx2"
"Sandy plains with a few scattered low rocky hills and ridges: chief soils seem to be sandy alkaline red earths (Gn2.13) and sandy alkaline red mottled soils (DrS.43). Associated are (Um1.43) soils on low rocky hills and

ridges. Other soils are likely too. As mapped, areas of unit My1 are included. Data are limited. Occurs on sheet(s): 3"
"Mx3"
"Plain with low ridges or steps, some swamps, some areas of kunkar: chief soils are alkaline red earths (Gn2.13) often containing gravels of various sorts, especially quartz and ironstone.Other soils such as (DrS.43) are likely in places. Data are limited. Occurs on sheet(s): 3"
"Mx4"
"Undulating plains with low and very low dune forms, kunkar, and areas of large melon-hole depressions; buried soil layers occur: chief soils are alkaline and neutral red earths (Gn2.13 and Gn2.12) with brown calcareous earths (Gc1.12 and Gc1.2). Associated are brown sands (Uc5.1) on dunes; and (Dr2.33) soils in small flats. Other soils are likely. As mapped, minor areas of unit My6 are included. Data are limited. Occurs on sheet(s): 3"
"Mx5"
"Plain: gently undulating, slightly convex plain of alkaline red earths (Gn2.13) with clay D horizons in some places, and possibly with other earths (Gn2). Associated are hard alkaline red soils (Dr2.33) and possibly other (D) soils such as (Db1.33) on the intermediate levels of the plain; and cracking grey clays (Ug5.2) with gilgais in the lower-lying situations. Occurs on sheet(s): 3"
"Mx6"
"Plains with swamps and saline depressions; buried soil layers occur: chief soils seem to be shallow alkaline red earths (Gn2.13) and hard alkaline red soils (Dr2.33). Other soils are likely. As mapped, some low ranges probably similar to the range portions of unit My6 are included. Data are limited. Occurs on sheet(s): 3"
"Mx7"
"Plain with broad shallow swampy areas; buried soil layers common at fairly shallow depths (2 ft or deeper): chief soils are red earths (Gn2.13) and other (Gn2) soils with hard alkaline red soils (Dr2.33). Not clear which of these two soil groups is dominant. Small areas of other soils occur. Occurs on sheet(s): 3"
"Mx8"
"Flat to irregularly undulating country with some low sandy dunes and sandy sheets; buried soil layers are usually found at shallow depths (2 ft or deeper): chief soils are alkaline red and grey-brown earths (Gn2.13), (Gn2.19), and (Gn2.46) and possibly other (Gn2) soils. Associated are hard alkaline red and brown soils (Dr2.33) and (Db1.33). The pattern of soil distribution is relatively complex. Occurs on sheet(s): 3"
"Mx9"
"Broad, gently undulating plains: chief soils are alkaline red earths (Gn2.13) in association with hard alkaline red soils (Dr2.33). Other soils include (Gc1.12) and (Gc1.22). Occurs on sheet(s): 5"
"Mx10"
"Plains: chief soils are alkaline red earths (Gn2.13). Other soils are likely but are not described. Occurs on sheet(s): 5"
"Mx11"
"Gently sloping valley plains: chief soils are alkaline red earths (Gn2.13) frequently underlain at moderate depth by calcrete (kunkar) which may be exposed on the surface in places. Associated soils include (Gn2.12) and the soils of unit AC9. Occurs on sheet(s): 5,6"
"Mx12"
"Flat to gently undulating plain: chief soils are alkaline red earths (Gn2.13) underlain, at least in part of the area, by a red-brown hardpan containing veins of calcium carbonate. Other soils include sandy rises of (Uc5.22) and (Dy5.84), also (Dy5.82); some (Dr2.33) soils may be present in portion of the area. Occurs on sheet(s): 5"
"Mx13"
"Flat to gently undulating plains overlying marine limestone: chief soils appear to be alkaline red earths (Gn2.13) but both neutral (Gn2.12) and acid (Gn2.11) red earths are present; to the north, where limestone is shallow and may outcrop, there are frequent red earthy sands (Uc5.21), while in the south there are minor areas of red duplex soils (Dr2.12) associated with unit Bz12. Occurs on sheet(s): 6"
"Mx14"
"Plains with dunes: chief soils are alkaline and neutral red earths (Gn2.13, Gn2.12) with the associated soils of unit Mx13. On the dunes there are red sands (Uc5.21) and (Uc5.11). Occurs on sheet(s): 6"
"Mx15"
"Plains with extensive playa lakes, and flanking dunes: chief soils of the plain appear to be alkaline, neutral, and acid red earths (Gn2.13, Gn2.12, Gn2.11) frequently overlying red-brown hardpan and in association with hard red soils (Dr2.43). Hard red soils (Dr) occur in some playas and there are areas of (Gc) and (Um) soils on calcrete (kunkar). Chief soils of the dunes appear to be red sands (Uc1.23). Occurs on sheet(s): 6"
"Mx16"
"Valley plains with occasional outcrops of marine sediments: chief soils are alkaline red earths (Gn2.13) but both neutral and acid red earths (Gn2.12, Gn2.11) occur too, as do smaller areas of hard red soils (Dr2.33) and other (Dr) soils. Occurs on sheet(s): 6"

"Mx17"
"Plains with occasional outcrops of marine sediments and extensive areas of parallel dunes: chief soils are alkaline red earths (Gn2.13) but both neutral and acid red earths (Gn2.12, Gn2.11) occur too. Soils of the dunes are largely red sands (Uc1) and (Uc5) and there are various undescribed (Dr) soils on rock outcrops. This unit is related to unit Mx16. Occurs on sheet(s): 6"
"Mx18"
"Gently undulating plains with frequent hills of granite, schist, and sedimentary rocks: chief soils on the plains appear to be alkaline and neutral red earths (Gn2.13, Gn2.12). Associated on the hills are hard red soils (Dr2.33) and other (Dr) soils together with shallow loams (Um5.51). Occurs on sheet(s): 6"
"Mx19"
"Plains on calcarenite and limestone; with some limestone outcrops: chief soils are shallow alkaline red earths (Gn2.13) with shallow loams (Um5.51), both overlying limestone, and some gypseous loams (Um) close to the boundary with unit SV7. Occurs on sheet(s): 6"
"Mx20"
"Small gently undulating valley plains: chief soils are alkaline red earths (Gn2.13) with neutral red earths (Gn2.12). Small areas of other soils such as (Dr3.33) occur in the vicinity of some watercourses. As mapped. small areas of adjoining units are included. Occurs on sheet(s): 8"
"Mx21"
"Alluvial plains with low levees, many braided stream channels, and some old infilled channels: dominant soils are deep loamy red earths (Gn2.13), with lesser (Gn2.12). Associated on older levees and scalded areas are loamy duplex soils (Dr2.13), (Dy2.13), and (Db1.13); these soils are often calcareous throughout. Small areas of deep grey-brown cracking clays (Ug5.24) and (Ug5.34) occur throughout. Occurs on sheet(s): 7"
"Mx22"
"Plains often flanking areas of regional drainage (unit SV10); some longitudinal sand dunes: chief soils are alkaline red earths (Gn2.13) with (Gn2.12) and (Uc5.21). Other soils include (Uc1.23) on the dunes. Occurs on sheet(s): 10"
"Mx23"
"Undulating to gently undulating plains with occasional low rises and scarps with some lateritic duricrust: chief soils are alkaline red earths (Gn2.13), below which smooth-ped clay D horizons may occur at various depths. Associated are (Gn2.12) soils. Minor soil occurrences include (Dr1) and (Uc) soils. Occurs on sheet(s): 10"
"Mx24"
"Plains on granite with some schist and gneiss and with occasional rocky hills and ridges: chief soils are alkaline and neutral red earths (Gn2.13, Gn2.12). Associated are areas of (Dr1.33) and (Dr1.43) soils mantled by quartz gravel and stones. Other soils include (Uc5.21). Occurs on sheet(s): 10"
"Mx25"
"Sandy plains with low sandy rises and scattered dunes, especially in the southern portions of the unit; small areas of rugged rocky hills are included locally: chief soils are alkaline and neutral red earths (Gn2.13, Gn2.12), with lesser areas of (Uc5.21) and deep (Uc1.43) sands on the plains and low rises. Other soils include (Uc1.23) on dunes and possibly (Gc) soils in some localities. Occurs on sheet(s): 10"
"Mx26"
"Plains on schists and gneiss; occasional rock outcrops: chief soils are alkaline and neutral red earths (Gn2.13, Gn2.12). Associated are some (Dr1.33) and (Dr1.43) soils possibly mantled with quartz gravels. Small areas of other soils may occur also. Occurs on sheet(s): 10"
"Mx27"
"Gravel plains and terraces developed on schist and gneiss, some rocky tracts: chief soils are alkaline and neutral red earths (Gn2.12, Gn2.13) mantled with stones and gravels. Associated are (Dr1.33) and (Dr1.43) soils also mantled with stones and gravels and sometimes with gilgai depressions of (Ug5.3) soils. Small areas of other soils may occur. Occurs on sheet(s): 10"
"Mx28"
"Undulating plains and pediments: chief soils are alkaline red earths (Gn2.13) and calcareous earths (Gc1.12). Other soils such as (Uc1.3) and (Uc5.21) may occur. Occurs on sheet(s): 10"
"Mx29"
"Alluvial plains: chief soils are sandy alkaline red earths (Gn2.13) with crusty loamy soils (Dr1.33) and (Dr1.43). Small areas of unit MM29 are included. Occurs on sheet(s): 10"
"Mx30"
"Plains on dolomite, limestone, and shale: chief soils are alkaline and neutral red earths (Gn2.13, Gn2.12). Associated locally are (Uc1.3), (Um5.11), and (Gc1.22) soils. Occurs on sheet(s): 10"
"Mx31"
"Gently undulating plains with some low gravelly rises: dominant soils are deep loamy or occasionally sandy red earths (Gn2.13), rarely (Gn2.12), with loamy red duplex soils (Dr2.33) and (Dr2.13) closely associated, particularly

on the low gravelly rises. Small areas of red calcareous earths (Gc2.21) and red cracking clays (Ug5.38) may occur in lower sites. In parts of the unit are low limestone ridges with rock outcrop and shallow gravelly calcareous loams (Um5.61) and (Um5.11). Data are fairly limited. Occurs on sheet(s): 10"
"Mx32"
"Gently undulating lands with occasional low rises: dominant soils are gravel-strewn loamy red earths (Gn2.13), with associated loamy red duplex soils (Dr2.13) and (Dr2.43). Shallow loams (Um1.43) and (Um5.51) occur on the rises and near rock outcrop. Small areas of cracking clays (Ug5.24) and (Ug5.34) may also occur. Occurs on sheet(s): 10"
"Mx33"
"Alluvial plains and stream levees; the unit is usually cut by major and minor stream channels: dominant soils are deep loamy or occasionally sandy red earths (Gn2.13), with lesser (Gn2.12). Associated marginally and on wider alluvial plains are scalded loamy red duplex soils (Dr2.13) and (Dr2.33), with occasional (Dr1.33) soils. Also occurring are uniform loams (Um6.24) and occasionally deep cracking clays (Ug5.34, Ug5.38). Occurs on sheet(s): 10"
"Mx34"
"Plains with longitudinal sand dunes and clay pans; some seasonal drainage-ways: chief soils are probably alkaline, and neutral, sandy red earths (Gn2.13, Gn2.12). Associated are the sand soils of the dunes including (Uc1.23) and (Uc5.12); the grey cracking clays of the clay pans including (Ug5.28), (Ug5.5), and (Ug5.3); and small areas~ of unit MM66. Other soils including (Gc) soils may occur. Data are limited. Occurs on sheet(s): 10"
"Mx35"
"Undulating plains with frequent sand dunes and clay flats: chief soils are probably alkaline red earths (Gn2.13). Associated are (Uc1.23) and (Uc5.12) sands of the dunes and (Ug5.2) and (Ug5.3) clays of the clay flats. Sand drift is common throughout the unit. Occurs on sheet(s): 10"
"Mx36"
"Gently undulating plain with some low sandy rises: chief soils are alkaline red earths (Gn2.13) on the plain and on low sandy rises. Associated are (Uc1.23) sands on the sandy rises and (Ug5.2) and (Ug5.3) clays in the occasional clay flats. Occurs on sheet(s): 10"
"Mx37"
"Plains with some sand dunes, clay pans, and box flats: chief soils are alkaline red earths (Gn2.13). Associated soils include (Gc1.21) on the plains; (Uc1.23) and (Uc5.1) on dunes; (Ug5.2) and (Ug5.3) in clay pans and box flats; and (Dr1.33) marginal to (Dr1) soil units. Occurs on sheet(s): 10"
"Mx38"
"Plains with low sandy rises and some sand dunes: chief soils are alkaline red earths (Gn2.13). Associated are small areas of the soils of adjoining units. Occurs on sheet(s): 10"
"Mx39"
"Broad shallow valleys: chief soils are alkaline red earths (Gn2.13), in association with sandy-surfaced red duplex soils, such as (Dr2.43) and (Dr1.43), and similar soils. Their dominance varies locally. Other soils may occur. Occurs on sheet(s): 10"
"Mx40"
"Flat to undulating valley plains and pediments; some rock outcrop: chief soils are alkaline and neutral red earths (Gn2.13, Gn2.12), often with a surface scatter of gravel. Associated are (Um5.3) soils on pediments; some (Ug5.38) plains flanking ultrabasic rocks; and some small areas of unit BB5. Red-brown hardpan frequently occurs beneath the (Um5.3) and (Gn2) soils. Occurs on sheet(s): 10"
"Mx41"
"Flat to undulating pediments marginal to unit AC1; granitic rock outcrop; some low escarpments: chief soils are alkaline red earths (Gn2.13), often underlain by nodular limestone pans at shallow depth (<24in.). Associated may be small areas of (Dy) and (Dr) soils as for units Ya28 and Nc2. Small patches of the soils of unit AC1 may be included. Occurs on sheet(s): 10"
"Mx42"
"Broad flat to undulating valleys with isolated granitic rock outcrops and some low escarpments; some seasonal lakes and clay pans: chief soils are alkaline red earths (Gn2.13) with nodular limestone pans, and calcareous earths (Gc1.12) on low rises. Associated are (Uc5.21) soils near granitic outcrops; areas of (Uc5.22) and (KS-Uc) soils marginal to unit AC1; and small areas of (Dy) soils, such as (Dy4.33), and the soils of unit Ya28. Occurs on sheet(s): 10"
"Mx43"
"Gently undulating valley plains and pediments; some outcrop of basic rock: chief soils are alkaline red earths (Gn2.13) with limestone or limestone nodules at shallow depth (< 24 in.) on gently sloping slightly concave plains with low gentle rises of (Gc1.12) soils. Associated are (Ug5.38) clay plains flanking ultrabasic rock outcrop; some (Um5.41) soils on steeper slopes; and some small inclusions of units BB5, AC1, and Mx41. There are some breakaways in places marginal to units AC1, SV2, and SV15. Occurs on sheet(s): 10"

"My1"
"Gently to strongly undulating tablelands, tableland remnants, and plains--at low elevation (< 1700 ft above sea level~broken by some steeper hilly areas: chief soils are neutral red earths (Gn2.12) mantled by siliceous and/or ironstone gravels. Associated are (i) ridge crests and low hills of shallow loams (Um1.43), (Um5.41), (Um5.51), and other (Um) soils, boulders including silcrete, and rock outcrops; (ii) limited areas of gravel-free red earths (Gn2.12, Gn2.13) in the relatively lower-lying sites (valleys); and (iii) soils of units CC19 and/or Nb3 along drainage-ways. Occurs on sheet(s): 3,4,10"
"My2"
"Undulating ridges broken by broad flat valleys: chief soils are gravelly and non-gravelly neutral red and yellow earths (Gn2.12 and Gn2.22). Associated are some shallow loams (Um1.43) on ridge crests; and hard-setting loamy soils with yellow clay subsoils (Dy2.43) in the broad flats, where small areas of soils of adjacent units also occur. Occurs on sheet(s): 3"
"My3"
"Gently undulating plains with occasional high ridges and cuesta-like scarps: chief soils of the gently sloping to flat areas are red earths (Gn2.12, Gn2.13, and Gn2.11) with some yellow earths (Gn2.2), all often with a surface scattering of ironstone gravel; on the higher ridges and scarps shallow loams (Um1.43) occur with some ferruginous rock outcrops, while in the lower-lying situations (Dr2.33) soils occur along with small areas of soils of adjacent units. Occurs on sheet(s): 3,4"
"My4"
"Gently undulating plains with dunes and occasional low stony ridges: extensive level areas of sandy and loamy red earths (Gn2.12 and Gn2.13) with lesser areas of yellow earths (Gn2.21 and Gn2.22) broken by occasional low rises of red earths (Gn2.12 and Gn2.13) mantled with siliceous gravel, or higher ridges with shallow loams (Um1.43). Associated are low dunes of variable frequency of occurrence with sandy red earths (Gn2.12 and Gn2.13), red earthy sands (Uc5.21), brown sands (Uc5.1), or siliceous sands (Uc1.2); and drainage lines of cracking clays (Ug5.2 and Ug5.3) with clay pans of (Dr1.33 and Dr1.43). This unit is similar to unit Mx1, which, however, seems to contain a greater proportion of soils with alkaline subsoils. Occurs on sheet(s): 3,4"
"My5"
"Plains with occasional low dune ridges: extensive flat areas of sandy red earths (Gn2.12 and Gn2.13) with smaller areas of yellow earths (Gn2.22) and hard-setting loamy soils with red clay subsoils (Dr2.33). The low dunes or occasional more-extensive sandy areas have deep siliceous sands (Uc1.2) or, less commonly, earthy sands (Uc5.2); associated lower-lying areas have strongly gilgaied cracking clays (Ug5.24 and Ug5.28) interwoven with (Dr2.33), (Dr2.43), and (Dy2.33) soils. Occurs on sheet(s): 3,4"
"My6"
"Narrow steep-sided ranges with gently sloping corridor-like areas between the ranges; some ranges with gently undulating crests. Chief soils seem to be neutral red earths (Gn2.12) with a complexity of other soils generally as follows: (i) (Gn2.12) soils, sometimes stony, in the corridors and lower flanks of the range slopes where they merge with alluvial cone areas similar to those portions of unit Mx8 which are subjacent to the ranges; (ii) various (Uc), (Um), and (D) soils on the steeper bouldery and rocky slopes of the ranges--these include (Uc1.23), (Uc4), (Um1.43), (Um4.1), (Dr3.42), and (Dy3.4) soils (some of these slope areas compare with unit Qc4); and (iii) shallow gritty often stony neutral red earths (Gn2.12) on undulating range crests, which may be underlain by clay layers in some areas. As mapped, areas similar to units Mx8 and Mx4 may be included. Data are limited. Occurs on sheet(s): 3"
"My7"
"Undulating to hilly terrain with ridges and hills often covered with tors: chief soils seem to be: gritty neutral red earths (Gn2.12); hard alkaline red soils (Dr2.43); and hard alkaline yellow mottled soils (Dy3.43) and (Dy3.33). Some (Uc) soils may occur. Data are limited. Occurs on sheet(s): 3"
"My8"
"Gently undulating terrain with gravelly ridges of variable frequency of occurrence: chief soils are gravelly and non-gravelly neutral red earths (Gn2.12) on the gently undulating terrain. Associated are: flat to undulating areas of hard neutral red soils (Dr2.32); and ridges of shallow loams (Um1.43) with some (Dr2.32) soils. Quartz gravels usually mantle the (Dr2) and (Um1) soil areas. The (Um1) soils overlie country rock often containing pockets of mottled clays. Compare units My9 and Qc3. Occurs on sheet(s): 3"
"My9"
"Undulating country: chief soils are neutral and alkaline red earths (Gn2.12 and Gn2.13) with some yellow earths (Gn2.2). Associated are low shaly ridges of (Dr2.32) and (Um4.1) soils, similar to unit Qc3; and variable areas of (Dr2.33) soils. As mapped, areas of units Qc3 and Ub44 are included. Some ironstone gravels and cemented bands occur, especially in western portions of the unit. Compare unit My8, which grades into this unit. Data are limited. Occurs on sheet(s): 3"
"My10"

"Undulating to rolling country with some long broad slopes, some tors: chief soils are neutral red earths (Gn2.12) often gritty and/or sandy, with some neutral yellow earths (Gn2.25) often locally prominent; and in the most easterly occurrences of the unit some (Gn2.15) soils. Associated are: variable areas of hard neutral and alkaline red soils (Dr2.32 and Dr2.33); scattered ridges and knolls of unit Qb1O; and smaller areas of (Dy) soils. The eastern occurrences of this unit and its companion unit Qb1O, taken together, have some features in common with unit Mu1. Ironstone gravels are of erratic occurrence. Data are limited. Occurs on sheet(s): 3"
"My11"
"Rolling to nearly flat country with some widely spaced ridges and hills: chief soils are neutral and alkaline red earths (Gn2.12 and Gn2.13), and in the more easterly occurrences of the unit some (Gn2.15 and Gn2.16) soils. Associated are: variable areas of hard alkaline red soils (Dr2.33), hard alkaline brown soils (Db2.43), and (Dy) soils; and some stony or shaly ridges and hills of units Qc4 and/or Qc3 or LK4. Data are limited. Occurs on sheet(s): 3"
"My12"
"Undulating with low hills and ridges: chief soils are neutral and alkaline red earths (Gn2.12 and Gn2.13) with some ridges and hills of unit Qc4. Compare unit My11. Occurs on sheet(s): 3"
"My13"
"Plains of neutral and alkaline red earths (Gn2.12 and Gn2.13): associated are (Dy5.43 and Dy5.42) soils on very gently undulating sandy mound areas, and soils of unit Oc12 in the relatively lowerlying sites. Occurs on sheet(s): 3"
"My14"
"Gently undulating plains of neutral red earths (Gn2.12) with sandy mound areas of (Dy5.43 and Dy5.42) soils. Other soils are likely also. Occurs on sheet(s): 3"
"My15"
"Plains (probably terrace remnants): chief soils are neutral and alkaline red earths (Gn2.12 and Gn2.13) which may be gravelly or gritty, and of shallow depth; they overlie buried soil materials. Compare unit Mz2. Data are limited. Occurs on sheet(s): 3"
"My16"
"Gently undulating plains at slightly higher elevation than the surrounding plains country: chief soils are neutral red earths (Gn2.12) with (a) clay D horizons or (b) waterworn stones and ironstone gravels below their sola, often at shallow depths (2-3 ft). Associated are siliceous sands (Uc1.22) on sand-hills, dunes, and sand sheets, sometimes with clayey D horizons; and (Dr2.33) soils in relatively flat, low-lying sites. Data are limited. Occurs on sheet(s): 3"
"My17"
"Moderately undulating lands with broad valleys: dominant soils are sandy red earths (Gn2.12) on most ridge crests and slopes. Associated are deep sands (Uc5.21) and (Uc1.23) on some ridge crests, and loamy duplex soils (Dr2.33) on flatter areas adjacent to drainage lines. Also included are small areas of clay soils (Ug5.2 and Ug5.3), together with some stony (lateritic) scarps (unit Fz2). Occurs on sheet(s): 4"
"My18"
"Moderately undulating lands with occasional steep-sided mesas: dominant soils are sandy or loamy red earths (Gn2.12 and Gn2.11). Associated are sandy soils (Uc1.22) and (Uc4.12) that are often shallow and gravelly. On flatter sites a range of duplex soils occur, chiefly (Dy2), (Dr2), and (Dy3). Data are limited. Occurs on sheet(s): 4"
"My19"
"Level or very gently undulating plains: dominant soils are sandy or loamy red earths (Gn2.12 and Gn2.11) with some yellow earths (Gn2.22 and Gn2.21). Associated are deep red sands (Uc1.23 and Uc1.22), often in the form of low dunes. Broad shallow drainage lines often have loamy duplex soils associated, chiefly (Dy3.42), (Dy2.42), or (Dr2.32). In other depressed areas shallow red earths are underlain by a clay D horizon. Small areas of clay soils (unit Ii1) may be included. Occurs on sheet(s): 4"
"My20"
"Level or very gently undulating plains: dominant soils are loamy red earths (Gn2.12) with some loamy yellow earths (Gn2.22). Lower landscape sites have a range of loamy duplex soils, chiefly (Dr2.43), (Dr2.33), (Db1.33), (Dy2.43), (Dy2.33), and (Dd1.33), and limited occurrences of gilgaied clays (Ug5.24). Small flood-plains associated with drainage lines have (Dr2.33) and (Dd1.33) soils, and occasionally some low sand dunes (Uc1.21, Uc1.22, and Uc1.23). Occurs on sheet(s): 4"
"My21"
"Undulating elevated plains with some steep-scarped dissected margins and occasional low mesa-like residual hills: dominant soils are loamy red earths (Gn2.12) with some yellow earths (Gn2.22) and (Gn2.42). Some lower sites have gilgaied grey clays (Ug5.24) or brown clays (Ug5.34) that are non-gilgaied. Occurs on sheet(s): 4"
"My22"
"Gently undulating alluvial plains fringing major drainage lines: dominant soils are loose sandy red earths (Gn2.12 and Gn2.11). Associated are old sandy levees and occasional low dunes with deep sandy soils (Uc5.21) and

(Uc5.11). Marginally included in the unit are sandy or loamy-surfaced mottled duplex soils (Dy5.41) and (Dy3.42). Occurs on sheet(s): 4"
"My23"
"Level mesas or tablelands of considerable extent and with steep-scarped margins; dissected lower hilly lands often with alluvial terraces and fans; some low hilly eroded mesa remnants: dominant soils of the extensive tablelands and mesas are loamy red earths (Gn2.12) with some (Gn2.11) and lesser yellow earths (Gn2.22). Some shallow stony loams (Um1.43) and (Um5.2) occur, particularly near scarped margins where they may be underlain by massive laterite. The dissected areas have mostly loamy duplex soils (Dy2.33), (Dy2.43), (Db1.13), and (Db1.33), with occasional areas of (Dr2.13) or cracking clays (Ug5.24) and (Ug5.34). Outwash fans mostly have (Db1.33) or (Dy2.43) soils. Occurs on sheet(s): 4"
"My24"
"Gently undulating plains with occasional high ridges: dominant soils are sandy and often gravelly red earths (Gn2.12) with lesser (Gn2.11) and (Gn2.22). Closely associated are sandy duplex soils with moderately deep A horizons and hard clay subsoils (Dy3.42 and Dy3.43). In lower sites are thin-surfaced loamy duplex soils (Dd1.13) and (Dd1.33) or gilgaied cracking clays (Ug5.24) and (Ug5.16). Occurs on sheet(s): 4"
"My25"
"Level or very gently undulating plains: dominant soils are deep sandy red earths (Gn2.12), occasionally (Gn2.11). Associated are similar sandy yellow earths (Gn2.22) and small areas of deep red sands (Uc1.23) and (Uc5.21). Also occurring are some loamy red and yellow earths (Gn2.12) and (Gn2.22) and occasional low lateritic scarps with shallow stony loams (Um1.43). Shallow drainage lines occurring in the unit have loamy duplex soils (Dy3.43) and (Dy2.43). Occurs on sheet(s): 4"
"My26"
"Gently undulating or level plains: dominant soils are hard loamy red earths (Gn2.12) and yellow earths (Gn2.22), (Gn2.32), and (Gn2.62). The red and yellow earths may vary locally in dominance, the former occurring mainly on slightly higher sites. Associated broad shallow drainage lines have loamy duplex soils, (Dy3.33) and (Dy3.43), similar (Dy2) soils, and small areas of (Dr2.13). Also included in the unit are some low laterite or sandstone scarps with shallow stony loams (Um1.43), and occasional eroded mottled rock pavements. Occurs on sheet(s): 4"
"My27"
"Level or very gently undulating plains: dominant soils are deep loamy red earths (Gn2.12), occasionally (Gn2.11). Slightly higher low broad ridges often have loamy or sandy yellow earths with a nodular ironstone horizon at shallow depths (Gn2.22), (Gn2.21), (Gn2.24), and (Gn2.62). In broad shallow drainage depressions loamy yellow earths may also occur, associated with limited areas of loamy duplex soils (Dy2.42) and (Dy3.42). The red earth plains may be bounded by scarped margins with shallow stony loams (Um1.43) and mottled rock outcrops. Occurs on sheet(s): 4"
"My28"
"Gently undulating lands with broad ridge crests and low rises: dominant soils are loamy or occasionally sandy red earths (Gn2.12), less often (Gn2.11). Associated are lesser loamy or sandy yellow earths (Gn2.22). On lower slopes and in drainage depressions loamy duplex soils (Dy3.43 and Dy3.42), and similar (Dy2) soils occur. Occasionally present are low lateritic scarps with shallow stony loams (Um1.43) and (Um4.1). Included in the unit, as mapped, are small areas of gilgaied cracking clays similar to units CC21 and CC33. Occurs on sheet(s): 4"
"My29"
"Level sandy plains with some slightly depressed scalded areas: dominant soils are sandy red earths (Gn2.12) and occasionally sandy yellow earths (Gn2.22) and (Gn2.42). At the margins of the unit duplex soils (Dr2.12 and Dr2.13), (Dr3.12 and Dr3.13) occur. The bare clay pan areas have eroded duplex soils (Dy2.43), (Dy2.33), (Dr2.43), (Dr2.33), (Db1.43), and (Db1.33), or occasionally very shallow loams (Um1.43) overlying mottled rock. Occurs on sheet(s): 4"
"My30"
"Very gently undulating plains: dominant soils are loamy red earths (Gn2.12), occasionally (Gn2.11), with lesser loamy yellow earths (Gn2.22) that are mostly nodular. In some areas erosion has exposed a hard mottled rock pavement with very shallow loams (Um1.43). Adjacent to drainage lines are small areas of red duplex soils (Dr2.33) or cracking clays (Ug5.24). Occurs on sheet(s): 4"
"My31"
"Level plains with occasional very slightly higher old sand-filled stream channels: dominant soils are sandy red earths (Gn2.12), with lesser (Gn2.11). Also commonly occurring, more particularly in the sand-filled channels, are red and yellow earthy sands (Uc5.21 and Uc5.22) together with other sand soils (Uc1.23 and Uc1.22). In slightly depressed areas loamy duplex soils may occur, chiefly (Dr2.33), (Dr2.43), (Dy2.33), and (Dy2.43). Other soils in the unit include small areas of loamy and sandy yellow earths (Gn2.22 and Gn2.21) and other red earths (Gn2.15 and Gn2.14). Occurs on sheet(s): 4"
"My32"

"Level alluvial fan plain: dominant soils are soft loamy or sandy red earths (Gn2.12) with lesser (Gn2.11). In many areas old sand-filled distributary channels occur, now slightly elevated above the plain. These have deep sands (Uc1.23) or earthy sands (Uc5.21 and Uc5.22). Throughout the unit small scalded areas are common with loamy red earths (Gn2.12) or duplex soils (Dr2.32 and Dr2.33). Other loamy earths occurring in the unit are (Gn2.35), (Gn2.95), and (Gn2.22). Occurs on sheet(s): 4"
"My33"
"Gently undulating plains or low broad ridges and some swampy depressions: dominant soils are sandy red earths (Gn2.12) with sandy or loamy duplex soils occurring in lower sites (Dy3.42 and Dy3.43), and similar (Dy2) soils. Small areas of gilgaied cracking clays (unit CC30) occur in some low sites, associated with (Dy2.33) soils. Occurs on sheet(s): 4"
"My34"
"Gently undulating plains, locally with stronger relief: dominant soils are loamy red earths (Gn2.12), with lesser (Gn2.11). Loamy yellow earths (Gn2.22) are commonly associated. Both earths are commonly strongly nodular at depth and in some instances are underlain by massive nodular laterite at shallow depths (15-20 in.). Broad shallow drainage-line valleys in the unit have loamy duplex soils (Dy2.43) and (Dr2.43); and small local depressed areas may have gilgaied clays (Ug5.24). At the dissected margins of the unit gravelly duplex soils (Dr2.33) and (Dr2.13) are common. Occurs on sheet(s): 4"
"My35"
"Undulating lands, often with high gravelly ridges: dominant soils are loamy or sandy red earths (Gn2.12 and Gn2.11) that are often gravelly. Lesser areas of yellow earths (Gn2.22) occur on lower slope sites. The high gravelly ridges have either sandy red earths (Gn2.12), extremely gravelly sandy soils (Uc5.11), (Uc1.21), and (Uc1.23), or stony loams (Um1.43) and (Um4.1). Occurring throughout the unit, mostly in lower sites, are small areas of loamy duplex soils (Db1.13), (Db1.33), (Dy2.33), and (Dy2.43), or gilgaied clays (Ug5.24) and (Ug5.34). Occurs on sheet(s): 4"
"My36"
"Gently undulating plains, sometimes with dissected scarped margins and some low sandstone mesas: dominant soils are deep sandy red earths (Gn2.12), with lesser (Gn2.11), which may contain quartz gravel at depth. Associated are smaller areas of loamy red earths (Gn2.12 and Gn2.11) and deep sandy duplex soils (Dy5.81). The dissected margins of the unit and the sandstone mesas have mostly shallow stony sands (Uc4.11), (Uc1.21), and (Uc2.12). Occurs on sheet(s): 4,7"
"My37"
"Undulating basalt plains and plateaux with many low stony rises and occasional low conical hills. The soil surface ranges from stone-free (rarely) to a frequent occurrence of basalt boulders and stony outcrop (most common). The dominant soils are loamy red earths of shallow to moderate depth (18-40 in.) that commonly have some large basalt boulders in the profile. The chief forms are neutral (Gn2.12), but slightly acid forms (Gn2.11) are also common, particularly the shallower soils. In most soils small ironstone nodules occur throughout, and deeper soils may tend to have smooth-ped structure at depth. Small areas of friable earths (Gn3.12 and Gn3.11) occur locally. Low stony basalt rises commonly occurring throughout the unit have very shallow stony (Um5.51) soils. Also occurring in the unit are slightly lower areas of loamy yellow earths (Gn2.21), (Gn2.61), and (Gn2.24); these may be locally dominant in some areas. Also included in the unit are some small stony plains of dark cracking clays (unit Kb24) that are too small to map separately. The more easterly extent of this unit has larger areas of gently undulating plains that have fewer low low stony rises and flow scarps. However, the soils nearly always have variable amounts of basalt boulders on the surface and throughout the profile. Yellow earths (Gn2.21), (Gn2.61), and occasionally (Gn3.21), thend to be more prominent in this area. Occurs on sheet(s): 4,7,10"
"My38"
"Very gently undulating outwash fan-plains from unit JJ12: dominant soils are deep sandy red earths (Gn2.12) with lesser (Gn2.11), (Gn2.16), and (Gn2.42); however, other sand soils (Uc1.23 and Uc1.21) are also common. Associated are a range of sandy or loamy duplex soils (Dy2.22), (Dr2.22), (Db1.33), and (Dy3.43). Small areas of clay soils of units CB7 and MMl3 are included in this unit, as mapped. Occurs on sheet(s): 4"
"My39"
"Undulating low rises that are old levees of major streams: dominant soils are loamy or sandy red earths (Gn2.12), occasionally with some yellow earths (Gn2.22) near the margins. Occurring in the unit, as mapped, are shallow drainage lines subject to flooding; these have uniform loamy soils (Um5.5) or, less commonly, clays (Ug5.24). Occurs on sheet(s): 4"
"My40"
"Gently undulating plains, often occurring as a plateau surface with steep-scarped margins: dominant soils are deep loamy red earths (Gn2.12), with lesser (Gn2.11). In slightly lower sites loamy yellow earths (Gn2.22) may occur, associated with small areas of loamy duplex soils (Dy3.42). The scarped margins have shallow loams (Um1.43) or (Um4.1) underlain by lateritic materials, mostly mottled rock. Occurs on sheet(s): 4,7"
"My41"

"Gently sloping areas flanking ranges: chief soils are neutral red earths (Gn2.12) with some patches of (KS-Gn2.21). Other soils may occur. Occurs on sheet(s): 5"
"My42"
"Flat to gently undulating terrain with small samphire flats and areas of exposed calcrete (kunkar): chief soils seem to be neutral and alkaline red earths (Gn2.12 and Gn2.13). Associated are yellow earths (Gn2.2) on included ridges and small areas of soils of adjoining units. Occurs on sheet(s): 5"
"My43"
"Undulating to strongly undulating areas flanking ranges: chief soils seem to be neutral red earths (Gn2.12) and yellow earths (Gn2.2). Associated are the soils of unit Ms9. Occurs on sheet(s): 5"
"My44"
"Undulating ridge and low hilly terrain with some mesas and buttes and small valley plains: chief soils seem to be neutral red earths (Gn2.12) with a variable content of ironstone gravel. Associated are shallow (Um) soils and (Dr) soils such as (Dr2.32) on hill slopes; and some (Dr2.33) soils in narrow valleys. As mapped, small areas of unit AC1 soils may be included. Occurs on sheet(s): 5"
"My45"
"Undulating terrain with small gently sloping plains and some ranges on basic schists, gneisses, and allied rocks: chief soils seem to be neutral red earths (Gn2.12) with a variable content of ironstone gravel. Associated are small areas of unit Fa4. Red-brown hardpan may occur in portions of the area, especially the northern portions. Occurs on sheet(s): 5,10"
"My46"
"Plains with occasional dunes and narrow saline flats and creeks: chief soils are neutral red earths (Gn2.12) with some alkaline red earths (Gn2.13). Associated are some red earthy sands (Uc5.21) mainly on and adjacent to dune formations. Occurs on sheet(s): 5"
"My47"
"Undulating terrain: chief soils seem to be neutral red earths (Gn2.12) and yellow earths (Gn2.21). Associated are red and yellow earthy sands (Uc5.21 and Uc5.22) and smaller flats of (Gn2.13) soils. Some red-brown hardpan is present below the soils. Occurs on sheet(s): 5"
"My48"
"Gently undulating to low hilly areas with gneissic rock outcrops: chief soils on the flatter portions seem to be neutral red earths (Gn2.12) underlain by a red-brown hardpan. Associated on the slopes are shallow (Um) and (Uc) soils such as (Um5.41), (Uc1.43), (KS-Uc1.43), and (KS-Uc5.22) with some shallow (Dy) and (Dr) soils such as (Dy2.2) and (Dr2.33). Occurs on sheet(s): 5"
"My49"
"Plains and their flanking slopes: chief soils are neutral and alkaline red earths (Gn2.12 and Gn2.13) with low rises of (Uc5.21), all underlain at shallow depths by a red-brown hardpan. Associated are saline flats with calcrete (kunkar) platforms having (Um5.11) and (Gc1.12) soils; and flanking slopes of the soils of units F8 and F9. Occurs on sheet(s): 5,6"
"My50"
"Broad plains with a scatter of surface gravels: chief soils are shallow neutral red earths (Gn2.12) and shallow earthy loams (Um5.3) in intimate microassociation. They are underlain by a red-brown hardpan at depths of 6-30in.. Occurs on sheet(s): 5,6,10"
"My51"
"Undulating areas on Permian sedimentary rocks; red-brown hardpan is widespread: dominant soils are neutral red earths (Gn2.12) with the hardpan at a shallow depth, but (Um5.3) soils are nearly as important. Other soils such as (Dr2.33), (Gc1.12), and (Um5.11) are found where the Permian sediments are exposed. Occurs on sheet(s): 6"
"My52"
"Outwash plain dominated by neutral red earths (Gn2.12) with some (Um5.52) soils. Occurs on sheet(s): 6"
"My53"
"Extensive plains dominated by neutral red earths (Gn2.12) with areas of acid and alkaline red earths (Gn2.11, Gn2.13). There is frequently a cover of surface gravels. There are minor areas of (KS-Gn2.11) soils adjacent to Robe River iron deposits and some hard red soils (Dr2.32) along creek lines. Occurs on sheet(s): 6"
"My54"
"Broad very gently undulating plains with scattered rock outcrops occurring as mesas: chief soils are neutral and acid red earths (Gn2.12, Gn2.11) with some hard red soils (Dr) occurring on pediments of unit Oc61. Occurs on sheet(s): 6,10"
"My55"
"Gently sloping outwash plains generally flanking the northern face of the Hamersley Range; coarse surface gravels are extensive: chief soils are neutral red earths (Gn2.12) with some (Gn2.11) and (Dr2.33) soils. Occurs on sheet(s): 6"
"My56"

"Plains with occasional sandy rises: chief soils are neutral and alkaline red earths (Gn2.12, Gn2.13) with low rises of red earthy sands (Uc5.21) and red siliceous sands (Uc1.23) frequently overlying red-brown hardpan. There are some yellow earthy sands (Uc5.22) marginal to unit AC9. Occurs on sheet(s): 6"
"My57"
"Extensive plains with parallel sand dune formations: chief soils of the plains are neutral red earths (Gn2.12) but there are also areas of acid (Gn2.11) and alkaline (Gn2.13) red earths with some hard red soils (Dr2.33) towards margins and around drainage lines. Chief soils of the dunes are red sands (Uc1.23) and (Uc5.21). Occurs on sheet(s): 6"
"My58"
"Plains with irregularly spaced elongate sand dunes; some swamps: chief soils are neutral red earths (Gn2.12) with (Gn2.19), (Gn2.22), (Gn2.32), (Gn2.62), and (Dy2.42) soils sometimes locally dominant. The soil surface is often covered by a layer of black ferruginous gravel. The dunes which are mainly stabilized have deep sands (Uc1.23), though some low broad dunes have earthy sands (Uc5.21). This unit may merge with units B28 and AB21 respectively. Occurs on sheet(s): 9"
"My59"
"Dissected plains developed on lateritized sandstone; with rock and laterite outcropping in elevated sites: main soils are stony neutral red earths (Gn2.12) with hard neutral red soils (Dr2.22) on flatter areas. There are some sand dunes (Uc1.23) with earthy sands (Uc5.21) in swales. Occurs on sheet(s): 9"
"My60"
"Plains with minor sandstone residuals on which there is extensive rock outcrop: main soils on the plains are neutral red earths (Gn2.12) and sandy neutral red soils (Dr5.32). Occurs on sheet(s): 9"
"My61"
"Sand plain with irregular dunes; active drainage systems: chief soils are neutral red earths (Gn2.12) and red earthy sands (Uc5.21). Associated are deep red sand dunes (Uc5.11) and (Uc1.23). Some (Dy5.42) soils occur in low-lying areas. Occurs on sheet(s): 9"
"My62"
"Gently undulating country developed on basalt with some exposures of underlying sandstone: chief units are plains with neutral red and neutral yellow earths (Gn2.12) and (Gn2.22) with a layer of fine ferruginous gravel on the surface. The low hilly interfluves have (Gn3.11) and shallow stony (Um6) soils. Other soils are (Uc5.11) and (Uc1.23) on sandstones and minor areas of (Ug5.15) along some streams. Occurs on sheet(s): 9"
"My63"
"Undulating country developed on granitic and metamorphic rocks with extensive lateritic remnants: chief soils are neutral red earths (Gn2.12) and (KS-Gn2.12) on plateau remnants. Associated are (Dr2.32) soils on lower slopes and valley plains. There are some sand plains with (Uc1.23) soils. Occurs on sheet(s): 9"
"My64"
"Plains with some dunes and hummocks, some drainage lines: chief soils are red earths (Gn2.12) with a surface covered by black ferruginous gravel. Associated are hard red duplex soils (Dr2.33 and Dr2.32) and some dunes and hummocks of red sands (Uc1.23) and (Uc5.11). As mapped, small areas of unit BA5 may be included. Occurs on sheet(s): 9"
"My65"
"Gently undulating plain with some low poorly defined dunes and some limestone outcrops: chief soils are loamy and sandy neutral red earths (Gn2.12). Associated are other (Gn2) soils such as (Gn2.62) and (Gn2.42). Small areas of shallow (U) soils occur on the limestone rises. Occurs on sheet(s): 8,9"
"My66"
"Gently undulating plains on lateritized volcanics, sediments, and metamorphics: chief soils are loamy and sandy neutral red earths (Gn2.12), sometimes containing moderate to large amounts of ironstone gravel (KS-Gn2.1). Soil depth varies from shallow to deep. Other soils include (Gn2.41) and (Gn2.2). As mapped, narrow plains of unit CC54 are included. Occurs on sheet(s): 8,9"
"My67"
"Gently undulating country derived from limestones, sandstones, and shales; some limestone outcrops: chief soils are neutral, and also alkaline, red earths (Gn2.12 and Gn2.13), often shallow and with other (Gn2) soils including (Gn2.4) and (Gn2.6) on areas of fill over limestones. Associated are various (D) soils such as (Dr2.31), (Dr2.72), (Dr2.33), (Dr3.62), (Dy3.42), (Dy5.42), (Db1.62), and (Dy2.42). Other soils include (Ug5.2) in depressions and (Um6) soils on limestones. Occurs on sheet(s): 8,9"
"My68"
"Gently undulating plains with some low hills and short steep scarps on lateritized sediments and volcanics: chief soils are neutral red earths (Gn2.12) with acid, and also neutral, yellow earths (Gn2.21 and Gn2.22). Associated are various soils including (KS-Uc4.1), (Uc4.1) on scarps and (Dy5.81) and (Dy3.81) containing ironstone gravel on gravelly rises. Occurs on sheet(s): 8"
"My69"

"Shallowly dissected lateritic plains or low plateaux with breakaways dissected into rounded spurs and rocky hill slopes on granite, gneiss, and schist: chief soils are neutral red earths (Gn2.12) often containing ironstone gravel and associated with shallow, often gravelly, (Uc) soils and rock outcrops. Small areas of other soils occur including some (Ug5) and (Dr) soils on the valley floors. Occurs on sheet(s): 8"
"My70"
"Almost flat to undulating plains with areas of very rough karst topography and developed on limestones, sandstones, and siltstones; a stony gravel pavement occurs in places: chief soils are neutral loamy red earths (Gn2.12) in association with neutral loamy yellow earths (Gn2.25) and less commonly (Gn2.64). Other soils are (Dy5.81) on sandy flats in some valleys; dark pedal clays (Uf6.32), dark pedal loams (Um6.21), and dark friable earths (Gn3.4) overlying limestone on flats in some valleys; cracking clays (Ug5.5) and (Ug5.2) in some depressions; and shallow (Uc) and (Um) soils on rock outcrop areas. Occurs on sheet(s): 8"
"My71"
"Plains: chief soils are neutral loamy red earths (Gn2.12) on the plains. Associated are grey clays (Ug5.5) and (Ug5.2) in depressions. Other soils include (Gn2.25) on the plains and marginal to depressions and minor areas of (Uc) soils on valley floors. Occurs on sheet(s): 8"
"My72"
"Gently sloping to undulating terrain on sandstones, siltstones, and some limestones; some hilly portions; some plateau remnants; and traversed by numerous streams: soil dominance varies markedly with locality but neutral red earths (Gn2.12) and acidic yellow earths (Gn2.24) are probably dominant. The general order of soil occurrence is flat to gently undulating crests of red earths (Gn2.12); dissection slopes of (Uc4.12) and (KS-Uc4.12) soils; upper slopes of sandy (Gn2.24) and (Gn2.12) soils; rocky and stony hill slopes o~ shallow (Uc) soils and stone-strewn (Gn2) soils; plateau remnants of the shallow soils of unit JV1; lower slopes and plains of sandy and loamy (Gn2.12) and (Gn2.24) soils; tributary alluvial plains of sandy (Gn2.12) and (Uc5.21) soils; and low-lying areas of (Gn2.64), (Gn2.3), (Gn2.7), and (Gn2.9) soils. As mapped, areas similar to unit My73 are included, as are small areas of adjoining units. Occurs on sheet(s): 8"
"My73"
"Gently sloping to undulating terrain on sandstones, siltstones, and some limestones; some hilly portions; some plateau remnants; and traversed by numerous streams: soil dominance varies markedly with locality but neutral red earths (Gn2.12) are probably dominant. In some areas there is a consistent pattern of sandy and loamy red earth (Gn2.12) flats broken by very low ironstone gravel rises on ridges of (Dy5.81), (KS-Dy5.81), and (KS-Dr5.81) soils. The (Gn2.12) soils are frequently margined by yellow earths such as (Gn2.24) and (Gn2.64). The above pattern is interrupted by plains of red earths (Gn2.12); sandy flats of (Dy5.81) soils; knolls and hills of (Uc4.1) and (KS-Uc4.1) soils; outcrop of laterite and/or mottled-zone and pallid-zone materials; and low-lying areas of (Gn2.3), (Gn2.7), and (Gn2.9) soils. As mapped, areas similar to unit My72 are included as well as small areas of adjoining units. Occurs on sheet(s): 8"
"My74"
"Gently undulating sandy plains underlain by limestones, sandstones, and siltstones, with limestone slabs and outcrop in places; also some narrow sandstone ridges: chief soils are sandy neutral red earths (Gn2.12) and possibly some alkaline red earths (Gn2.13) in association with yellow earths (Gn2.25 and Gn2.24). Other soils are dark pedal loams (Um6.21), dark pedal clays (Uf6.32), and, less commonly, (Gn3.4) soils. They are relatively shallow soils and occur amid much outcropping slab limestone. Minor soils include (Um5.51) overlying limestone and (Ug5.2) soils in depressions and on some slopes. Occurs on sheet(s): 8"
"My75"
"Undulating terrain with low hills and some more rugged ridges on limestones, sandstones, and siltstones with some areas of basalts. Chief soils are probably neutral red earths (Gn2.12) with some alkaline red earths (Gn2.13) and yellow earths such as (Gn2.24) and (Gn2.64) on the areas of undulating terrain. Associated are (Gn3.12) soils on gentle basaltic slopes; (Ug5.13) soils in depressions close to basalts and strewn with basaltic stones and boulders; probably some (Um6.21) and (Uf6.32) soils on limestones; and (Uc) soils on sandstones. Occurs on sheet(s): 8"
"My76"
"Gently undulating terrain on dolerite with some stony ridges and hills: chief soils are loamy neutral red earths (Gn2.12) often with a strew of surface gravel on sloping terrain. Associated are areas of (Ug5) soils including (Ug5.13) on ribbon plains and (Ug5.2) in depressions. Shallow (U) soils occur on the stony ridges and hills. There are some narrow valleys of the soils of unit Mb15. As mapped, small areas of unit JJ31 are included. Occurs on sheet(s): 8"
"My77"
"Gently sloping terrain: chief soils are neutral red and acid red earths (Gn2.12 and Gn2.11), some of which contain moderate to large amounts of ironstone gravel (KS-Gn2.1); some of these gravels are highly manganiferous. Small areas of soils common to unit AC15 occur also. Occurs on sheet(s): 8"
"My78"

"Gently undulating terrain developed on lateritized sediments: chief soils are probably neutral red earths (Gn2.12), with yellow earths such as (Gn2.21) and (Gn2.61) and earthy sands, notably (Uc5.22). Any of these soils may be dominant locally. Other soils may occur, especially (KS-Uc4.1) and (Uc4.1). There are some flood-plain areas similar to unit Mb15. Occurs on sheet(s): 8"
"My79"
"Gently undulating country developed from lateritized sediments: chief soils are neutral red earths (Gn2.12) and yellow earths (Gn2.21, Gn2.22, and Gn2.24) and (Gn2.61), all often containing ironstone gravels are commonly occurring throughout the gently sloping portions of the area. Any of these soils may be dominant locally. Other soils are (Gn2.64), (Gn2.8), and (Gn2.9) in flats; (Uc5.2) in some deep sand areas; and (KS-Uc4.1) and (Uc4.1) sands on steeper slopes throughout. As mapped, small areas of units JV4, 006, II6,II8,II5, and AB30 may be included. Occurs on sheet(s): 8"
"My80"
"Gently undulating plains slightly elevated above the adjoining cracking clay plains; some narrow ridges and hills with rock outcrop; some shallow depressions: chief soils on the long gentle slopes and low rises are neutral red earths (Gn2.12) with a variable content and surface scatter of ironstone gravels. Associated are some (Uc5.21 and Uc5.22) soils on slopes and in depressions; loamy (Gn2) soils such as (Gn2.12) and (Gn2.21) marginal to the cracking clay plains; and some shallow gravelly and stony (Uc) soils on ridges and hills. Small areas of units BA13, BY4, and My82 are included. Occurs on sheet(s): 8,10"
"My81"
"Gently undulating plains of neutral red earths (Gn2.12) as for unit My80 but with a large number of losandstone hillocks and ridges with outcropping rock and very shallow gravelly (Uc1.4) soils. Occurs on sheet(s): 8"
"My82"
"Gently undulating sandy country with low limestone rises of variable frequency of occurrence: chief soils are sandy neutral red earths (Gn2.12). Associated are shallow sandy calcareous soils (Uc1.3) full of limestone rubble on the limestone rises, with lesser areas of shallow red-brown siliceous sands (Uc1.23), often less than 12 in. deep and overlying limestone. Occurs on sheet(s): 8,10"
"My83"
"Plateaux and their remnants developed on ferruginous sandstone, conglomerate, and quartz sandstones, often margined by rocky knolls and steep slopes of unit JV1: chief soils seem to be red and yellow earths (Gn2.12) and (Gn2.24), containing variable amounts of ironstone gravels, together with red and yellow~ earthy sands (Uc5.21 and Uc5.22) on the flat to gently sloping plateau crests. Smaller areas of other soils are likely. Occurs on sheet(s): 8"
"My84"
"Undulating lateritic plain with cliffs fringing the coast in places: chief soils seem to be to be sandy red and yellow earths (Gn2.12) and (Gn2.24) some of which contain ironstone gravels, together with red and yellow earthy sands (Uc5.21 and Uc5.22). Some areas similar to unit MY2 may occur and smaller areas of other soils including white sands (Uc) are likely. Occurs on sheet(s): 8"
"My85"
"Gently undulating alluvial plain with old channels and levees: dominant soils are hard deep loamy red earths (Gn2.12), with associated brown earths (Gn2.42). Adjacent to streams sandy red earths (Gn2.12) may occur, with (Uc4.32) sands on some levees, while loamy yellow earths (Gn2.62) occur in some shallow depressions. Deep sands (Uc5.21, Uc5.22) sometimes occur on old infilled channels. Data are fairly limited. Occurs on sheet(s): 7,8"
"My86"
"Gently undulating plains with isolated sandstone outcrops: dominant soils are deep loamy red earths (Gn2.12, Gn2.11). Associated are loamy yellow earths (Gn2.22) and loamy red duplex soils (Dr2.12) in lower sites. Adjacent to drainage lines loamy yellow duplex soils (Dy2.33) and (Dy2.43) occur, with loamy red earths (Gn2.12, Gn2.13) on stream levees. Shallow sands (Uc4.1), (Uc4.21), and (Uc5.21) occur near outcrops. Data are very limited. Occurs on sheet(s): 7"
"My87"
"Moderately to strongly undulating lands with some steep sandstone scarps: dominant soils are gravelly loamy red earths (Gn2.12, Gn2.11). On scarps and steep slopes shallow gravelly loams (Um1.43) and (Um4.1) occur. Gravel-strewn loamy red duplex soils (Dr2.12) occur on lower slopes. Data are limited. Occurs on sheet(s): 7"
"My88"
"Gently undulating to undulating lands with some rock outcrop and much siliceous shale and chert on the soil surface: dominant soils are gravelly loamy red earths (Gn2.12). Associated soils are nodular loamy yellow earths (Gn2.22) and gravelly-surfaced red duplex soils (Dr2.13) and (Dr2.43). On stream levees are deep loamy red earths (Gn2.12, Gn2.13), with deep stratified loams (Um5.42) away from the levees. Shallow sands (Uc5.22) and shallow gravelly loams (Um1.3) and (Um1.4) occur adjacent to rock outcrop. Occurs on sheet(s): 7"
"My89"

"Gently undulating plains with sandstone outcropping at the low scarped margins: dominant soils are sandy and occasionally loamy red earths (Gn2.12), often with ironstone nodules at depth. Associated soils are yellow earths (Gn2.21, Gn2.22) with some grey earths (Gn2.94) and (Gn2.81) occurring in lower sites. Shallow sands (Uc5.21, Uc5.22), (Uc4.21), and (Uc2.12) occur near the scarped margins. Data are very limited. Occurs on sheet(s): 7"
"My90"
"Gently undulating alluvial plains with numerous stream channels and levees; some outwash fans occur adjacent to hilly sands to the west of the unit: dominant soils are loamy red earths (Gn2 12), with associated (Gn2.11), (Gn2.42), (Gn2.22),and (Gn2.62). Sandy red earths (Gn2.11, Gn2.12) and deep fine sands (Uc5.21, Uc5.22) occur on some stream levees. Adjacent to old channels are loamy duplex soils (Dr2.13), (Db1.13), and (Dy2.13). Deep cracking clays (Ug5.25, Ug5.24) and (Ug5.34) occur throughout the unit and in some areas may be locally dominant. Deep gravelly sands (Uc5.23, Uc5.22) occur near some larger stream channels. Occurs on sheet(s): 7"
"My91"
"Stream levees, infilled channels, and some flood-plains: dominant soils are deep loamy red earths (Gn2.12), with associated (Gn2.15), (Gn2.13), and (Gn2.42, Gn2.43). Occasional deep sandy red earths (Gn2.11, Gn2.12) and deep uniform loams (Um5.52) also occur. In old infilled channels and on back slopes of levees are red earths (Gn2.1) and loamy duplex soils (Dr2.12, Dr2.13), (Db1.13, Db1.12), and (Dy2.13); these areas are often badly wind-eroded. Small areas of deep cracking clays (Ug5.34), (Ug5.25), uniform clays (Uf6.31, Uf6.33), (Uf6.51), and massive cracking clays (Ug5.5) also occur. Occurs on sheet(s): 7,10"
"My92"
"Gently undulating plains with some low rises of quartz gravels and some massive nodular laterite: dominant soils are nodular deep loamy red earths (Gn2.12, Gn2.11). Associated soils are similar brown and yellow earths (Gn2.42) and (Gn2.22). In shallow depressions and drainage lines are loamy nodular duplex soils (Dy2.82), (Dy3.53), (Dy2.42), and (Db1.22) and nodular grey earths (Gn2.82) and (Gn2.95). On the low rises are very gravelly or nodular loams (Um5.51), often overlying massive nodular laterite. Occasional infilled channels have deep red sands (Uc5.21), while on stream levees are deep loamy red earths (Gn2.12, Gn2.11). Some scalded areas adjacent to streams have loamy brown duplex soils (Db1.32). Occurs on sheet(s): 7"
"My93"
"Gently undulating plains with some shallow drainage lines: dominant soils are shallow to moderately deep nodular loamy red earths (Gn2.12) that may overlie massive nodular laterite. Common associated soils are shallow nodular loams (Um5.51) and (Um4.2) and sands (Uc5.21) overlying massive nodular laterite. Minor associated soils are various earths (Gn2.22), (Gn2.11), (Gn2.82), (Gn2.42), and occasional slightly higher areas of sandy red earths (Gn2.15, Gn2.12). Occurs on sheet(s): 7"
"My94"
"Alluvial plains with some old channels and lagoons: dominant soils are deep fine sandy and loamy red earths (Gn2.12), with occasional (Gn2.11) and (Gn2.42). Scalded areas adjacent to some old channels have loamy red duplex soils (Dr2.12, Dr2.13); associated soils in areas away from the levees are sandy and loamy yellow or grey earths (Gn2.22), (Gn2.62), (Gn2.82), and (Gn2.95) and occasional loamy duplex soils (Dy2.12) and (Dy2.42). Occurs on sheet(s): 7"
"My95"
"Gently undulating alluvial plains with many old levees and infilled channels: dominant soils are deep loamy red earths (Gn2.12, Gn2.13), with lesser brown earths (Gn2.42, Gn2.43) and deep sands (Uc5.21) and loams (Um5.22). Associated are loamy duplex soils (Dr2.13, Dr2.12) and (Dy2.13, Dy2.12), occasionally (Dr1.33) and (Dr1.43). Areas of deep cracking clays (Ug5.25, Ug5.24, and Ug5.28) occur throughout the unit and may be locally dominant. Data are fairly limited. Occurs on sheet(s): 7,10"
"My96"
"Very gently undulating plains: a range of earth soils are present but loamy red earths (Gn2.12) underlain by massive laterite are probably dominant. Similar soils (Gn2.15, Gn2.11, and Gn2.14) are closely associated. Loamy yellow earths (Gn2.24) are common in slightly lower areas. Red friable earths (Gn4.11) and (Gn3.11) also occur, chiefly towards the southern margin of the unit where it adjoins the basalt plains of unit Mo30. Occurs on sheet(s): 7"
"My97"
"Gently undulating valley plains with some very steep low hills of massive limestone and occasional lower rounded hills: dominant soils of the plains are loamy red earths (Gn2.12), with lesser (Gn2.11). On some sloping sites are red friable earths (Gn3.12) and loamy red duplex soils (Dr2.12) and (Dr2.22). The steep limestone hills have little soil except for small areas of shallow loams (Um5.51) on lesser slopes. Lower rounded hills have shallow stony loams (Um4.1), (Um4.21), and (Um2.12) or shallow sandy loams (Uc4.2) and (Uc2.12). Loamy duplex soils (Dy2.32) occur on the lower slopes. Occurs on sheet(s): 7"
"My98"
"Low to steep hilly country with mesas and buttes sometimes capped with pisolitic ironstone and laterite on ferruginized and silicified sandstone and greywacke with extensive valley plains, some lakes and lagoons, and

some transgressive longitudinal sand dunes: chief soils are probably neutral red earths (Gn2.12) and red earthy sands (Uc5.21) on the valley plains. Associated on the hill tops are shallow stony and gravelly sands and sandy loams, such as (Uc1.43), often with block laterite and pisolitic ironstone; and (Uc1.23) soils on the sand dunes. Other soils may occur, including some (Ug5) soils on alluvial fans. Occurs on sheet(s): 10"
"My99"
"Plains with extensive gravel pavements and small tracts of longitudinal dunes: chief soils are shallow red earths (Gn2.12) and earthy loams (Um5.3) underlain by a red-brown hardpan. Associated are (Uc5.21) soils in sandy areas; (Uc1.23) sands on dunes; and (Um1.43), (Um5.51), and other shallow soils on low silcrete and laterite residuals. Occurs on sheet(s): 10"
"My100"
"Gently sloping plains with extensive gravel pavements: chief soils are shallow red earths (Gn2.12) underlain by a red-brown hardpan. Occurs on sheet(s): 10"
"My101"
"Broad plains with a scatter of surface gravel, some wanderrie banks, some salt flats: chief soils are shallow neutral red earths (Gn2.12) and shallow earthy loams (Um5.3) underlain by a red-brown hardpan at depths of 6-30 in. Associated are (Uc5.21) soils underlain by a red-brown hardpan on the wanderrie banks, and (Dr) soils adjacent to salt flats. Occurs on sheet(s): 10"
"My102"
"Plains principally on mudstone and shale but with some areas derived from gneissic rocks; gravel pavements: chief soils are shallow neutral red earths (Gn2.12) and shallow earthy loams (Um5.3) underlain by redbrown hardpan and alternating with alluvial plain areas of (Dr2.33) soils also underlain by red-brown hardpan. Other soils include (Uc5.21) on occasional wanderrie banks and other shallow (Um) and (Uc) soils. Occurs on sheet(s): 10"
"My103"
"Undulating terrain with low ridges and hills mainly on mudstones and shales; some silcrete-capped residuals; stony and gravelly pavements are common: chief soils are shallow neutral red earths (Gn2.12) and shallow earthy loams (Um5.3) underlain by red-brown hardpan. Associated are (Dr2.33) and (Dr1.33) soils on alluvial plain areas; (Uc5.21) soils on sandy areas; (Uc1.43) and (Um1.43) soils on the steeper slopes and ridges; and (Um5.11) soils on calcrete in narrow valleys. Occurs on sheet(s): 10"
"My104"
"Undulating plains with low rocky ridges and hills, some of which are capped by laterite: chief soils are neutral red earths (Gn2.12) and red earthy sands (Uc5.21) sometimes containing ironstone gravels. Other soils include shallow stony (Uc1.4) and (Uc1.2), also (KS-Uc) on the ridges and hills; (Uc1.23) on included dunes; and some (Gn2.13) in low-lying sites. Occurs on sheet(s): 10"
"My105"
"Plains, occasionally with low rocky hills: chief soils are neutral red earths (Gn2.12) of variable degree of sandiness, and red earthy sands (Uc5.21) with lesser areas of (Gn2.13) soils. Minor areas of other soils may be included locally. Occurs on sheet(s): 10"
"My106"
"Outwash plains and fans: chief soils are red earths (Gn2.12) and red earthy sands (Uc5.21), but some yellow earths (Gn2.2) and (Gn2.6) together with yellow earthy sands (Uc5.22) may occur in the less well-drained sites. Occurs on sheet(s): 10"
"My107"
"Generally somewhat broken and uneven undulating terrain with some hilly portions on granites and gneiss. some rock outcrops: chief soils are neutral and alkaline red earths (Gn2.12, Gn2.13) with red earthy sands (Uc5.21). Small areas of shallow stony sands (Uc) occur on areas of stronger relief. Occurs on sheet(s): 10"
"My108"
"Old terrace formations flanking ranges; some mesas and buttes; variable stone and gravel pavement: chief soils are neutral red earths (Gn2.12) and crusty loamy soils (Dr1.33) and (Dr1.43). Small areas of soils o~ adjacent units are also likely. Occurs on sheet(s): 10"
"My109"
"Outwash plains and dissected fan and terrace formations flanking ranges of sedimentary and some metamorphic, volcanic, and granitic rocks; some stony hills of unit BA21 are included; some lateritic conglomerates; some calcretes (kunkar); soil pattern is very variable: chief soils are neutral red earths (Gn2.12) and red earthy sands (Uc5.21). Other soils include (Gn2.11, Gn2.13); stony varieties of (Uc1.23) and (Uc5.21); (Um5.11) and (Gc) soils on calcretes; and (Um1.43) on stony rises. Some small areas similar to unit MM27 may be included. Occurs on sheet(s): 10"
"My110"
"Plains with some longitudinal dunes; some stony residuals of sedimentary rocks which are sometimes capped with a lateritic duricrust: chief soils are neutral red earths (Gn2.12) with lesser areas of (Gn2.11, Gn2.13). Associated

are (Uc5.21) soils in interdune areas, (Uc1.23) soils on dunes, and (KS-Uc5.21) soils on residuals. Occurs on sheet(s): 10"
"My111"
"Extensive plains with a few low dunes; occasional low stony residuals: chief soils are neutral red earths (Gn2.12) with red earthy sands (Uc5.21). (Uc1.23) sands occur on the dunes. Small areas of unit My1O9 may be included. Occurs on sheet(s): 10"
"My112"
"Extensive plains with numerous dunes which are often short and of irregular shape and orientation: chief soils are neutral red earths (Gn2.12) and red earthy sands (Uc5.21). (Uc1.23) sands occur on the dunes. Small areas of unit BA21 may be included. Occurs on sheet(s): 10"
"My113"
"Plains with occasional dunes and low rubbly calcrete mounds: chief soils are neutral red earths (Gn2.12) and red earthy sands (Uc5.21). Other soils include (Uc1.23) on dunes and (Um5.11) on calcretes. Occurs on sheet(s): 10"
"My114"
"Sandy plains broken by granitic ranges, hills, and ridges; occasional lateriteor silcrete-capped buttes; occasional dunes; some low rubbly calcrete mounds; and a few seasonal swamps: chief soils are neutral red earths (Gn2.12) with (Uc5.21) on the plains. Associated are shallow stony sands (Uc1.43) and (Uc1.23) on the hills where rock outcrop is frequent; (Uc1.23) sands on the dunes; (Um5.11) soils on the calcrete mounds; small areas of (Dr1.33) and (Dr1.43) soils, occasionally with (Ug5.3) in gilgai complex in some valleys and on some foot slopes, spurs, and terraces; and (Ug5.2) clays in swampy and clay flat areas. Occurs on sheet(s): 10"
"My115"
"Plains with occasional dunes; a few rock outcrops; some low rubbly calcrete mounds; some gravel pavements: chief soils are neutral and alkaline red earths (Gn2.12, Gn2.13). Associated are (Uc5.21) soils on the plains and (Uc1.23) on the dunes. Small areas of unit BB25 are included on the calcrete areas. Occurs on sheet(s): 10"
"My116"
"Plains with many, often short, dunes; calcrete mounds and flats; occasional rock outcrops; laterite and silcrete remnants as outcrops of boulders and stones; some gravel pavements: chief soils are neutral red earths (Gn2.12) with (Uc5.21). Other soils include (Uc1.23) on the dunes and (Gn2.13) on the plains. Small areas of unit BB25 are included on the calcrete areas. Occurs on sheet(s): 10"
"My117"
"Generally similar to unit My116 but with a very few low dunes that are often short in length. Occurs on sheet(s): 10"
"My118"
"Plains: chief soils are neutral red earths (Gn2.12). Associated are (Dr1) soils such as (Dr1.33), sometimes with a stone and gravel mantle and some gilgais with (Ug5.3) soils in the depressions. Small areas of other soils on fans, sandy banks, and channels are likely. Occurs on sheet(s): 10"
"My119"
"Undulating plains with low rocky ridges and hills some of which are capped by laterite: dominant soils are neutral red earths (Gn2.12) and red earthy sands (Uc5.21), some of which contain ironstone gravels. Associated are stony (Uc1.4) and (Uc1.2) soils on the ridges and hills and (Uc1.23) sands on occasional dunes. Occurs on sheet(s): 10"
"My120"
"Low dissected undulating plateaux on schist and gneiss with spurs, ridges, and mesas; some with laterite cappings: chief soils are neutral red earths (Gn2.12) often containing ironstone gravels. Associated are (Dr1) soils, such as (Dr1.33) on pediments; (Um5.11) and (Gc) soils on calcrete platforms; some shallow stony soils (Uc1.3) and (Uc1.4) with rock outcrop on areas of strong relief; (Gn2.13, Gn2.12) in main valleys; and (Dr1) soils in gilgai complex with (Ug5.3) soils in some side valleys. Occurs on sheet(s): 10"
"My121"
"Plains with occasional low granitic hills: chief soils are neutral and acid red earths (Gn2.12, Gn2.11) with red earthy sands (Uc5.21). There are shallow (Uc) soils and rock outcrop on the hills. Occurs on sheet(s): 10"
"My122"
"Undulating plains and pediments below low rises, ridges, and mesas on schist, gneiss, and granite: chief soils are neutral red earths (Gn2.12) and crusty loamy soils (Dr1.33) and (Dr1.43), some with stone and gravel pavements and with gilgai depressions of (Ug5.3) soils. There are some shallow stony (Uc) soils and ironstone gravel cappings in areas of strong relief. Occurs on sheet(s): 10"
"My123"
"Hills and ridges with undulating valleys on porphyry and basic rocks: chief soils of the undulating areas are neutral red earths (Gn2.12), while shallow stony (Uc) and (Um) soils with rock outcrop and some laterite duricrust occur on the hills and ridges. Occurs on sheet(s): 10"
"My124"

"Undulating plains with some strike ridges and small mesas: dominant soils are neutral red earths (Gn2.12). Associated are a variety of soils including (Uc5.21) on the plains; stony (Uc1.4) and some (Dr1.33) soils on ridges and mesas; (Ug5) and yellow (Gn2) soils in pans and swamps; and some (Uc1.3) and (Um5.11) soils on calcrete platforms. Occurs on sheet(s): 10"
"My125"
"Flood-out plains, levees, and sand banks: chief soils are probably neutral red earths (Gn2.12) and red earthy sands (Uc5.21). Associated are a variety of soils including (Dr1.43), (Db2.32), (Gn2.52), and (Gn2.6) on flood-plain areas; (Ug5.3) and (Ug5.2) in depressions; and (Uc) soils on levees and sand banks. Occurs on sheet(s): 10"
"My126"
"Gently undulating sandy plain with some limestone ridges: dominant soils are sandy neutral red earths (Gn2.12). Other soils include (Ug5.3) and (Ug5.2) in depressions; and (Uc1.3), (Um5.11), and (Gc) soils on the ridges. Small areas of units II13 and Lh2 are included. Occurs on sheet(s): 10"
"My127"
"Gently undulating sandy plains: chief soils are neutral red earths (Gn2.12) and red earthy sands (Uc5.21). Other soils are likely also. Occurs on sheet(s): 10"
"My128"
"Sandy plains: chief soils are neutral and alkaline red earths (Gn2.12, Gn2.13) with (Uc5.21). There are scattered limestone ridges of unit BA42 in the western portion and unit Fd1 in the eastern portion. Occurs on sheet(s): 10"
"My129"
"Sandy plains and low ridges: chief soils are neutral and alkaline red earths (Gn2.12, Gn2.13) with (Uc5.21) and low ridges of unit Ld2. Occurs on sheet(s): 10"
"My130"
"Plains and ridges: chief soils are probably neutral and alkaline red earths (Gn2.12, Gn2.13). Associated soils include (Dr2.33) and (Dr1.33) flanking the ridges which are similar to unit Fz33; (Uc5.21) on the plains; and occasional dunes of (Uc1.23). Occurs on sheet(s): 10"
"My131"
"Plains with some mesas and buttes: chief soils are neutral red earths (Gn2.12) and red earthy sands (Uc5.21). Associated are mesas and buttes of unit Fc2 and small hilly areas similar to unit BA43. Other soils include (Dr) soils on pediments of the mesas and (Uc1.23) on dunes. Occurs on sheet(s): 10"
"My132"
"Level or gently undulating plains: dominant soils are deep loamy red earths (Gn2.12, Gn2.11, and Gn2.15), sometimes with gravel on the surface and in the profile. Associated at the margins of the unit are occasional gravelly-surfaced loamy red duplex soils (Dr2.13), (Dr2.43), and (Dr2.12). Occurs on sheet(s): 10"
"My133"
"Gently undulating plains with occasional small undulating areas with rock outcrop: dominant soils are loamy red earths (Gn2.12, Gn2.11). Associated are gravelly-surfaced duplex soils (Dr2.13), (Dr2.43), and (Db1.13). On the undulating areas are shallow sands (Uc4.12), (Uc5.21), and (Uc1.23) and sandy red earths (Gn2.11, Gn2.12). Data are very limited. Occurs on sheet(s): 10"
"My134"
"Narrow alluvial plains with numerous braided channels and low stream levees: dominant soils are deep loamy or fine sandy red earths (Gn2.12), with associated deep brown earths (Gn2.42) and deep sands (Uc5.21). On the back slopes of levees loamy red duplex soils (Dr2.43), (Dr2.13), and (Dr2.33) may occur. Data are limited. Occurs on sheet(s): 10"
"My135"
"Gently undulating alluvial plains and outwash fans; dominant soils are sandy or loamy red earths (Gn2.12, Gn2.13), with associated brown earths (Gn2.42, Gn2.43) and lesser yellow earths (Gn2.62). Gravel-strewn loamy red duplex soils (Dr2.12, Dr2.13) are associated on the outwash fans. Occurs on sheet(s): 10"
"My136"
"Gently undulating to undulating lands with occasional rock outcrop: dominant soils are moderately deep loamy red earths (Gn2.12, Gn2.15), with lesser loamy or sandy (Gn2.41) and (Gn2.13) soils. Associated are gravelly-surfaced loamy red duplex soils (Dr2.12, Dr2.13) that may be locally dominant. Near outcrops are shallow gravelly loams (Um5.51) and (Um1.43). Occurs on sheet(s): 10"
"My137"
"Gently undulating plains: dominant soils are deep loamy red earths (Gn2.12) with occasional (Gn2.11); quartz gravel may occur throughout the profile. Associated in some lower sites are loamy red duplex soils (Dr2.13) and (Dr2.43). Loamy red earths (Gn2.13, Gn2.12), with lesser similar (Gn2.4) soils, occur on stream levees. Occurs on sheet(s): 10"
"My138"

"Gently undulating outwash slopes and plains: dominant soils are deep loamy or sandy red earths (Gn2.12), with lesser (Gn2.11); usually there is quartz gravel throughout the profile. Associated are deep brown earths (Gn2.42) and deep red-brown or brown sands (Uc5.21). Occurs on sheet(s): 10"
"My139"
"Gently undulating plains: dominant soils are deep loamy red earths (Gn2.12, Gn2.11), with associated gravellysurfaced loamy red duplex soils (Dr2.13), (Dr2.43), and (Dr2.12) and similar (Db) soils. Small areas of deep cracking clays (Ug5.24, Ug5.25) and (Ug5.34, Ug5.38) also occur. Stream levee soils are deep loamy or fine sandy red earths (Gn2.13, Gn2.12). Occurs on sheet(s): 10"
"My140"
"Very gently undulating to undulating lands with some sandstone outcrop adjacent to major streams: dominant soils are deep loamy or occasionally sandy red earths (Gn2.12), with occasional acid and alkaline forms (Gn2.11, Gn2.13). Loamy duplex soils (Dr2.33) and (Dy2.33) and deep cracking clays (Ug5.38, Ug5.34) occur in lower sites and in drainage lines. Shallow gravelly sands (Uc1.41, Uc1.43) and (Uc5.11) occur adjacent to rock outcrop. Occurs on sheet(s): 10"
"My141"
"Very gently undulating plains with occasional low mesas; in parts of the unit low relict sand dunes occur: dominant soils of the plains are loamy or occasionally deep sandy red earths (Gn2.12) with lesser (Gn2.11). Small areas of loamy red duplex soils (Dr2.33, Dr2.32) occur adjacent to drainage lines. The low mesas have shallow stony loams (Um1.43) and (Um5.51), together with similar (K-Um) soils. The relict sand dunes have deep red sands (Uc1.23). Data are limited. Occurs on sheet(s): 10"
"My142"
"Gently undulating plains with occasional low stony ridges and some silcrete boulders; some areas are gravelcovered: dominant soils are neutral red earths (Gn2.12). Associated with them are (Um5.51) and (Gn2.13) soils; while (Dr2.33) soils with some (Ug5.3) soils occur on slopes and in flats slightly depressed below the general level. As mapped, areas of unit Fa46 may be included. Red-brown hardpan may sometimes occur, especially in the western areas of the unit. Occurs on sheet(s): 10"
"My143"
"Sandy and, less commonly, gravel-covered plains of neutral red earths (Gn2.12) and possibly earthy sands (Uc5.21) interspersed with open treeless areas and clay pans of grey cracking clays (Ug5.2) and, less commonly, brown cracking clays (Ug5.3). Associated are small areas of other soils, including (Gn2.2) marginal to the (Ug5) clay plains and sandy (Dy) soils, such as (Dy5.22), on some small creek flood-plains where a variety of soils occur. There are occasional small dunes, possibly of (Uc5.21) soils, but (Uc1.23) may occur also. Occurs on sheet(s): 10"
"My144"
"Sandy plains with scattered longitudinal sand dunes: chief soils are sandy neutral red earths (Gn2.12). Associated are probably (Uc5.21) soils, with (Uc1.23) sands on the dunes. Occurs on sheet(s): 10"
"My145"
"Similar to unit My144 but with extensive clay pans, clay plains, and corridors of grey cracking clays (Ug5.2) and some (Ug5.5) which may be dominant locally. Occurs on sheet(s): 10"
"My146"
"Sandy plains: dominant soils are deep sandy neutral red earths (Gn2.12). Some red earthy sands (Uc5.21) may be associated on the plains and occasional low dunes. Occurs on sheet(s): 10"
"My147"
"Sandy plains with low dunes and numerous small clay pans: chief soils are sandy neutral red earths (Gn2.12). Associated are grey cracking clays (Ug5.2) and (Ug5.5) in the clay pans. Other soils including (Uc5.21) may occur on the sandy plains and dunes where (Uc1.23) sands may be present also. Occurs on sheet(s): 10"
"My148"
"Gently undulating plains with some low stony ridges and silcrete boulder areas; there is a light gravel cover: chief soils are neutral red earths (Gn2.12), sometimes underlain by red-brown hardpan and (Um5.3) loams. Associated are (Um5.51) soils on some silcrete boulder areas, and (Dr2.33) soils sometimes underlain by redbrown hardpan on pediments and flats. Other soils may occur. Occurs on sheet(s): 10"
"My149"
"Gently undulating plains with clay pans (often numerous) and lakes; occasional sand dunes: chief soils are probably sandy neutral, and alkaline, red earths (Gn2.12, Gn2.13). Red-brown hardpan may occur below the (Gn2) soils in places. Associated are (Ug5.28) and (Ug5.5) clays of the clay pans. Other soils include (Dr2.52) and (Dr4.73) flanking the clay pans, and (Uc1.2) on dunes. Occurs on sheet(s): 10"
"My150"
"Plains with sand dunes and broken by small rough hilly areas of unit BA36: chief soils are probably neutral red earths (Gn2.12), with (Uc5.21). Associated are (Uc1.23) sands on the dunes. Occurs on sheet(s): 10"
"My151"

"Plains with some low scarps locally; some clay pans: chief soils are probably neutral red earths (Gn2.12). Other soils may include (Ug5.5) in clay pans and shallow stony soils (Uc) on scarps. Occurs on sheet(s): 10"
"My152"
"Plains with some short dunes; occasional rock outcrop; laterite and silcrete remnants; some ironstone gravel pavements: chief soils are neutral red earths (Gn2.12) and red earthy sands (Uc5.21) underlain at least in part by red-brown hardpan, especially adjoining unit Nb27. Other soils may occur. Occurs on sheet(s): 10"
"My153"
"Broad valley plains and pediments with isolated granitic rock outcrops: chief soils are neutral red earths (Gn2.12) with a scatter of surface gravels. Associated are (Uc5.21) soils near granite outcrops and (Um5.3) soils on pediments. Red-brown hardpan occurs frequently below the soils. Occurs on sheet(s): 10"
"My154"
"Undulating country on acid volcanic rocks and sedimentary materials: chief soils are probably neutral red earths (Gn2.12) with a variable content of ironstone gravel. Other soils, such as (Gn2.13) and (Gc) soils, may occur also. Occurs on sheet(s): 10"
"Mz1"
"Gently undulating to hilly: three groups of soils are common--red earths (Gn2.11 and Gn2.12); hard red soils (Dr2.21, Dr2.22, and Dr2.33); and red friable earths (Gn3.12 and Gn3.13). Dominance varies locally and is not well known. As mapped, areas of soils common to units Ms1, Ke9, and Mo5 are included. Occurs on sheet(s): 3"
"Mz2"
"Flat to gently undulating (?terrace remnants): red earths (Gn2.11 and Gn2.12) on flat to gently undulating areas. Associated are red friable earths (Gn3.12 and Gn3.13) in the vicinity of basalt-strewn ridges and knolls some of which have cracking clays such as (Ug5.32) on their crests and slopes; some (Dr2.33) soils; and some low gravelly hillocks of unit Ms1 soils. Occurs on sheet(s): 3"
"Mz3"
"Undulating lands with occasional low lateritic scarps: dominant soils are loamy slightly acid deep red earths (Gn2.11). Some similar sandy red earths also occur; higher marginal slopes may also have deep sandy duplex soils (Dy5.41) and (Dy5.81), and the low lateritic scarps have shallow gravelly loams (Um1.43). Some valley floors may have small flood-plains of deep dark clays (Ug5.15) derived from an adjacent unit (Kb11). Occurs on sheet(s): 4"
"Mz4"
"Narrow low hilly cuesta-like range: dominant soils are sandy or loamy red earths (Gn2.11) with some yellow earths (Gn2.21) on flatter crests. Shallow stony loams (Um1.43) are closely associated, particularly with scarps. The marginal lower dip slopes often have deep sands (Uc1.21) and (Uc2.22) and sandy-surfaced mottled duplex soils (Dy5.41) and (Dy3.42). Occurs on sheet(s): 4"
"Mz5"
"Undulating to gently undulating elevated plains often bounded by steep lateritic scarps, smaller residual occurrences of the unit often occur as scarp-bordered low mesas: dominant soils are slightly acid loamy red earths (Gn2.11) which may occasionally contain nodular gravels. Associated are smaller areas of loamy yellow earths (Gn2.21, Gn2.22, Gn2.24, and Gn2.64) containing nodular gravels. The lateritic scarps have a range of shallow stony soils, chiefly (Um1.43), (Dy3.41), (Dy3.42), (Dr3.41), and occasionally (Uc2.12). Some flat ridge tops have (Dy2.43) soils with acid clays below 30 in. In broad valley floors and on some lower slopes loamy mottled duplex soils (Dy3.42 and Dy3.43) occur. Small stream flood-plains also have loamy duplex soils (Dy2.43). Occurs on sheet(s): 4"
"Mz6"
"Undulating or very gently undulating plains: dominant soils are loamy red earths (Gn2.11 and Gn2.12) with slightly smaller areas of yellow earths (Gn2.21 and Gn2.22). In some yellow earth areas a sink-hole gilgai microrelief may be associated--the puffs and flatter areas have loamy-surfaced duplex soils (Db1.13) and (Dy3.13) while in deeper depressions rusty-mottled clays (Ug5.24) occur. Occurs on sheet(s): 4"
"Mz7"
"Rolling country with broad rounded rises passing into low hilly terrain in places: chief soils are red earths (Gn2.11). Associated are (Dy3.41) soils with some lateritic gravels on mid to lower slopes, and some (Dr2.21) soils on mid slopes. Minor soil occurrences include (Dy2.21) and (Db1.13) on slopes above the adjoining plains, and (Gn2.24) containing lateritic gravels on upper slopes. Occurs on sheet(s): 4"
"Mz8"
"Plateaux with a rolling to low hilly surface, some minor scarps; dissected steep slopes around margins of the plateaux: chief soils are red earths (Gn2.11, Gn2.12, and Gn2.14) with sandy to loamy surfaces; some are snuffy and some contain much lateritic gravel. In places smooth-faced pedal clays occur at depth below the red earths. Associated are (Gn3.11) soils on gully slopes under softwood, and (Dy3.41) and (Dy5.81) also on dissection slopes. Small areas of other soils include (Dr2.41), (Gn3.74), (Um4.1) (Um2.12), and (Gn3.91). Occurs on sheet(s): 4"
"Mz9"

"Low to moderately hilly terrain with prominent mesas showing well-defined scarps--the partially stripped and dissected remnants of unit Mz8: chief soils are snuffy and ironstone gravelly red earths (Gn2.11, Gn2.12, and Gn2.14) on mesa tops and gentle colluvial slopes. Associated are (Dy3.41) and (Dr2.41) soils below scarps and on gentle slopes, and gravelly (Um2.12) soils on stripped rounded crests. Minor soils include (Dy3.43) on lower slopes, (Gn3.91) in depressions, and (Gn3.94) on upper slopes. Occurs on sheet(s): 4"
"Mz10"
"Low hilly lands with a high proportion of large (lateritic) mesas which are in part defined by scarps; some rougher hills with rock outcrops in dissected areas bordering the mesas: chief soils are deep snuffy red earths (Gn2.11), some containing lateritic nodules and gravels. Associated are (Um6.13) soils containing lateritic material on the crests of some mesas, (Gn3.11) soils in valleys bordering the mesas, and (Ug5.14) and (Gn3.43) soils on dissection slopes. Minor soil occurrences include (Um2.12) on stony crests with outcrops, and (Dr2.4) soils on dissection slopes. Occurs on sheet(s): 4"
"Mz11"
"Low hilly upland of broad gently sloping ridges and short moderate to gentle slopes grading to almost rolling terrain: chief soils are red earths (Gn2.11 and Gn2.14) on gently sloping broad crests. Associated are (Dr2.41) and other (Dr) soils with (Dy3.41) and (Dy2.41) on dissection slopes, (Dy3.43) and (Ug5.15) on lower slopes and flats, and (Ug5.24) and (Gn3.43) on broad rises and knolls slightly below the (Gn2.1) soil areas. Occurs on sheet(s): 4"
"Mz12"
"Dissected (?basaltic) plateau with rolling surface and clay laterite scarps; 1500-1700 ft above sea level: chief soils are snuffy red earths (Gn2.11). Associated are shallow gravelly (Gn2.11) soils on scarps and upper slopes, and some (Gn3.11) on the upper slopes. Occurs on sheet(s): 4"
"Mz13"
"Level or very gently undulating plains, occasionally with scarped margins: dominant soils are slightly acid deep sandy red earths (Gn2.11), occasionally (Gn2.12). Associated are sandy yellow earths (Gn2.21), mostly with a nodular ironstone layer at moderate depths, and red and yellow earthy sands (Uc5.21 and Uc5.22). As mapped, smaller areas of similar loamy red and yellow earths are also included. Occurs on sheet(s): 4"
"Mz14"
"Alluvial fan plain with many old slightly elevated (2-3 ft) sand-filled channels: dominant soils are deep slightly acid sandy red earths (Gn2.11), with lesser (Gn2.12). The sand-filled channels have deep sands (Uc1.23 and Uc1.22) and deep earthy sands (Uc5.21 and Uc5.22). Also occurring in the association are small areas of sandy yellow earths (Gn2.21 and Gn2.22). Occurs on sheet(s): 4"
"Mz15"
"Undulating to gently undulating lands with some high ridges and occasional low lateritic scarps. A complex array of soils is present, depending mainly on landscape position. The dominant soils, which tend to occur on higher landscape sites, are loamy red earths (Gn2.11), which often contain an ironstone nodule horizon. Also occurring on upper slopes are loamy yellow earths (Gn2.22), associated with other earths (Gn2.84) and (Gn2.64). Lower slopes and valley floors mostly have loamy duplex soils (Dy3.42 and Dy3.43), with lesser (Dy2.43 and Dy2.42). On some high non-lateritic ridge crests sandy to loamy acid duplex soils (Dy3.41) occur, associated with lesser (Dy5.41) and (Dy5.81). The low lateritic scarps have shallow stony soils (Um1.41) and (Uc2.12). Occurs on sheet(s): 4"
"Mz16"
"Very gently undulating plains: dominant soils are slightly acid deep loamy or rarely sandy red earths (Gn2.11), with lesser (Gn2.12). Associated are slightly higher rises or dissected marginal slopes with mostly sandy yellow earths (Gn2.21 and Gn2.24), which commonly have a prominent nodular ironstone horizon by 30 in. or less. Loamy yellow earths occur in some broad drainage depressions together with smaller areas of loamy duplex soils (Dy3.42). Occurs on sheet(s): 4,7"
"Mz17"
"Undulating lands with occasional lateritic scarps and low mesas: dominant soils are slightly acid loamy red earths (Gn2.11) which often contain many ironstone nodules at depth. Associated are neutral loamy red earths (Gn2.12), and lesser loamy yellow earths (Gn2.22 and Gn2.25). The soils of the scarps and mesas are loamy red earths (Gn2.12) on the more extensive surfaces, elsewhere shallow stony loams (Um1.43) and (Um4.1) are common. On scarp slopes and in local depressions loamy duplex soils (Dy3.43) and (Dy2.43) occur. Marginally the unit may grade into or be closely associated with red and brown cracking clays (Ug5.38) and (Ug5.34), which have slight to moderate gilgai microrelief. Occurs on sheet(s): 4"
"Mz18"
"Gently undulating plateau surface, often bounded by steep lateritic scarps where marginally dissected: dominant soils are deep slightly acid loamy red earths (Gn2.11), with some small marginal areas of loamy yellow earths (Gn2.21). The marginal lateritic scarps have shallow red earths (Gn2.11) and stony loams (Um1.43) and (Um4.1), also less commonly (Uc2.12). Elsewhere the margins of the unit have the sands of unit Bz9. Small dissected mesa remnants are also included in the unit. Occurs on sheet(s): 4"
"Mz19"

"Gently undulating elevated plains: dominant soils are deep slightly acid sandy or occasionally loamy red earths (Gn2.11). On the marginal slopes sandy or loamy duplex soils (Dy5.42) and (Dy3.42) occur, together with small areas of red duplex soils (Dr2.12) from the adjacent unit Qa14. Occurs on sheet(s): 4"
"Mz20"
"Tilted and dissected plateau remnants (cuesta forms) with steep scarp slopes: chief soils of the gently sloping plateau tops are red earths (Gn2.11) and/or (Gn2.14). Associated are (Um2.12) and (Um4.1) soils on the steeper slopes with (Um6.21), (Gn3.12), and other (Um6) soils on the more basic rocks. Minor soil occurrences include (Dr2.21), (Dy2.42), and (Ug5.14). As mapped, small areas of unit CC23 may be included. Occurs on sheet(s): 4"
"Mz21"
"Smooth low hilly terrain at low elevation: chief soils are very deep acid sandy red earths (Gn2.11) on broad crests and gentle slopes with minor areas of (Gn2.22) soils. Associated are (Dy2.41), (Dy3.41), (Dy3.42), (Dy2.43), and (Dy3.43) soils with some ironstone gravels on lower slopes and low sites generally. Minor soil occurrences include (Dr3.61) and (Uc4.1). Occurs on sheet(s): 4"
"Mz22"
"Broad plains with few gentle undulations and some small breakaways near drainage lines; there is a variable cover of surface gravels: chief soils appear to be acid red earths (Gn2.11) overlying red-brown hardpan with shallow loamy soils (Um5.3) on hardpan which may outcrop. As mapped, there may be inclusions of unit AB18. Occurs on sheet(s): 6"
"Mz23"
"Extensive flat and gently sloping plains with a scatter of surface gravels, similar in topography to unit My5O: chief soils are shallow acid red earths (Gn2.11) and shallow earthy loams (Um5.3) often occurring in intimate microassociation. Red-brown hardpan occasionally outcrops and is normally present within a depth of 30 in. As mapped, soils of units Oc47 and My5O may be included. Occurs on sheet(s): 6"
"Mz24"
"Extensive plains similar to unit Mz23 of Sheet 6 but with small sand ridges: chief soils are acid red earths (Gn2.11), with other (Gn) and (Um) soils of adjoining units. Soils of the sand ridges are (Uc1.23) and (Uc5.21). Red-brown hardpan occurs at greater depth than in surrounding units. Occurs on sheet(s): 6,10"
"Mz25"
"Plains associated with the Fortescue valley; there is a surface cover of stony gravels close to the ranges and hills: chief soils are acid red earths (Gn2.11) with some neutral red earths (Gn2.12); red-brown hardpan is absent. Associated are areas of calcareous earths (Gc) and loams (Um1) on calcrete (kunkar) and some hard red (Dr) soils around creek lines. Occurs on sheet(s): 6,10"
"Mz26"
"Plains formed on weathered granitic rocks: main soils are gritty red earths (Gn2.11). Associated soils are gritty sands (Uc4.21). Occurs on sheet(s): 9"
"Mz27"
"Rocky plateaux and ridges, with some broad valley floors, developed on quartzite, sandstone, and shale: main soils are shallow red earths (Gn2.11) developed on the lower slopes. Other soils are ironstone gravels (KS-Uc4.2) on residuals with much rock outcrop on upper slopes, and eroded hard red soils (Dr2.82) and (Dr2.32) on valley floors. Occurs on sheet(s): 9"
"Mz28"
"Stable flood-plains flanking active flood-plains: main soils are acid red earths (Gn2.11) with much ferruginous gravel on their surfaces. Associated soils are (Dr2.33). There are minor areas of red sand (Uc1.23). Occurs on sheet(s): 9"
"Mz29"
"Elevated undulating plateaux with stepped marginal slopes or steep scarped margins: dominant soils are deep loamy or occasionally sandy red earths (Gn2.11) that may have ironstone nodules in the profile. Near the margins massive nodular laterite often occurs. Marginal to the red earths and in lower sites are small areas of very gravelly nodular loamy yellow earths (Gn2.21), and shallow gravelly sands (Uc4.2) and loams (Um4.2) with some sandstone outcrop. Deep loamy duplex soils (Dy3.43) occur in local depressions. Occurs on sheet(s): 7,10"
"Mz30"
"Undulating low plateau, occasionally with low scarped margins: dominant soils are loamy, or occasionally sandy, red earths (Gn2.11), less commonly (Gn2.14), or yellow earths (Gn2.21). The soils are often strongly nodular at depth. Closely associated marginally in areas of lower relief are extremely nodular or gravelly bleached sands (Uc2.21, Uc2.22); the ironstone nodules may be cemented to form massive nodular laterite. Near the dissected margins other sands occur, chiefly (Uc4.11) and (Uc1.23) overlying sandstone at shallow depths. Some associated larger streams have levees with loamy red earths (Gn2.15) or fine sands (Uc4.2). Occurs on sheet(s): 7"
"Mz31"
"Low hilly to hilly lands with very occasional conical basalt peaks: dominant soils are moderately deep to deep loamy red earths (Gn2.11, Gn2.14), but are closely associated with similar red friable earths (Gn3.11, Gn3.14) and

friable red loamy duplex soils (Dr4.11). Shallow stony loams and clays (Um6.33, Um6.31), and (Uf6.33) occur adjacent to rock outcrop and on flow scarps. Deep cracking clays (Ug5.14, Ug5.16) are common on the lower slopes and drainage lines. Occurs on sheet(s): 7"
"Mz32"
"Undulating lands with occasional low sandstone mesas or high ridges: dominant soils are sandy red earths (Gn2.11), with associated (Gn2.14). On lower slopes deep sands (Uc4.21) and (Uc2.21) occur, and occasionally sandy yellow earths (Gn2.24) and bleached grey earths (Gn2.94). Shallow sands or grey earths (Gn2.84) occur on the low sandstone mesas. Data are limited. Occurs on sheet(s): 7"
"Mz33"
"Low hilly dissected sandstone plateaux with undulating outwash fans: dominant soils are moderately deep loamy or sandy red earths (Gn2.11), with shallower gravelly red earthy sands (Uc5.21) occurring on more dissected areas. Occasional higher sandstone mesas have shallower bleached sands (Uc2.21) of unit Ca35. The undulating outwash fans have deep sandy red earths (Gn2.11, Gn2.14), sandy mottled yellow earths (Gn2.64) and (Gn2.74), and areas of deep bleached sands (Uc2.21) on lower slopes and in broad drainage depressions. Data are fairly limited. Occurs on sheet(s): 7"
"Mz34"
"Gently undulating plains: dominant soils are moderately deep to deep loamy red earths (Gn2.11, Gn2.12), occasionally with gravel and ironstone nodules throughout the profile. Associated soils, usually in lower sites, are gravelly-surfaced loamy red duplex soils (Dr2.12, Dr2.13). Small areas of deep grey-brown cracking clays (Ug5.24, Ug5.25) with associated loamy-surfaced duplex soils (Db1.33), (Dy2.33), (Db1.13), and (Dy2.13) also occur. Occurs on sheet(s): 7,10"
"Mz35"
"Moderately to strongly undulating lands with some low scarped hills; ferruginous sandstone or massive nodular laterite outcrop may be common: dominant soils are nodular and often gravelly loamy or occasionally sandy red earths (Gn2.11), with (Gn2.14) also occurring. Similar loamy yellow earths (Gn2.21, Gn2.24) are common on lower slopes. On more extensive undulating low plateaux there are small areas of loamy red friable earths (Gn3.11). In small drainage depressions throughout the unit deep bleached sands of unit Ca43 are common. Occurs on sheet(s): 7"
"Mz36"
"Pediments with some steep hills on granites; granitic residuals; bosses and tors: chief soils are acid red earths (Gn2.11) overlying a red-brown hardpan. Other soils include (Uc5.11) and (Dr2.32). Occurs on sheet(s): 10"
"Mz37"
"Gently undulating to undulating lands with occasional rock outcrop: dominant soils are shallow to moderately deep gravelly loamy red earths (Gn2.11, Gn2.12). Closely associated are shallow nodular loams (Um5.51) overlying a compact ironstone nodule horizon. Other associated soils are gravelly-surfaced shallow red duplex soils (Dr2.13, Dr2.12), (Dr2.43), and (Dr3.42). In lower sites are small areas of deep grey cracking clays (Ug5.24, Ug5.25) and loamy duplex soils (Db1.13), (Dy2.13), (Db1.33), and (Dy2.33). Occurs on sheet(s): 10"
"Mz38"
"Gently undulating to undulating lands with some steeper gravelly rises: dominant soils are loamy red earths (Gn2.11, Gn2.12), sometimes with gravel throughout the profile. Associated are gravelly-surfaced loamy red duplex soils (Dr2.13), (Dr2.43), and (Dr3.43). On the rises are very gravelly loams (Um5.51) and occasional (Um1.43). Small areas of grey cracking clays (Ug5.24, Ug5.25), with associated loamy duplex soils (Dy2.13), (Db1.13), (Dy2.33), and (Db1.33), occur in lower sites. Loamy red earths (Gn2.12) occur on stream levees. Data are limited. Occurs on sheet(s): 10"
"Mz39"
"Gently undulating plains with many outwash fans and levees: dominant soils are loamy red earths (Gn2.11 Gn2.12), with lesser (Gn2.44) and (Gn2.15); some red earths are gravelly throughout the profile. Associated on slight rises are gravelly-surfaced loamy red duplex soils (Dr2.13). In lower sites near some drainage line~ are small areas of grey cracking clays (Ug5.24, Ug5.25) and loamy duplex soils (Dr2.13), (Db1.13). Occurs on sheet(s): 10"
"Mz40"
"Gently undulating to undulating plains with some granite tor outcrop: dominant soils are shallow to moderately deep sandy red earths (Gn2.11, Gn2.12). Associated soils are shallow loamy sands (Uc4.12), massive sandy red duplex soils (Dr2.83, Dr2.81) and (Dr2.53), and structured sandy red duplex soils (Dr2.13), (Dr2.43). (Dr3.13), and (Dr2.11). Near rock outcrop very shallow sands (Uc1.23, Uc1.21) occur. Occurs on sheet(s): 10"
"Mz41"
"Undulating lands with some areas of rock outcrop: dominant soils are shallow red earths (Gn2.11). Associated are gravelly-surfaced shallow red duplex soils (Dr2.12, Dr2.13) and shallow gravelly loams (Um5.51). Occurs on sheet(s): 10"
"Mz42"

"Level to very gently undulating plains with low lateritic scarp margins: dominant soils are moderately deep to deep loamy red earths (Gn2.11, Gn2.12). Occasional similar yellow earths (Gn2.21, Gn2.22) occur in slightly depressed areas. Shallow gravelly loams (Um5.51) and (Um1.43, Um1.41) occur adjacent to the scarped margins and on low rises with lateritic outcrop. Loamy red duplex soils (Dr2.33), (Dr2.13) occur at the margins of the unit adjoining the clay plains of units MM35, MM33, and similar units. Occurs on sheet(s): 10"
"Mz43"
"Broadly undulating lands with long slopes and low stony rises, occasional eroded mesa remnants occur: dominant soils are loamy red earths (Gn2.11), with lesser (Gn2.12). On lower slopes and adjacent to drainage lines loamy red duplex soils (Dr2.32, Dr2.33) and (Dr2.13) occur, and occasionally red cracking clays (Ug5.38). On the gravel-strewn rises the soils are shallow stony loams (Um1.43), (Um5.51), and similar (K-Um) soils. Similar soils occur on the mesa remnants. Occurs on sheet(s): 10"
"NN1"
"River flood-plains: relatively large and poorly drained, flat areas of deep dark cracking clays (Ug5.4) and (Ug5.16) with some melon-hole microrelief. Associated are friable yellow mottled soils (Dy5.1), and well-drained sandy levee soils (not described). As mapped, small islands of adjacent units are included. Occurs on sheet(s): 3"
"NN2"
"Level alluvial marine plains adjacent to tidal flats; the unit may be inundated for short periods by flood waters and partly by very high tides: dominant soils are massive heavy clays (Ug5.4) with closely associated (Ug5.5), (Uf6.41), (Uf6.42), (Uf6.32), and (Uf6.33); thin-surfaced loamy duplex soils (Dd2.13) and (Dd2.33); and similar (Dd1) and (Dy2) soils. Small areas of self-mulching clays (Ug5.16) and (Ug5.24) occur in lower sites and in slight gilgai depressions. At their coastal margins the marine plains merge into salt pans with (Uf6.61) and other undescribed saline soils. These also occur adjacent to the many small tidal channels that dissect the marine plains. At the inland margins the unit grades to loamy duplex soils (Dy3.43). Occurs on sheet(s): 4"
"NN3"
"Seasonally flooded coastal plains, rarely showing weak (< 6 in.) gilgai development, and underlain by estuarine clays and muds, some of which may be calcareous: chief soils are non-self-mulching dark and grey cracking clays (Ug5.4)* and (Ug5.5)*, often with calcareous concretions in some part of the profile, and/or containing gypsum, and/or gleyed at depth. Other cracking clays, such as (Ug5.29)~, having a thin self-mulching surface (~ 1 in. thick), occur as small puffy areas. There are also some small patches with powdery dark surfaces. The clays and muds below the solum of the soil are layered and of variable permeability. Small areas of units NN4 and Jw1 may be included. Occurs on sheet(s): 8"
"NN4"
"Swampy depressions marginal to the seasonally flooded coastal plain; underlain by estuarine clays and muds: chief soils are dark non-self-mulching cracking clays (Ug5.4)* in association with grey cracking clays (Ug5.28)* and other soils such as (Dd1.11), both of which have moderately organic or peaty surface horizons, while plastic clays such as (Uf6.61) may occur in locally wet situations. Small areas of unit NN3 may be included. Occurs on sheet(s): 8"
"NN5"
"Seasonally flooded coastal plains, considerable portions of which remain wet well into the dry season: chief soils are non-self-mulching dark and grey cracking clays (Ug5.4 and Ug5.5)*, often with calcareous concretions in some part of the profile and/or containing gypsum and/or gleyed at depth. Fairly large wet swampy areas of plastic clays probably including (Uf6.4), (Uf6.5), and (Uf6.6) may be associated as well as the other soils of units NN3 and NN4. As mapped, areas of units NN3, NN4, and Jwl may be included. Occurs on sheet(s): 8"
"NV1"
"Flat to gently undulating coastal plain generally with ill-defined drainage lines but there are some entrenched creeks with terraces: chief soils are acidic leached gley soils (Dg2.41) on the extensive tea-tree flats. Associated are (Uc2.2) and (Uc2.3) soils on the flats with (Dy3.41) soils on low rises and higher flat areas. Minor soil occurrences include (Gn2.94 and Gn2.95) in clay depressions, (Uc2.22) on terraces; and gravelly (Gn2.14) over clay D horizons. Small areas of unit Wa20 are included. Occurs on sheet(s): 4"
"NV2"
"Gently undulating alluvial plains: dominant are deep sandy gleyed duplex soils (Dg2.41), with similar mottled grey duplex soils (Dy3.41, Dy3.42) and (Dy3.21) associated; these are more common in the southern extent of the unit. Adjacent to some streams are small lower plains with deep grey-brown friable earths (Gn3.91). Also occurring are small sandy outwash fans with deep bleached sands (Uc2.32) or sandy bleached grey earths (Gn2.94). Near the adjoining granite hills are low ridges with sandy red earths (Gn2.14) and shallow sands (Uc4.22). At the coastal margin the unit grades into mangrove swamps. Occurs on sheet(s): 7"
"NX1"
"Flat to very gently sloping coastal plain with a few low dunes, tidal mud flat, and saline marshes (commonly less than 10 ft above sea level with some areas up to 25 ft above sea level): chief soils seem to be saline gley soils (Dg2.63) and saline grey muds and clays (Um) and (Uf) on the mangrove mud flats. Associated are (Dg2.42) and

(Gn3.95) soils in saline marshes and (Uc1.23) and (Uc2.23) soils on the low dunes. Data are very limited and practically restricted to the marginal areas of the unit. As mapped, small areas of unit Z6 may be included. Occurs on sheet(s): 4"
"NY1"
"Coastal plains, generally low lying, poorly drained, and subject to flooding (lower and middle reaches of river flood-plains, swamps, estuarine areas, and tidal marshes): chief soils seem to be friable acidic gley soils (Dg4.11), (Dg4.41), and (Dg4.81); friable acidic yellow mottled soils (Dy5.11); leached sand soils (Uc2.2) and/or (Uc2.3); and sandy acidic yellow mottled soils (Dy5.61), (Dy5.41), and (Dy5.81) in a complex and not well-known pattern, generally as follows: (i) flat to gently sloping areas of (Dg4.11), (Dg4.41), and (Dg4.81) or (Dy5.11), and/or (Ug5.16) and (Ug5.4), with some (Dd3.11) and (Uf6.41); (ii) sandy flats and swamps of (Uc2.2), and/or (Uc2.3), and/or acid peats (O); and (iii) slightly raised sandy areas of (Dy5.61), (Dy5.41), and (Dy5.81) with (Uc2.2) and (Uc4.2). Small areas of units NY2 (Sheet 3) and B9 are included. Occurs on sheet(s): 3,4"
"NY2"
"River flood-plains and coastal plains similar to unit NY1 but with a higher proportion of better-drained land: chief soils of the flats and gently sloping areas are friable acidic gley soils (Dg4.11, Dg4.41, and Dg4.81) and/or friable acidic yellow mottled soils (Dy5.11) and/or cracking clays (Ug5.16) and (Ug5.4) with other soils such as (Dd3.11) and (Uf6.41). Associated are narrow river valleys extending back into the hills and having slopes of (Dy5.61 and Dy5.81) and/or (Dy3.21 and Dy3.41) soils, small flood-plains of (Dg4) and (Dy5) soils, and terraces of (Um6.11) and other undescribed soils; and swamps and flats of leached sand soils (Uc2.2 and/or Uc2.3) towards the coast. Small areas of units Mg24 and Mf5 are included also. Soil pattern is complex and not well known. Occurs on sheet(s): 3"
"NY3"
"Coastal plains, lower and middle reaches of river flood-plains, swamps, estuarine areas, and tidal marshes, generally low-lying poorly drained areas subject to flooding: chief soils seem to be friable acidic gley soils (Dg4.11), (Dg4.41), and (Dg4.81); friable acidic yellow mottled soils (Dy5.11); and acidic grey friable earths (Gn3.91). Associated soils are (Dg2.41), (Dd3.11), and (Db4.11). This unit is similar to unit NY1 but the leached sands (Uc2) and other sandy-surfaced soils, such as (Dy5.61), are of very minor occurrence. Occurs on sheet(s): 4"
"NZ1"
"Undulating swampy sandstone plateau: chief soils are sandy acidic gley soils (Dg3.81) and (Dg4.41), and leached sands (Uc2.12). Associated are shallow forms of yellow earths, such as (Gn2.43, Gn2.21, and Gn2.24), often containing some ironstone gravels; and leached sands (Uc2.3) and open (treeless) areas of acid peats (O) underlain by sandy or clayey strata. Data are limited and soil dominance is doubtful. Movement of iron compounds evident in underlying rocks. The unit has some features comparable with those of units Sj2 and Mb5 (ii). Occurs on sheet(s): 3"
"NZ2"
"Shallow swampy flat valley floors at moderately high elevation: chief soils are sandy acidic gley soils (Dg3.81) and hard acidic gley soils (Dg2.81) and (Dg1.81). Associated are possibly some (Dy5.8) soils. As mapped, there are included areas of unit JZ2, particularly ironstone gravels (KS-Uc4) and leached sands (Uc2.2 and Uc2.3). Occurs on sheet(s): 5"
"Na1"
"Dissected tableland: undulating stony plains of crusty loamy soils (Dr1.13) and (Dr1.33), which may form gilgais and also gilgai complexes with cracking brown clays (Ug5.3); interspersed with mesas and buttes capped by shallow calcareous loamy soils (Um5.11) and/or residues of past weathering cycles such as remnants of sandstone, gypsum, silcrete, laterite, etc.; traversed by broad shallow valley plains of deep calcareous loamy soils (Um5.12) with saline flats, gypsum mounds, and swamps. Some brown sands (Uc5.1) and brown calcareous earths (Gc) may occur also. Occurs on sheet(s): 1,10"
"Na2"
"Plains: crusty loamy soils (Dr1.13 and Dr1.33) in association with grey-brown highly calcareous loamy earths (Gc1.12) and small areas of cracking brown clays (Ug5.3) which may form gilgais with the crusty loamy soils. Scattered pavements of stones. Occurs on sheet(s): 1,10"
"Na3"
"Plains with lakes and creek channels: crusty loamy soils (Dr1.13) and (Dr1.33), hard patches, in association with cracking brown clays (Ug5.3), soft patches; areas of brown calcareous earths (Gc); and yellow-grey clays (Ug5.2) in and around lakes, creek channels, and former drainage-ways. Occurs on sheet(s): 1,10"
"Na4"
"Undulating plains with low hillocks and remnants of dissected tablelands: crusty loamy soils (Dr1.13 and Dr1.33) with shallow calcareous loamy soils (Um5.11) on plains; rock outcrops and shallow calcareous loamy soils (Um5.11) on hillocks; grey-brown highly calcareous loamy earths (Gc1.12) on tableland remnants; deep calcareous loamy soils (Um5.12) in the creek valleys; and some sand dunes and drifts of brown sands (Uc5.1) close to valleys. Occurs on sheet(s): 1,10"

"Nb1"
"Plains: valley plains and terraces of crusty loamy soils (Dr1.33) with cracking brown clays (Ug5.3), gilgai features. Occurs on sheet(s): 1"
"Nb2"
"Plains: valley plains and terraces of crusty loamy soils (Dr1.33) with cracking brown clays (Ug5.3), gilgai features; smaller areas of grey-brown highly calcareous loamy earths (Gc1.12); small areas of saline grey clays (Ug5.2) and various alluvial soils (unclassified). Occurs on sheet(s): 1"
"Nb3"
"Plains--flat areas fringing drainage lines, sometimes dissected by stream channels; also small internal drainage basins and some low flat levee-type deposits associated with both functional and non-functional drainage lines: chief soils are crusty loamy soils (Dr1.33) and (Dr1.43) with some smaller areas of (Dy1.33), (Db0.33), and (Db1.33) and (Db1.43) soils. Associated are cracking clays (Ug5.2 and Ug5.3) in channels and depressed areas, and red earths (Gn2.13 and Gn2.12) on slightly higher ground. Most areas are strongly deflated by wind and to a lesser degree by water erosion. Occurs on sheet(s): 3,4,10"
"Nb4"
"Plains with numerous wind-deflated areas: chief soils are crusty loamy soils (Dr1.33), (Dr1.43), and (Dr1.13). Associated are slightly higher areas of sandy and loamy red earths (Gn2.13, Gn2.12) and other earths, such as (Gn2.83) and (Gn1), or occasional low sandy dunes (Uc1.23); and slightly lower-lying areas of cracking brown clays (Ug5.38, Ug5.34) and also cracking grey clays (Ug5.24). Occurs on sheet(s): 3,4,10"
"Nb5"
"Plains associated with major and minor drainage-ways, and characterized by numerous clay pans: chief soils are red and brown crusty loamy soils (Dr1.33 and Dr1.43) and (Db0.33 and Db0.43). Associated are slightly gilgaied (few inches) cracking grey and brown clays (Ug5.2, Ug5.5, and Ug5.3); dunes of unit B12. Generally similar to unit CC18 but clay pans and crusty loamy soils are more common. Occurs on sheet(s): 3"
"Nb6"
"Plain: slightly elevated plain of crusty loamy soils (Dr1.33) with a prominent stone pavement occurring between depressions of cracking brown clays (Ug5.38). As mapped, this unit includes small areas of unit Nb3 and red earths (Gn2.12). This unit is, in part, related to unit Na1 of Sheet 1. Occurs on sheet(s): 3,4"
"Nb7"
"Uneven and broken plains with gravel and stone pavements, scald patches, and clay pans and traversed by low narrow ridges and knolls of bare rock including shales, limestones, sandstones, and quartzites; some laterite and silcrete cappings: chief soils on the plains are crusty loamy soils (Dr1.33), (Dr1.43), and (Dr1.13) with hard loamy soils (Dr2.33)--calcretes may be associated with the (Dr) soils at shallow depth. Other soils include (Um1.43) on the ridges and knolls and possibly (Um5.11) on calcrete in narrow valleys. Occurs on sheet(s): 10"
"Nb8"
"Alluvial plains with sand banks and dunes, pans, channels, and scalded areas: chief soils are crusty loamy soils (Dr1.33), (Dr1.13), and (Dr1.43) with hard loamy soils (Dr2.33); some stone pavements occur. Other soils include (Uc1.23), (Uc5.13), and (Uc5.21) in sandy areas. Occurs on sheet(s): 10"
"Nb9"
"Undulating plains on granite and gneiss with occasional rocky hills: chief soils of the plains are crusty loamy soils (Dr1.33), (Dr1.13), and (Dr1.43, Dr1.42) mantled by a variable stone and gravel cover of quartz. Small areas of (Gn2.12), (Uc), and other soils occur. Occurs on sheet(s): 10"
"Nb10"
"Undulating stony plains on granite, schist, and gneiss with occasional rocky quartz ridges: chief soils are crusty loamy soils (Dr1.33), (Dr1.13), and (Dr1.43) with stone and gravel mantles. Associated are (Gn2.12, Gn2.13) and (Uc5.21) soils. Occurs on sheet(s): 10"
"Nb11"
"Undulating stony plains on schist and gneiss: chief soils are crusty loamy soils (Dr1.33), (Dr1.13), and (Dr1.43) with stone and gravel mantles. Associated soils include (Gn2.12) on the stony plains; (Gc), (Um5.11), and (Uc1.3) on calcrete platforms; and sandy (Gn2.12) and (Uc5.21) on alluvial areas. Occurs on sheet(s): 10"
"Nb12"
"Pediments and plains largely on sandstones, schist, and gneiss; some low mesas and buttes; some small flood-plains: chief soils are crusty loamy soils (Dr1.33) and (Dr1.13) with a variable stone and gravel mantle and with some gilgai depressions of (Ug5.38) soils. Other soils include shallow stony loams (Um1.43) and sands (Uc1.43) on the mesas and deep (Uc1.43) sands on the flood-plains. Occurs on sheet(s): 10"
"Nb13"
"Plains: dominant soils are crusty loamy soils ~Dr1.33), (Dr1.13), and (Dr1.43) with variable stone and gravel mantles and with some gilgai depressions of (Ug5.3) and (Ug5.5) soils. Associated soils are (Gn2.12, Gn2.13) and other, unclassified soils on levees, channels, pans, and sand banks. Occurs on sheet(s): 10"
"Nb14"

"Stony downs--undulating to rolling terrain covered with gravels and stones of silicified rock, and with mesas and buttes frequently composed of outcropping rock, often sandstone: chief soils are probably crusty loamy soils (Dr1.33, Dr1.32) and (Dr1.13, Dr1.12) although some (Dr2.33) soils may occur too. Associated are brown cracking clays (Ug5.37, Ug5.34) usually in gilgai microassociation with the (Dr) soils; but they may also be the dominant soils of included plains where the (Dr) soils are the associates. Occasionally transgressed by dunes of (Uc1.23) soils. Occurs on sheet(s): 10"
"Nb15"
"Stony undulating plains with widely spaced longitudinal sand dunes: chief soils are crusty loamy soils (Dr1.33, Dr1.32) and (Dr1.13, Dr1.12). Associated are brown cracking clays (Ug5.37, Ug5.34), often in gilgai microassociation with the (Dr) soils; and the (Uc1.23) sands of the dunes. Other soils may occur. Occurs on sheet(s): 10"
"Nb16"
"Stony downs--long undulating slopes with cuesta scarps, mesas, and buttes; block silcrete and sometimes laterite on breakaways; siliceous gravels and stones cover the surface; narrow valleys and small seasonally swampy clay pans occur; shallow sand drifts are common; there are also occasional sand dunes, deposits of gypsum (kopi), and gypsum dunes: the soil pattern is complex. The chief soils are crusty loamy soils (Dr1.33, Dr1.32), brown cracking clay (Ug5.3) often in gilgai association with the (Dr) soils, and powdery clays (Uf 1.13) and possibly (Uf 1.23). Any of these soils may be locally dominant. Other soils include (Ug5.2) clays in valleys, seasonal swamps, and clay pans where (Ug5.5) clays may occur also; and (Um1.43) soils on scarp slopes. Occurs on sheet(s): 10"
"Nb17"
"Similar to the more gently sloping portions of unit Nb16, with the addition of superimposed longitudinal sand dunes of (Uc1.2) soils. Occurs on sheet(s): 10"
"Nb18"
"Similar to unit Nb17 but with clay pans of (Ug5.2) and (Ug5.5) soils in some interdune corridors. Occurs on sheet(s): 10"
"Nb19"
"Dissected stony plateaux with silcrete cappings on shale, claystone, and sandstone; surfaces are mantled by siliceous gravels and stones: chief soils are crusty loamy soils (Dr1.33, Dr1.32), (Dr1.13), and (Dr1.43) that occur on plateau summits and pediment slopes. Associated are brown clays (Ug5.38) in gilgai depressions on plateau summits; various shallow stony soils such as (Uc1.4), (Um1.4), and (Um5.11) on areas of strong relief; and (Uc5.21) soils on fringing plains. Occurs on sheet(s): 10"
"Nb20"
"Broken terrain of steep-sided hills, dissected spurs, erosional terraces, and plains, mainly on sandstone; surfaces are mantled by siliceous stones and grave}s: chief soils are crusty loamy soils (Dr1.33, Dr1.32), (Dr1.13), and (Dr1.43) on spurs and slopes generally. Associated are red earths (Gn2.12) on terraces and plains. Other soils include shallow stony soils (Uc) and (Um) on areas of strong relief; (Gn2.13) and (Um5.11) soils in calcreted valleys and terraces; and (Uc5.21) soils locally on plains. Occurs on sheet(s): 10"
"Nb21"
"Low marginally dissected cuestas with silcrete cappings along scarps on claystone and sandstone; stone and gravel pavements are a feature: chief soils on the summits are crusty loamy soils (Dr1.33, Dr1.32), (Dr1.13), and (Dr1.43) with brown clays (Ug5.38) in gilgai depressions. Other soils include shallow stony soils (Uc) and (Um) on areas of strong relief. Occurs on sheet(s): 10"
"Nb22"
"Undulating stony plains on shale, claystone, and sandstone; stone and gravel pavements are a variable feature: chief soils are crusty loamy soils (Dr1.33), (Dr1.13), and (Dr1.43), locally with gilgai depressions of brown clays (Ug5.3). There are some transgressive dunes of (Uc1.2) sands and occasional swamps of (Ug5.2) and (Ug5.5) soils. Occurs on sheet(s): 10"
"Nb23"
"Broken stony plains on sandstone and conglomerate with calcrete-capped terraces: chief soils are probably crusty loamy soils (Dr1.33), (Dr1.13), and (Dr1.43), but there are many shallow stony soils also, including (Um5.11), (Um1.4), (Uc1.3), and (Uc1.2). Other soils include (Gc) on calcrete areas with the (Um5.11) soils, and some (Uc5.21) soils in sandy areas. Occurs on sheet(s): 10"
"Nb24"
"Undulating stony plains with low ridges and rises on claystone and sandstone: chief soils are probably crusty loamy soils (Dr1.33), (Dr1.43), (Dr1.13), and (Dr1.32), with some weak gilgai microrelief possibly with (Ug5.3) clays in the depressions. Associated are (Um5.11) and (Gc) soils on calcreted areas; and (Gn2.13, Gn2.12) with (Uc5.21) soils on included sandy plains. Occurs on sheet(s): 10"
"Nb25"
"Flat-topped hills, mesas, and cuestas on shales, limestones, and sandstones and stony lowlands all covered by dense silcrete stone and gravel pavements: chief soils are crusty loamy soils (Dr1.33, Dr1.32), (Dr1.13), and

(Dr1.43). Associated are shallow sandy soils (Uc1.3) and (Uc1.4) with rock outcrop on areas of strong relief. Small areas of (Uc5.21), (Gn2.1), and (Dr1) soils occur in the narrow valleys, and (Gc) soils may occur locally. Occurs on sheet(s): 10"
"Nb26"
"Stony downs--more or less regularly rolling slopes with some scarps, mesas, and buttes; some block silcrete and laterite on breakaways; siliceous gravels and stones mantle the surface; narrow valleys; some mound springs; some gypsum deposits; some clay pans; occasional sand dunes: chief soils are crusty loamy soils (Dr1.33, Dr1.32) and (Dr1.12, Dr1.13), often in gilgai complex with brown cracking clays (Ug5.38). The soil pattern is complex and the (Ug5.3) clays may be dominant locally. Associated are (Uf1.13) and possibly (Uf1.23) clays. There are also small areas of many other soils, including (Um1.43) and (Um5.11), which occur in areas of strong relief. Occurs on sheet(s): 10"
"Nb27"
"Dissected tablelands--broad undulating plains with mesas, buttes, scarps, and pedimented areas; block silcrete and possibly laterite on breakaways; siliceous gravels and stones mantle the surface; narrow valleys; clay pans and seasonal swamps: chief soils are crusty loamy soils (Dr1.33, Dr1.32), (Dr1.13, Dr1.12), and (Dr1.43) with some gilgai depressions of (Ug5.38) clays. Associated are (Dr1.16) soils on the pediments and possibly other soils underlain by the red-brown hardpan; but the extent of the hardpan and the (Dr1.16) soils is not known. There are also small areas of many other soils, including (Um1.43) and (Um5.11), which occur in areas of strong relief. Occurs on sheet(s): 10"
"Nb28"
"Strongly undulating terrain largely covered with quartz gravels and dissected by many small drainage-ways: chief soils are probably crusty loamy soils (Dr1.33) and (Dr1.13), with shallow gilgai depressions of (Ug5.3) soils. Associated are sandy and stony areas of (Gn2.12, Gn2.13) soils. Red-brown hardpan is exposed in some roadside ditches. There are small inclusions of unit BA50. Occurs on sheet(s): 10"
"Nb29"
"Rolling stony downs with silcrete boulders and stone and gravel mantles: chief soils are crusty loamy soils (Dr1.33) and (Dr1.13), with brown cracking clays (Ug5.3). There are small inclusions of unit Fa48. Occurs on sheet(s): 10"
"Nb30"
"Dissected plateaux with rocky scarps: chief soils are crusty loamy soils (Dr1.33) and (Dr1.13) covered with silcrete stones and gravels. Associated are shallow gilgai depressions of (Ug5.3) clays. There are (Um1.43) and probably (Um5.51) soils in the silcrete and conglomerate boulder areas on scarp slopes and crests. Occurs on sheet(s): 10"
"Nb31"
"Rolling stony downs: chief soils are crusty loamy soils (Dr1.33), (Dr1.13), and (Dr1.43) with a variable (often thick) stone and gravel mantle and with shallow gilgai depressions of (Ug5.3) clays more frequent than in unit Nb30. There are narrow stream valleys of unit MM72; mesas and buttes of unit Nb30; and small hilly areas of unit Fz1. Occurs on sheet(s): 10"
"Nb32"
"Gently undulating terrain with a scatter of surface stones and gravels: chief soils are crusty loamy soils (Dr1.33) and (Dr1.13), with gilgai depressions of (Ug5.3) clays. Associated are (Gn2.13) soils on sandy areas and narrow plains of (Ug5.3) and (Ug5.2) clays. Occurs on sheet(s): 10"
"Nb33"
"Plains with some pediments flanking hills and ranges; there is a thin scatter of surface gravels: chief soils are crusty loamy soils (Dr1.33) and (Dr1.43), with shallow gilgai depressions of (Ug5.3) clays that may be dom inant locally. There are some low sandy rises of (Gn2.13) soils marginal to adjoining sandy soil units. Shallow sand drift is extensive in some areas. Occurs on sheet(s): 10"
"Nb34"
"Strongly rolling terrain with hills and ridges: chief soils are crusty loamy soils (Dr1.33) and (Dr1.43), with shallow gilgai depressions of (Ug5.3) clays. Associated are (Um5.11), (Um1.43), and (Um5.41) soils on the hills and ridges, with some (Gc) soils, notably (Gc1.12), on flatter sites within the hills. Occurs on sheet(s): 10"
"Nb35"
"Stony downs--undulating terrain with some scarps, mesas, and buttes; a mantle of stones and gravels cover the soil surfacenarrow valleys: chief soils are crusty loamy soils, especially (Dr1.33) and (Dr1.13), which often occur in weak gilgai complex with brown cracking clays (Ug5.3). Associated locally are (Uf1.13) an possibly (Uf 1.23) clays. Other soils may occur, especially (Um5.11) on some mesas and buttes. As mapped areas of unit Nb36 and narrow valleys of unit BG1 are included. Occurs on sheet(s): 10"
"Nb36"
"Gently sloping pediments and plains mantled by stones and gravels; sand spreads and dunes; mesas and butte~ narrow valleys and some lakes (normally dry): chief soils are crusty loamy soils, especially (Dr1.33) an (Dr1.13),

with brown cracking clays (Ug5.3) often associated in weak gilgai microrelief. There are soils unit DD26 on the sand spreads and dunes, of unit BG1 in the narrow valleys, and (Um5.11) soils on son mesas and buttes. As mapped, small areas of units Nb35 and BB32 may be included. Occurs on sheet(s): 10"
"Nb37"
"Plains; dissected piedmont alluvial plains with a strew of stones and gravels: chief soils are crusty loan soils, especially (Dr1.33) and (Dr1.13), often in weak gilgai complex with brown cracking clays (Ug5.3). Small areas of (Gc) soils occur on the plains, and (Um5.12) soils occur in valleys. Occurs on sheet(s): 10"
"Nb38"
"Dissected tableland: chief soils are crusty loamy soils, especially (Dr1.33) and (Dr1.13), often in weak gilgai complex with brown cracking clays (Ug5.3) and possibly (Uf1.13) clays on the gently undulating tableland crests. Associated are various shallow soils (undescribed) on the scarps. Occurs on sheet(s): 10"
"Nb39"
"High dissected stony tablelands: chief soils are probably crusty loamy soils, especially (Dr1.33) and (Dr1.13) with some gilgai depressions of brown cracking clays (Ug5.3). Other soils occur, including shallow soils of the scarps. Occurs on sheet(s): 10"
"Nb40"
"Rolling stony downs mantled by a strew of stones and gravels: chief soils are probably crusty loamy soils, especially (Dr1.33), (Dr1.13), and (Dr1.43), in gilgai complex with brown cracking clays (Ug5.3) that may be dominant in some areas. Other soils may occur. Occurs on sheet(s): 10"
"Nb41"
"Rolling stony downs mantled by a strew of stones and gravels; some mesas and buttes; shallow valleys; lakes: chief soils are crusty loamy soils, especially (Dr1.33), (Dr1.13), and (Dr1.43), which may form gilgais and also gilgai complexes with cracking brown clays (Ug5.3). Associated soils include shallow loams such as (Um5.11) and (Um1.43) on mesas and buttes, together with residues of past weathering cycles, sandstone, gypsum, silcrete, and laterite. Small areas of unit DD1 may be included in low-lying sites. Occurs on sheet(s): 10"
"Nb42"
"Remnants of stony downs often with prominent hills, mesas, and buttes: chief soils are crusty loamy soils, especially (Dr1.33) and (Dr1.13), with (Ug5.3) clays in gilgai complex on the rolling downs areas; shallow calcareous loams (Um5.11) on the hills, mesas, and buttes; and areas of (Gc) soils, especially (Gc1.12) and (Gc1.22), on areas of gentler relief. Any of these may be dominant locally. Occurs on sheet(s): 10"
"Nc1"
"Plains with some swamps and lunettes: crusty loamy soils (Dr1.43), hard patches, in association with cracking brown clays (Ug5.3), soft patches; both in association with other crusty loamy soils (Dr1.33) and (Dy1.43) and areas of grey-brown highly calcareous loamy earths (Gc1.12). Incomplete data. Occurs on sheet(s): 1,3"
"Nc2"
"Gently undulating plains with some gilgai areas, and irregularly broken by small remnants of sand plain, unit AC1, and granitic bosses and tors: chief soils seem to be crusty loamy soils (Dr1.43), (Dr1.33), and (Dr1.83) with brown and grey-brown calcareous earths (Gc1.12) and (Gc1.22). Associated are small areas of unit AC1 soils, usually on main drainage divides; variable areas of red and yellow earths (Gn2.12) and (Gn2.21) often with ironstone gravel on the surface; and various (Dy) soils as for unit Ya28. As mapped, areas of other units may be included. Occurs on sheet(s): 5,10"
"Nc3"
"Riverine plains: chief soils are crusty loamy soils (Dr1.43), (Dr1.83), and (Dr1.33). Associated are a variety of deep sandy (Uc) soils, including (Uc1.31). Occurs on sheet(s): 10"
"Nc4"
"Plains and terraces flanking ranges: dominant are crusty loamy soils including (Dr1.43), (Dr1.33), (Dr1.42), and (Dr4.82) with variable gravel and stone mantles. Associated are (Ug5.3), (Gn2.12) soils on the plains and terraces and shallow (Uc1.4) soils on included low hills and mesas. Occurs on sheet(s): 10"
"Nc5"
"Plains and flood-out areas with clay pans: chief soils are crusty loamy soils (Dr1.43, Dr1.42). Associated soils include (Uc5.21) on the plains, (Ug5.5) and (Ug5.6) in the clay pans, and (Uc1.23) on dunes. Occurs on sheet(s): 10"
"Nd1"
"Undulating lands strewn with siltstone, sandstone, and billy gravel: dominant soils are thin-surfaced (1-3 in.) loamy red duplex soils (Dr1.32), occasionally (Dr1.33), mostly of shallow depth. Associated are similar (Dr2) soils. Adjacent to rock outcrop are areas of shallow stony loams (Um1.43) and (Um5.51), and in parts of the unit there may be relict semi-active sand dunes with (Uc1.23) soils. Data are limited. Occurs on sheet(s): 10"
"Nd2"

"Gently undulating plains to gently rolling downs, generally covered with a gravel mantle: chief soils are crusty loamy soils (Dr1.32, Dr1.33), with some (Dr1.13, Dr1.12) and gilgai depressions of (Ug5.34) clays of variable extent and frequency. Other soils may occur. Occurs on sheet(s): 10"
"Nd3"
"Dissected low plateaux of cuesta form mantled with gravels and with mesas and buttes: chief soils are crusty loamy soils (Dr1.32, Dr1.33) and (Dr1.43), with gilgai depressions of (Ug5.3) clays, including (Ug5.37, Ug5.34). Other soils include (Um1.43) on the steeper dissected cuesta scarp margins. Occurs on sheet(s): 10"
"Nd4"
"Undulating pediments and outwash fans with narrow ridges, mesas, and buttes, usually with a cover of silcrete stones and gravels: dominant soils are crusty loamy soils (Dr1.32, Dr1.33) and (Dr1.43), with variable areas of brown cracking clays (Ug5.3). Associated in some areas are (Dr2.33, Dr2.32) soils and small alluvial plains of (Ug5.34) soils, while in others a few sand dunes with (Uc1.23) soils are found. Occurs on sheet(s): 10"
"Nd5"
"Pediments and plains covered with silicified sandstone gravels and stones, below fairly prominent scarp ridges: chief soils are crusty loamy soils (Dr1.32, Dr1.33). Associated are cracking clays (Ug5.38) in gilgai depressions throughout, but usually more common in areas of gentler relief, and locally dominant on plain tracts. Other soils include powdery clays (Uf1.13) and possibly (Uf1.23) on the pediments, in microassociation with the (Dr1) soils. Occurs on sheet(s): 10"
"Nd6"
"Stony downs--gently undulating to rolling pediments and plains dissected by streams and covered by gravels and stones of silicified sandstone: dominant soils are crusty loamy soils (Dr1.32, Dr1.33) in intimate association with brown cracking clays (Ug5.38, Ug5.37, and Ug5.34) that may be dominant locally, especially in areas of gentler relief. Some small areas of (Ug5.2) soils may occur along the lower margins of the unit. Occurs on sheet(s): 10"
"Nd7"
"Dissected plateau frequently of cuesta form and with steep scarp slopes often with rock outcrop and mottled and pallid weathering zones, mesas, and buttes: chief soils of the crests are crusty loamy soils (Dr1.32, Dr1.33) and brown clays (Ug5.38, Ug5.34), with dominance varying locally between the (Dr1) and the (Ug5) soils. Silcrete gravels and stones cover the surface of these soils. Associated are the shallow but undescribed soils of the scarp slopes. Occurs on sheet(s): 10"
"O1"
"Outwash plains: hard alkaline red soils (Dr2.23 with small areas Dr2.33); small areas cracking clay soils (Ug5.15, Ug5.16, and Ug5.2), also hard alkaline yellow mottled soils (Dy3.43); minor areas (Um6.21) and (Uf6.11); various alluvial soils (unclassified) in the stream valleys. Occurs on sheet(s): 1"
"O2"
"Undulating: hard alkaline red soils (Dr2.23) often containing ironstone gravels in the surface horizons, small areas (Dr2.33), and cracking grey clays (Ug5.2). Occurs on sheet(s): 1"
"O3"
"Hills and valleys: alternating, subparallel hilly ridges and valleys with a general N.-S. trend. Shallow forms of hard alkaline red soils (Dr2.23) with (Um5.41); (Um5.11) and shallow varieties of (Um6) especially (Um6.23) occur on the hilly ridges; while on the hill slopes and in the valleys (Dr2.23) with (Dr2.33), which increases in area towards the northern portion of the unit, occur with small areas of cracking clay soils (Ug5.15, Ug5 16, Ug5 2, and Ug5.3); friable earths (Gn3.13); grey-brown highly calcareous loamy earths (Gc1) in the northern portion of the unit; and also minor areas of soils belonging to groups (Dr3.22), (Dy3.4), and (Dy5.4); while on present stream terraces occur (Dr2.23) and deep varieties of (Um6) with various alluvial soils (unclassified) on the flood-plains. Occurs on sheet(s): 1"
"O4"
"Hills with fringing outwash plains: hard alkaline red soils (Dr2.23) on the plains; shallow variants of (Dr2.23) with (Um5.41) on the hills and brown calcareous earths (Gc) on hill slopes; hard alkaline yellow mottled soils (Dy3.43) and alluvial soils (unclassified) in the valley bottoms. Small areas of hard neutral yellow mottled soils (Dy3.22) occur in the Cleve Hills. Occurs on sheet(s): 1"
"O5"
"Valley plains and terraces: hard alkaline red soils (Dr2.23 and Dr2.33) with some cracking clays (Ug5.2 and Ug5.3); saline soils and various alluvial soils (unclassified) in the lower-lying situations. Occurs on sheet(s): 1"
"O6"
"Undulating plain: hard alkaline red soils (Dr2.23) with smaller areas of (Dr2.33) and some areas of cracking clays (Ug5.2 and Ug5.3) which may be dominant in the lower-lying situations. Occurs on sheet(s): 1"
"O7"
"Low rolling hills: shallow hard alkaline red soils (Dr2.23) in association with shallow red-brown sandy soils (Uc6.13). Occurs on sheet(s): 1"
"O8"

"Rounded hill slopes with some scarps: shallow forms of hard alkaline red soils (Dr2.23) in association with friable loamy soils (Um6.42, Um6.43, and Um6.21); dark structured clays (Uf6.11); smaller areas of shallow red subplastic clay soils (Uf5.31); red friable earths (Gn3.12); cracking clays (Ug5.15, Ug5.16, and Ug5.2) and sandy alkaline yellow mottled soils (Dy5.4 and Dy5.8). Occurs on sheet(s): 1"
"O9"
"Undulating: soils as for 08 but the proportion of cracking clays (Ug5) and sandy alkaline yellow mottled soils (Dy5) is larger; hard alkaline yellow mottled soils (Dy3.43) and leached sands (Uc2.2) occur in small areas also. Occurs on sheet(s): 1"
"O10"
"Hills and valleys: a northern continuation of unit 03 but with the conspicuous addition of greybrown highly calcareous loamy earths (Gc1.12) which are co-dominant especially on the hill slopes. Occurs on sheet(s): 1"
"O11"
"Undulating: a ridge and valley formation generally similar to that of unit 03 but on a subdued scale. Grey-brown highly calcareous loamy earths (Gc1.12) with shallow porous loamy soils (Um6.2) on the ridges; shallow forms of hard alkaline red soils (Dr2.23) on the slopes of the ridges; hard alkaline red soils (Dr2.23) with cracking clays (Ug5.2 and Ug5.3) on the lower slopes and in the valleys. Occurs on sheet(s): 1"
"O12"
"Valley plains and river terraces: hard alkaline red soils (Dr2.23 and Dr2.33) with some crusty loamy soils (Dr1.33); grey-brown highly calcareous loamy earths (Gc1.12) a feature of some terrace levels; saline soils (unclassified) on some flood-plains. Occurs on sheet(s): 1"
"O13"
"Hills with small basin plains: hills of outcropping rocks with shallow hard alkaline red soils (Dr2.23) and with amorphous loamy soils (Um5.11 and Um5.41); small basin plains of shallow hard alkaline red soils (Dr2.23 and Dr2.33) in association with grey-brown highly calcareous loamy earths (Gc1.12); saline and alluvial soils (unclassified) in the creek valleys. Occurs on sheet(s): 1"
"O14"
"Undulating with scattered hills: shallow hard alkaline red soils (Dr2.23 and Dr2.33) in association with sandy alkaline yellow soils (Dy5.43 and Dy4.43) with smaller areas of coherent sandy soils (Uc6). Hills with rock outcrops and amorphous loamy soils (Um5). Occurs on sheet(s): 1"
"O15"
"Plains: hard alkaline red soils (Dr2.23 and Dr2.33) in association with hard alkaline yellow mottled soils (Dy3.43) and sandy alkaline yellow mottled soils (Dy5.43) on plains and river terraces with leached sand (Uc2.2) and various other soils (unclassified) on creek and river flood-plains. Occurs on sheet(s): 1"
"OO1"
"Flood-plains with stony rises, levees, and channels: chief soils are grey clays (Ug5.5) with low puffs of (Ug5.2) clays in gilgai microrelief on the main valley floors. Associated are (Dy5.81) soils containing ironstone gravels on sandy plains. Other soils include (Um6.21), (Uf6.32), and (Gn3.4) on limestones; (Gn2.12) soils on levees; and (Gn2.2), (Gn2.7), and (Gn2.9) soils in low-lying sites. Occurs on sheet(s): 8"
"OO2"
"Flood-plains with billabongs and levees; chief soils are probably grey clays (Ug5.5) with low mounds or puffs of (Ug5.2) in which the top inch is self-mulching, in weak gilgai microrelief on back plains and in other depressions where (Gn2.64), (Gn2.74), (Dy2.43), and (Dy3.43) soils may occur also. Associated are sandy and loamy yellow and red earths (Gn2.22) and (Gn2.12) on the older levees and some valley floors. Other soils include (Uc1.43) on the younger levees and alluvial banks. As mapped, small areas of adjoining units may be included. Occurs on sheet(s): 8"
"OO3"
"Flood-plains, back plains, and extensive poorly drained flats: chief soils are grey clays (Ug5.5) on all the flatter areas and in depressions, probably with some (Ug5.2) soils in gilgai formations. Associated are variable areas of (Gn2.64), (Gn2.95), (Gn2.74), and (Gn2.12) soils on rises and levees. Occurs on sheet(s): 8"
"OO4"
"Generally a ridge and slope terrain with bouldery outcrops of silicified rock on the ridges: chief soils are probably grey clays (Ug5.5) with a moderate gilgai microrelief (12 in.) and with (Ug5.2) soils on the selfmulching puffs. Some areas have stone-covered surfaces. Associated are (Dr2.32) soils often in complex with the (Ug5) soils; (Dr2.52) soils on broad low rises; small patches of soils common to unit My72; and shallow (Uc1.41) soils on the ridges. Occurs on sheet(s): 8"
"OO5"
"Flood-plains with channels and some swampy areas: chief soils are probably grey clays (Ug5.5) and (Ug5.2) in association with yellow earths such as (Gn2.74). Other soils include the undescribed soils of the swampy areas. Occurs on sheet(s): 8"
"OO6"

"Flat to gently undulating plains often with a rough somewhat irregular surface; some weak (< 6 in.) gilgais; some shallow depressions: chief soils are deep grey clays either not self-mulching (Ug5.5) or with only about 1 in. of self-mulching surface (Ug5.28). Associated are (Dy3.4) soils that vary in area, being prominent in some localities but not in others. Small areas of units 116, My80, JV4, and My79 may be included. Occurs on sheet(s): 8"
"OO7"
"Plains of clayey alluvia derived mostly from limestones: chief soils are grey clays (Ug5.5) and (Ug5.2) with some weak gilgai (< 12 in.). The (Ug5.5) soils are not self-mulching whereas the (Ug5.2) soils are; however, their self-mulching layer is confined to about the surface inch. Small areas of other soils may be included. Occurs on sheet(s): 8"
"OO8"
"Flood-plains and levees: chief soils on the plains are probably grey clays (Ug5.5) with low mounds or puffs of (Ug5.2) in which the top inch is self-mulching. There may be some weak gilgai microrelief. Associated soils on the levees include silty clays, probably (Uf6) soils, and possibly other soils similar to the associate soils of unit 002. Occurs on sheet(s): 8"
"OO9"
"Level to gently undulating alluvial plains with numerous anastomosing old infilled channels: dominant soils are deep massive mottled grey cracking clays (Ug5.5), with closely associated (Ug5.4) and (Ug5.28, Ug5.24); lesser areas of (Ug5.6), (Ug5.16), and (Ug3.2) soils also occur. Marginal to the clays are the loamy duplex soils (Dy2.33), (Dy2.13), (Db1.33), (Dy2.43), (Dy3.33), (Db1.43), and (Dr2.33) of unit Si12. The infilled channels and levees have stratified loamy earths (Gn2.41) and loams (Um5.52) and also deep sands (Uc5.21), (Uc5.11), and lesser (Uc2.34) and (Uc2.21). Occurs on sheet(s): 7"
"OO10"
"Plains: chief soils are cracking clays (Ug5.5) and (Ug5.2). Small areas of other soils may occur. Occurs on sheet(s): 10"
"OO11"
"Clay pans, salt pans, and lake floors subject to seasonal flooding; some gypsum and calcrete (kunkar) deposits may occur marginally: chief soils are grey clays (Ug5.5), but lesser brown clays (Ug5.6) also occur. Associated are (Ug5.2) clays. Other soils may occur. Occurs on sheet(s): 10"
"OO12"
"Clay pans and lakes in interdune corridors and plains; subject to seasonal flooding: chief soils are grey clays (Ug5.5) which may be quite saline. Other soils may occur. As mapped, some sand dunes of unit B43 may be included. Occurs on sheet(s): 10"
"Oa1"
"Alluvial basins of subdued relief: flat to gently sloping basin floor of hard alkaline red soils (Dr2.13) with undulating stony areas of unclassified red soils and with flanking hill slopes of hard neutral red soils (Dr2.12) and hard alkaline red soils (Dr2.13). Occurs on sheet(s): 2"
"Oa2"
"Dissected plateaux at low elevation: plains of hard alkaline red soils (Dr2.13) often in gilgai microassociation with dark cracking clays (Ug5.1), and grey and brown cracking clays (Ug5.2 and Ug5.3), small areas of other soils such as (Dr2.33), (Dy3.43), and (Dd1.1); also with (1) low, broad, sprawling stony rises of (Dr2.13), (2) low rounded hills of various (D) soils such as (Db1.23) with boulder strewn slopes, and (3) incised, often gorge-like, stream valleys of undescribed soils. Occurs on sheet(s): 2"
"Oa3"
"Dissected plateaux, narrow flat-topped ridges of hard alkaline red soils (Dr2.13) dissected by deeply incised valleys of various soils, including dark cracking clays (Ug5.1), with narrow floodplains of undescribed soils. Occurs on sheet(s): 2"
"Oa4"
"Moderately undulating lands with some low hills: dominant are red loamy duplex soils (Dr2.13), (Dr2.33), (Dr2.32), and (Dr2.22) with closely associated similar (Db1) soils. The soil surface is often strewn with silcrete (billy) gravel. Smaller areas of deep red clays (Ug5.38), (Ug5.34), and dark clays (Ug5.15) also occur together with smaller areas of red friable earths (Gn3.13). Occurs on sheet(s): 4"
"Oa5"
"Gently sloping small plains or alluvial colluvial fans; often dissected by many small erosion channels; the unit is often marginal to lateritic scarps and the soil surface is often strewn with silcrete (billy) or ferricrete (ironstone) gravels: dominant are loamy red duplex soils (Dr2.13), (Dr2.23), and (Dr2.33), and occasionally (Dr2.43). In some areas the (4-6 in.) A horizon may be removed by erosion. Associated are smaller areas of (Dy2.33), (Db1.33), and red clays (Ug5.37, Ug5.38). Small stony lateritic mesas with (Um1.43) shallow soils are included in the mapped unit. Occurs on sheet(s): 4,10"
"Oa6"

"Low hilly to gently rolling terrain with some small basaltic knolls: chief soils seem to be hard alkaline red soils (Dr2.13) on crests and upper slopes. Associated are: a variety of soils such as (Dg4.81), (Dy5.83), (Ug5.16), (Ug5.28), (Dd2.13), and (Uf6.33) on lower slopes (where the (Ug), (Dd), and (Uf) soils are common there is a similarity with unit Kc7); small areas of (Gn3.43) soils on crests; small areas of (Um6.21) soils on basaltic knolls; and (Ug5.15) and (Dy2.73) soils along the narrow valleys. Small areas of other soils may occur. Occurs on sheet(s): 4"
"Oa7"
"Plains: chief soils are hard alkaline red soils (Dr2.13) with some dark cracking clays (Ug5. 1 5). Associated are a variety of (D) soils including (Dr2.23), (Db1.12), (Db4.13), (Dy3.22), (Dr4.63), and (Dd1.23) soils in complex with (Ug5.1) soils. Occurs on sheet(s): 4"
"Oa8"
"Moderately undulating lands: dominant soils are loamy-surfaced red duplex soils of mostly shallow depth (Dr2.13 and Dr2.12). Higher ridges have shallow stony loams (Um1.43) and (Um5.51), while on lower slopes and on occasional small plains cracking clays (Ug5.22) and (Ug5.32) may occur, often with linear gilgai. Occurs on sheet(s): 4"
"Oa9"
"Undulating lands with broad rounded ridge crests and wide shallow valleys, some rock outcrop on higher ridges: dominant are loamy duplex soils of shallow to moderate depth (1424 in.). The chief form is (Dr2.13) but (Dr2.12) is closely associated. Other soils occurring include (Dr2.22 and Dr2.23), (Gn3.12), and (Db1,12 and Db1.13). In lower landscape sites cracking clays (Ug5.22), (Ug5.32), and (Ug5.14) usually occur together with some loamy (Dy2.43) soils associated with small stream flood-plains. Occurs on sheet(s): 4"
"Oa10"
"Rolling terrain of hard alkaline red soils (Dr2.13) with dark (Ug5.15) and grey (Ug5.25) cracking clays. Other soils are likely. Occurs on sheet(s): 4"
"Oa11"
"Dissected stony pediments and hills occurring at foot of unit Gfl; some residuals of more resistant rocks occur as mesas. On deeply dissected areas lime is released from weathering of more basic rocks: chief soils are hard alkaline red soils (Dr2.13) and other (Dr) soils. There are also shallow (Um5.51) and (Uc) soils associated with rock outcrop; some cracking clays (Ug5.37) on pediments associated with basic rocks; and some shallow calcareous loam soils (Um1.2). Occurs on sheet(s): 6,10"
"Oa12"
"Narrow dissected coastal plains at the foot of unit Fy2. Chief soils appear to be hard alkaline red soils (Dr2.13). Associated are some saline flats, and a seaward fringe of recent shelly dunes (Uc1.11). Occurs on sheet(s): 6"
"Oa13"
"Moderately to strongly undulating lands with some low hills and much limestone or dolomite outcrop; occasional high rocky scarp margins: dominant soils are moderately deep (2436 in.) gravelly surfaced (chert) dark red duplex soils (Dr2.13) with shallow loamy A horizons. They occur mainly on broad crests and long slopes. Associated soils on steeper slopes and near rock outcrops are shallow gravelly loams (Um1.3), (Um5.51), and occasionally (Um1.43). Small isolated patches of grey-brown cracking clays (Ug5.2) occur with the (Dr) soils. On lower slopes and on some areas of low relief are important areas of loamy red earths (Gn2.12 and Gn2.13) and some loamy-surfaced yellow duplex soils (Dy3.23). Occurs on sheet(s): 7,8"
"Oa14"
"Moderately undulating lands with broad ridge crests; rock outcrop is common: dominant soils are shallow to moderately deep loamy red duplex soils (Dr2.13), with associated (Dr2.12) and (Db1.13). The duplex soils usually have a gravel-strewn surface and gravelly A horizons. On slopes adjacent to rock outcrop are very gravelly shallow loams (Um5.51) and (Um1.43). Loamy red earths (Gn2.12) occur on stream levees. Occurs on sheet(s): 7,10"
"Oa15"
"Gently undulating to undulating lands: dominant soils are gravel-strewn loamy red duplex soils (Dr2.13), with associated (Dy2.13, Dy2.12) and (Db1.13). Cracking grey-brown clays (Ug5.2) are also common with lesser (Uf6.33). Small areas of gravel-strewn earths (Gn2.43) and (Gn2.22) may also occur. Occurs on sheet(s): 7"
"Oa16"
"Gently undulating to undulating lands with occasional isolated low hills: dominant soils are moderately deep loamy red duplex soils (Dr2.13), with lesser (Dr2.23). Closely associated are other loamy duplex soils including (Dy3.43), (Dy3.33), (Dy2.22), and (Db1.33). Shallow gravelly loams (Um4.2) and (Um2.12) or sands (Uc2.12) and (Uc2.21) occur on the ridge crests and on the low hills. Dark cracking clays (Ug5.16) occur on the alluvium of some minor streams. Data are limited. Occurs on sheet(s): 7"
"Oa17"
"Alluvial plains with small infilled channels and occasional low rises: dominant are loamy red duplex soils (Dr2.13), with associated (Dr2.43), (Db1.13), and (Db1.43), and (Dy2.13) soils; some areas have siliceous gravel on the surface. Occurring throughout the unit are small areas of deep cracking clays (Ug5.24, Ug5.25) and

(Ug5.34, Ug5.35). Low rises and infilled channels have loamy red earths (Gn2.12, Gn2.13, and Gn2.11). Occurs on sheet(s): 10"
"Oa18"
"Gently undulating plains: dominant are gravelly-surfaced loamy red duplex soils (Dr2.13) and (Dr2.43), with lesser (Dr2.33), (Db1.43), (Db1.13), and (Dy2.13) soils. Areas of deep cracking clays (Ug5.24, Ug5.25) and (Ug5.34, Ug5.35) are common and may be locally dominant. Occasional small rises with loamy red earths (Gn2.11, Gn2.12) also occur. Occurs on sheet(s): 10"
"Oa19"
"Gently undulating to undulating lands, occasionally with stronger relief and much rock outcrop: dominant are gravelly-surfaced shallow red duplex soils (Dr2.13), with lesser (Dr2.12) and (Db1.13). Associated are shallow to moderately deep gravel-strewn loamy red friable earths (Gn3.12), with occasional uniform clays (Uf6.31) and cracking clays (Ug5.24, Ug5.25). Shallow gravelly loams (Um1.43), (Um5.41), and (Um5.51) are common near rock outcrop. Areas of relatively stone-free loamy red earths (Gn2.12, Gn2.11, and Gn2.14) occur in valley floors. Occurs on sheet(s): 10"
"Oa20"
"Gently undulating to undulating lands with occasional rock outcrop: dominant are gravel-strewn shallow red duplex soils (Dr2.13), with lesser (Dr2.12), (Dr3.11), and (Dr3.51). Shallow to moderately deep loamy red earths (Gn2.12) are common associated soils and may be locally dominant. Shallow gravelly loams (Um5.51), (Um1.43), and (Um5.41) and sands (Uc4.12), (Uc4.22), and (Uc1.23) occur near rock outcrop. Along stream levees are deep loamy or sandy red earths (Gn2.12) and lesser (Gn2.42) soils. Occurs on sheet(s): 10"
"Oa21"
"Gently undulating lands with occasional rock outcrop: dominant soils are gravelly-surfaced loamy red duplex soils (Dr2.13), with lesser (Dr2.43). Associated are some cracking grey clays (Ug5.24) or brown clays (Ug5.34). Near rock outcrop are shallow calcareous loams (Um6.22) and (Um1.3). Stream levees have loamy red earths (Gn2.13). Occurs on sheet(s): 10"
"Oa22"
"Gently undulating to undulating lands with dolomite outcrop: dominant soils are shallow gravel-strewn loamy red duplex soils (Dr2.13). Associated are shallow gravelly loams (Um6.24, Um6.22) and (Um1.43). Some calcareous earths (Gc2.22) may also occur. Occurs on sheet(s): 10"
"Oa23"
"Gently undulating to undulating lands with occasional granite tor outcrop: dominant soils are shallow to moderately deep loamy red duplex soils (Dr2.13), with lesser (Dr2.33), (Dr2.12), (Dr2.83), and (Dr2.63). Associated are Fitty red friable earths (Gn3.13), while areas of lesser relief and stream levees have loamy red earths (Gn2.12, Gn2.11). Adjacent to rock outcrop are shallow coarse loamy sands (Uc4.12) and (Uc5.11) and coarse sands (Uc1.23). Occurs on sheet(s): 10"
"Oa24"
"Gently undulating to undulating lands with occasional low gravelly rises: dominant are gravel-strewn loamy red duplex soils (Dr2.13), with lesser (Dr2.33) and (Dr2.43). Associated are loamy red earths (Gn2.12, Gn2.11). In lower areas deep grey-brown cracking clays (Ug5.24, Ug5.25) occur. Some shallow gravelly loams (Um5.51) and (Um1.43) may occur on rises. Data are very limited. Occurs on sheet(s): 10"
"Ob1"
"Hilly with rock outcrops: middle and lower hill slopes of hard alkaline red soils (Dr2.23) with siliceous sands (Uc1.23) and rock outcrops on upper slopes. Occurs on sheet(s): 2,3"
"Ob2"
"River terraces and flats with plain remnants: higher river terraces of hard alkaline red soils (Dr2.23) with plain remnants of (Dy5.8) and (Dy3.4) soils and with lower terraces and flats of undescribed (U) soils. Occurs on sheet(s): 2"
"Ob3"
"Floodplain: plains of hard alkaline red soils (Dr2.23, Dr2.33, and Dr2.43) with hard alkaline yellow mottled soils (Dy3.43) in low-lying situations; dense clay D horizons occur bow the sola in some places at least. Occurs on sheet(s): 2"
"Ob4"
"Long narrow ridge: long, steeply sloping ridge of red friable porous earths (Gn4.11) with boulders and flanked by broader, undulating slopes of hard alkaline red soils (Dr2.23) with grey and brow cracking clays (Ug5.2 and Ug5.3) on the lower slopes. Occurs on sheet(s): 2"
"Ob5"
"Dissected terrace: plain of hard alkaline red soils (Dr2.23) some containing ironstone gravs with hard alkaline yellow mottled soils (Dy3.43) in less well-drained situations; and some areas of high-lev river gravs. Occurs on sheet(s): 2"
"Ob6"

"River terraces flanked by steep valley slopes: the highest terrace has hard alkaline red soils (Dr2.23), the middle terrace deep dark porous loamy soils (Um6.12), and the lowest terrace undescribed (U) soils; these terraces are flanked by steep hill slopes of hard acidic yellow mottled soils (Dy3.41) with shallow (Uc) and (Um) soils. Occurs on sheet(s): 2"
"Ob7"
"Gently undulating with long broad slopes and characterized by occasional stone-strewn hilly ridges: chief soils are hard alkaline and neutral red soils (Dr2.23 and Dr2.22) often with a surface scatter of stones and gravel. Associated are some (Dy) and (Gn2.1) soils. Data are limited. Occurs on sheet(s): 3"
"Ob8"
"Stepped undulating plain with very low ridges, sometimes gravelly, and rocky hillocks: chief soils are hard alkaline red soils (Dr2.23 and Dr2.33). As mapped, small areas of units Va18, Qb10, and Qc3 are included. Occurs on sheet(s): 3"
"Ob9"
"River terraces and flood-plains (middle and lower river terraces): chief soils are hard alkaline red soils (Dr2.23). Associated are areas of (Ug5.16) and (Dy3.43) soils; (Db2.42) and (Dr2.22) soils along some tributary stream terraces; and various (Um) soils, including (Um5.5) on the lower terraces and flood-plains. The upper reaches of some tributary streams may have areas of unit Ra3. As mapped, areas of unit Qd1 are included. Data are limited. Occurs on sheet(s): 3"
"Ob10"
"River terraces and flood-plains: chief soils are hard alkaline and neutral red soils (Dr2.23 and Dr2.22) with various other (D) soils, including (Db1.43). Associated are red earths (Gn2.12) on terrace remnants and probably other soils. Compare unit Ob9. Data are limited. Occurs on sheet(s): 3"
"Ob11"
"Gently undulating country: chief soils are hard alkaline red soils (Dr2.23) and possibly other (D) soils. Associated are low gravelly hillocks and ridges of shallow loams (Um4.1). Compare units Ob7, Qc3, My11, and Oc13. Occurs on sheet(s): 3"
"Ob12"
"Undulating to strongly undulating with some long, broad, and gentle slopes, broken by hilly ridges with rock outcrops; also with some flat terrain in the area below Herveys Range: chief soils are hard alkaline and neutral red soils (Dr2.23 and Dr2.22). Associated are: areas of other soils including (Dr2.33) on flats in the undulating terrain, (Gn3.12) and (Gn2.12) on slopes, and (Um4.1) on ridges and hillocks; and (Ug5.2) soils on flat land (?terrace remnants) in the area subjacent to Herveys Range, the extent of which is unknown. Data are limited. Occurs on sheet(s): 3"
"Ob13"
"Stepped undulating terrain with gravelly ridges and hillocks, some rock outcrops: chief soils are hard alkaline red soils (Dr2.23 and Dr2.43), the latter being restricted to low-lying sites. Associated are gravelly ridges of (Dr2.32) and other (Dr2) soils, and also (Dy3.42) soils; broad convex slopes of brown cracking clays (Ug5.3); and some flat areas of (Dy3.42) and (Dr2.33) soils. As mapped, areas of unit Qc4 are included. Occurs on sheet(s): 3"
"Ob14"
"Almost flat to strongly undulating terrain with long gentle slopes sometimes broken by ridges: chief soils are hard alkaline red soils (Dr2.23). Associated are relatively small occurrences of many soils, including: dark cracking clays, such as (Ug5.13 and Ug5 .15), usually on slopes and in valleys; (Dr2.22) and shallow loams such as (Um4.1), usually on ridges; (Dy2.43) and (Dy3.43) soils, usually in flat areas and valleys. As mapped, small areas of units Gb12, Qb19, and Ra4 are included. Erosion has exposed subsoils in many places. Occurs on sheet(s): 3"
"Ob15"
"Undulating to hilly--generally subparallel ridges of unit Qb19 separated by undulating slopes of unit Ob14: chief soils are hard alkaline and neutral red soils (Dr2.23 and Dr2.22). Occurs on sheet(s): 3"
"Ob16"
"Broken topography--undulating to low hilly terrain broken by steeply sloping cuesta-like ridges: chief soils of the undulating to low hilly areas are hard alkaline red soils (Dr2.23) and sometimes (Dr2.33). Associated are steep ridges with bare rock walls on their east-facing slopes, and various soils, including (Uc2.2), (Dy5.42), and (Gn2.15), usually covered with waterworn gravels on their gentler slopes. As mapped, areas of unit Kc1 are included. Data are limited. Occurs on sheet(s): 3"
"Ob17"
"Undulating to hilly with some steep ridges, rock outcrops: chief soils are hard alkaline and neutral red soils (Dr2.23 and Dr2.22) with cracking clays, such as (Ug5.13), (Ug5.15), and (Ug5.3); sometimes the (Dr) and (Ug) soils form soil complexes. Associated are a variety of soils including related (Db) and (Dy) soils, and (Dr2.33) soils towards the western and northern limits of the unit. Data are limited. Occurs on sheet(s): 3"
"Ob18"

"Undulating or strongly undulating lands with occasional low hilly areas: dominant are fairly shallow red loamy duplex soils (Dr2.23), (Dr2.33), and (Dr2.43), all with extremely gravelly A horizons. Similar (Dy2) soils are associated. On higher ridge crests and on the low hills the extremely gravelly shallow loams (Um1.43), (Um4.1), and (Um2.12) of unit Fz12 occur. Small areas of gravelly red friable earths (Gn3.13 and Gn3.12) occur locally. Occurs on sheet(s): 4"
"Ob19"
"Pediplains and hills on bentonitic siltstones and other marine rocks. Stony surface pavements are a common feature: chief soils are hard alkaline red soils (Dr2.23) and other (Dr) soils. Associated are some shallow (Um) soils on rock and minor inclusions of red earths (Gn) on plains. Occurs on sheet(s): 6"
"Ob20"
"Valley plains and river terraces: hard alkaline red soils (Dr2.23) and (Dr2.33), with some crusty loamy soils (Dr1.33). Grey-brown highly calcareous loamy earths (Gc1.12) are a feature of some terrace levels; saline soils (unclassified) occur on some flood-plains. This unit was designated 012 on Sheet 1. Occurs on sheet(s): 10"
"Oc1"
"The following description is slightly modified from that given for unit Oc1 on Sheet 2; it includes unit P1 of Sheet 1. Plains with low sand-hills, prior streams, depressions, swamps, and present stream valleys. Layered soil and sedimentary materials below the sola of present-day soils are important factors in soil variability owing to their influence on drainage characteristics: chief soils are hard alkaline red soils (Dr2.33), other (Dr2) and (D) soils with grey and brown cracking clays, commonly (Ug5.24) and (Ug5.35). The detailed soil pattern is complex: the relatively higher, better-drained portions of the plains have hard alkaline red soils (Dr2.23 and Dr2.33) and smaller areas of other soils including (Dr2.]2) and (Dr3.23); the relatively intermediate portions of the plain have (Dr2.33) in association with hard alkaline brown soils (Db1.33 and Db1.43) and gilgai puffs of cracking clays (Ug5.2 and Ug5.3) in some places, small areas of other soils include (Dr2.43) and (Dr3.43); the relatively lower portions of the plains, depressions, and swampy areas have hard alkaline yellow mottled soils (Dy4.43 and Dy3.43) in association with cracking clays (Ug5.2), (Ug5.4), (Ug5.5), (Ug3.2), often in gilgai formation; low sand-hills have deep sandy neutral red mottled soils (Dr5.62) and (Uc1.2) soils; prior streams have very variable "well-drained soils" in the stream bed and (Dr2.23, Dr2,33, Dr2.43), or shallow varieties of (Gn2.13) soils on their levees which may merge with the relatively higher porttions of the plain; present stream valleys have flood-plains of (Dy3.4), 9Gn), and (Um) soils. As mapped, areas of unit CC3 may be included. Occurs on sheet(s): 1 (as unit P1), 2,3"
"Oc2"
"Undulating to low hilly areas of hard alkaline red soils (Dr2.33) and smaller areas of (Dr2.23 and Dr2.43) with hard alkaline yellow mottled soils (Dy3.43) in the less well-drained sites and on lower slopes; minor areas of gilgais. Occurs on sheet(s): 2"
"Oc3"
"Plains with domes, lunettes, and swampy depressions, and divided by continuous or discontinuous low river ridges associated with prior stream systems--the whole traversed by present stream valleys; layered soil or sedimentary materials common at fairly shallow depths: chief soils are hard alkaline red soils (Dr2.33), grey and brown cracking clays, commonly (Ug5.24) and (Ug5.35), and other (D) soils in a complex soil pattern with the following general features: (i) well-drained to moderately drained plains of (Dr2.33) with (Db1.33 and Db1.43), often with thin A horizons (<4 in. thick); (ii) moderately to poorly drained gilgai plains subject to some seasonal flooding of (Ug5.3), (Dr2.33), (Db1.43), (Dy2.33 and Dy2.43), and (Ug5.2) soils; (iii) poorly drained gilgai plains subject to frequent seasonal flooding of (Ug5.2), (Ug5.3), (Db1.43), (Dy2.43), (Dd1.33 and Dd1.43), and (Ug5.4) soils; (iv) swampy depressions of (Dd1.33 and Dd1.43), (Db1.43), (Dy2.43), (Dy3.43), and (Ug5) soils; (v) domes and/or lu. Occurs on sheet(s): 3"
"Oc4"
"Plains with swamps--prior streams not evident--severe erosion present: chief soils are shallow forms of hard alkaline red soils (Dr2.33) and/or their erosion products, probably with related (D) soils. Associated are grey and brown cracking clays (Ug5.2) and (Ug5.3) in gilgai complexes. As mapped, areas of units CC1, CC15, and Mx4 may be included. Data are limited. Occurs on sheet(s): 3"
"Oc5"
"Plains underlain by fluviatile clays, and with some swamps especially towards the western margin: chief soils are hard alkaline red soils (Dr2.33). Associated are: various (D) soils including (Dr2.23), (Dr2.43), (Db1.33), (Dy2.33); grey and brown cracking clays (Ug5.2) and (Ug5.3) generally as gilgai complexes with the (D) soils in the relatively lower-lying sites; and some areas of earths, such as (Gn2.1) and (Gn2.46). The thickness of the A horizon of the (D) soils is very variable, from 4 to 18 in.. Occurs on sheet(s): 3"
"Oc6"
"Very gently sloping plain; buried soil layers common: chief soils are hard aLkaline red soils (Dr2.33) possibly with some (Dr2.23) and (Gn2) soils. Minor areas of (Ug5.2 and/or Ug5.3) may occur along Mirrool Creek. This area may be a localized expression of unit Oc5. Occurs on sheet(s): 3"
"Oc7"

"Undulating country with broad slopes and low, narrow, often gravelly or stony ridges: chief soils are hard alkaline red soils (Dr2.33) throughout the undulating terrain. Associated are: red earths (Gn2.12 and Gn2.13), sometimes with clay D horizons, in depositional sites; gravelly or stony ridges of hard neutral red soils (Dr2.32 and Dr2.42) and shallow loams (Um4.1) similar to unit Qc3; and small gilgai areas with some cracking clays (Ug5.2 and Ug5.3). Data are limited. Occurs on sheet(s): 3"
"Oc8"
"Plain with lagoons and swamps: chief soils are hard alkaline red soils (Dr2.33) with cracking clays (Ug5.2 and Ug5.3). Other soils are likely. As mapped, areas of units Mx3 and My12 are included Data are limited. Occurs on sheet(s): 3"
"Oc9"
"Plains: chief soils are hard alkaline red soils (Dr2.33). Associated are: various (D) soils including (Db1.33), (Dy2.43), (Dy3.43), and (Dd1.33) probably in some discontinuous slope sequence; grey and brown cracking clays (Ug5.2 and Ug5.3) in local gilgai areas; and minor areas of (Gn2) soils The (D) soils usually have thin A horizons (< 6 in.) and especially so on the open plain. As mapped areas of unit CC14 are included. Occurs on sheet(s): 3"
"Oc10"
"Rolling to hilly country with some steep slopes, gently undulating hill-tops, low cliffs, and occasionally escarpments; traversed by flat to undulating valleys: chief soils are hard alkaline and neutral red brown, yellow, and dark soils: red (Dr2.33), (Dr2.23), (Dr2.43), (Dr2.32), (Dr2.22); brown (Db1.33) (Db1.43); yellow (Dy2.33), (Dy2.43), (Dy3.43), (Dy3.42); dark (Dd1.33), (Dd1.43), (Dd1.42) (Dr2.32) notably occurs on gravelly hill-tops. Associated are: the (Ug5) soils of unit Ke12, which forms soil complexes with the above (D) soils in some areas; some basaltic hills and knolls of (Ug5.1) (Ug5.3), (Db3.12), (Gn3.42), and (Um6) soils; some (Uf6.31) and/or (Gn3.13) soils; some (Um4.1 and/or (Um4.2) soils and possibly other shallow (Um) or (Uc) soils on steep slopes; (Dy3.41) (Dr3.41), and (Dr2.41) soils as for unit Tb41; and various (Um) and (Uc) soils along the streams where some salinity is evident. This unit is very broad and the soil pattern is complex. Northward it grades towards the soil co. Occurs on sheet(s): 3"
"Oc11"
"Plain: chief soils are hard alkaline red soils (Dr2.33) with some cracking clays (Ug5.1) and areas of red earths (Gn2.15) towards the foot of the range. Data are limited. Occurs on sheet(s): 3"
"Oc12"
"Plains associated with functional and non-functional drainage-ways adjacent to hill country: gently undulating plains of hard alkaline red soils (Dr2.33) at the relatively higher elevations, in toposequence with related (D) soils, such as (Db1.33 and Db1.43), (Db2.33 and Db2.43), (Dy2.43), and (Dd1.33) in intermediate drainage positions and passing to cracking grey clays (Ug5.2) in the relatively lower lying sites where there is some slight gilgai (few inches) development. Either the (Dr) or the (Db) soils may be dominant locally. Small areas of red earths (Gn2.1), unit Mx5, in the western portion and unit My13 south of the Macquarie River may be included. Occurs on sheet(s): 3"
"Oc13"
"Broad, gently undulating slopes of hard alkaline red soils (Dr2.33) in variable (and unknown) association with the (D) soils of unit Ms1. Included are small areas of the chief soils of units Mz1 and Mo5. Occurs on sheet(s): 3"
"Oc14"
"Plains: chief soils are hard alkaline red and brown soils (Dr2.33) and (Db1.33) possibly with some (Dy3.43) soils also. Associated are slightly elevated, flat areas of red earths (Gn2.13) (compare unit My13); and melonhole areas of various cracking clays (Ug5.2) and (Ug3) with very low ridges of gravelly red earths (Gn2.12). Occurs on sheet(s): 3"
"Oc15"
"Plain: chief soils are hard alkaline red soils (Dr2.33) and dark cracking clays (Ug5.16 and Ug5.15), with (Db1.33) and (Dd1.33) soils, all often occurring as various soil complexes. Occurs on sheet(s): 3"
"Oc16"
"Plain: chief soils are hard alkaline red and brown soils (Dr2.33) and (Db1.33). Associated are some areas of dark cracking clays (Ug5.1) in the lower-lying sites, and undescribed soils on creek terraces. There are some general similarities with unit Oc15. Occurs on sheet(s): 3"
"Oc17"
"Gently undulating plain: chief soils are hard alkaline red and brown soils (Dr2.33) and (Db1.33). Associated are cracking clay soils (Ug5.2 and Ug5.3). All soils may form soil complexes. Data are limited. As mapped, areas of units Ro1 and Ms1 may be included. Occurs on sheet(s): 3"
"Oc18"
"Plain with some sandy areas: chief soils are hard alkaline red soils (Dr2.33) with sandy alkaline yellow mottled soils (Dy5.43) in the sandy areas. Associated are: similar (Db) soils; some low, often gravelly ridges of shallow (Um), (Dr2), and (Dy3) soils; some basalt ridges of (Db3) and (Ug5.1) soils. As mapped, areas of unit Oc17 are

included. This unit has some similarities with unit Ro1 and the gentler portions of unit Wa12. Occurs on sheet(s): 3"
"Oc19"
"Undulating ridges characterized by waterworn gravels some of which are iron cemented: chief soils are shallow forms of hard alkaline red soils (Dr2.33). Associated are some cracking clays (Ug5.1). Data are limited. Occurs on sheet(s): 3"
"Oc20"
"Plain--generally slightly raised above the level of the adjacent cracking clay plains: chief soils are shallow forms of hard alkaline red soils (Dr2.33) which usually contain ironstone gravels. Associated are: the (D) soils of unit Ro2; the Ug5 soils of units CB1 and MM3; and some lateritic residuals. Acid clays may underlie these areas There are similarities between this unit and units Oc21 and My3 of south-western Queensland. Occurs on sheet(s): 3"
"Oc21"
"Very gently undulating plains or occasional low flat terraces fringing drainage lines: chief soils are hard alkaline red soils (Dr2.33 and Dr2.43). Associated are red earths (Gn2.1) on the more elevated areas, and cracking clays (Ug5.2 and Ug5.3) and also hard alkaline brown soils (Db1.33) in the lowerlying sites. Occurs on sheet(s): 3,4"
"Oc22"
"Undulating lands with some plains fringing drainage-ways: dominant are red loamy duplex soils (Dr2.33 and Dr2.43) with some (Dr2.32 and Dr2.23). Associated are similar brown duplex soils (Db1.23 and Db1.33) and small areas of brown clays (Ug5.32 and Ug5.37). A gravel layer is often present on the surface of the soils. Small low hilly lateritic mesas (units Fz1 and Fz2) are included. Occurs on sheet(s): 4"
"Oc23"
"Moderately undulating to rolling lands with occasional low hills: dominant are red loamy duplex soils (Dr2.33) and (Dr2.43) with some (Dr2.13). Associated are similar (Db1) soils. Some high ridges are strewn with silcrete (billy) gravel. Local stream flood-plains have areas of grey clays (Ug5.24 and Ug5.25) and loamy or sandy-surfaced duplex soils (Dy2.43), (Dy3.43), (Dy3.42), and (Dr3.23). Occurs on sheet(s): 4"
"Oc24"
"Broadly undulating lands: dominant are thin-surfaced loamy duplex soils (Dr2.33), (Dr2.13), and (Dr2.43); similar (Db1) soils are closely associated. In lower sites small areas of brown and grey cracking clays (Ug5.32), (Ug5.22) occur; deeper variants (Ug5.34) and (Ug5.24) are sometimes gilgaied. Small areas of loamy red earths (Gn2.12) are included. Occurs on sheet(s): 4"
"Oc25"
"High hilly or mountainous areas; steep-sided dissected flat-topped low ranges; small strongly undulating to low hilly marginal areas; all soils are shallow and stony with numerous rock outcrops and much variation is common over short distances: dominant soils are loamy-surfaced (Dr2.33) and (Dr2.43) with some (Dr3.33). Commonly associated are similar (Db1) soils and important areas of shallow very stony (Um1.43), (Um4.1), and (Um2.12) soils. Other duplex soils also occur, chiefly (Dy2.43), (Dy2.33), and (Dy3.33), with deeper (Dy2.43) soils common along associated small streams. Occurs on sheet(s): 4"
"Oc26"
"Strongly undulating lands with some low hills: dominant are shallow stony loamy red duplex soils (Dr2.33) with lesser (Dr2.43) and (Dr2.13). Closely associated are similar (Db1) and (Dy2) soils and occasionally (Dd1.43). Adjacent to streams small flood-plains of (Dy2.43) soils occur. Occurs on sheet(s): 4"
"Oc27"
"Strongly or moderately undulating lands with a prominent quartz gravel surface layer: dominant soils are extremely gravelly red loamy duplex soils mostly of shallow depth. Chief form is (Dr2.33) but others (Dr2.32), (Dr2.13), (Dr2.12), (Dr2.43), and (Dr2.42) commonly occur. Associated are similar (Dr3) soils. On higher ridges very shallow gravelly loams (Um1.43) are common, occasionally with (Uf6.31). Also occurring in the unit are less-gravelly earths (Gn3.12) and (Gn2.12), other gravelly duplex soils (Dy2.33), and very small areas of dark cracking clays (Ug5.1). Occurs on sheet(s): 4"
"Oc28"
"Level or occasionally very gently undulating alluvial plains associated with drainage lines: dominant are red duplex soils with a relatively thin loamy A horizon (Dr2.33) and (Dr2.43). Closely associated are similar (Dy2) and (Db1) soils. All duplex soils frequently have a scalded surface; the A horizon may be entirely removed by erosion. Closely associated in the unit are small clay plains (Ug5.29 and Ug5.24), (Ug5.34 and Ug5.38). In some areas relict stream channels or occasional low broad dunes have sandy red or yellow earths (Gn2.12, Gn2.11, and Gn2.22). Occurs on sheet(s): 4"
"Oc29"
"Alluvial flood-plains often dissected by stream channels, many areas are wind-deflated: dominant are loamy red duplex soils (Dr2.33) and (Dr2.13) with closely associated similar (Db1) and (Dy2) soils. Also occurring are small areas of grey or brown clays (Ug5.24) and (Ug5.34) which may be moderately gilgaied. Occurs on sheet(s): 4"
"Oc30"

"River terraces: chief soils are hard alkaline red soils (Dr2.33). Associated are some (Dy3.43) soils; and small areas of other soils are likely. As mapped, areas of soils of unit Qb29 may be included. Occurs on sheet(s): 5"
"Oc31"
"Broad flat valleys: chief soils are hard alkaline red soils (Dr2.33) with acid clay strata below about 5-6ft depth. Associated are small areas of other soils including gilgai formations along drainage-ways. As mapped, small areas of units Vb2, Sl28, DD9, and Va66 are included. Occurs on sheet(s): 5"
"Oc32"
"A generally rolling terrain with some low gilgais: chief soils are hard alkaline red, yellow, and dark soils (Dr2.33), (Dy2.43), and (Dd1.33) in intimate association with Fey and brown cracking clays (Ug5.2 and Ug5.3), including (Ug5.38). Data are very limited. Occurs on sheet(s): 5"
"Oc33"
"Undulating plains with some low gilgais: chief soils seem to be hard alkaline red soils (Dr2.33) in intimate and complex association with calcareous earths (Gc1.22) and (Gc1.12). Other soils include red earths (Gn2.12 and Gn2.13). Occurs on sheet(s): 5"
"Oc34"
"Broad flat valleys: chief soils are hard alkaline red soils (Dr2.33). Associated are red earths (Gn2.13 and Gn2.12). Other soils may occur, including (Dr2.43), (Db2.43), (Dy3.43), (Gc1.22), (Gc1.12), and some (Ug5.2) with gilgais. Small areas of unit Vd7 occur at the head of some valleys. Occurs on sheet(s): 5"
"Oc35"
"Gently undulating to rolling terrain with some ridges and uneven slopes and with the variable presence of lateritic mesas and buttes; some granitic rock outcrops: chief soils are hard alkaline red soils (Dr2.33), (Dr2.63), (Dr2.73) with variable areas of (Dy) soils such as (Dy3.43), (Dy3.83), (Dy3.42), and (Dy3.41). Associated are some (Dr2.22) soils; patches of soils of unit Ms8; and some (Gn2.12) soils on slopes especially in the more northern and eastern areas of the unit. Occurs on sheet(s): 5"
"Oc36"
"Undulating to hilly terrain of pediments with some lateritic mesas and breakaways: chief soils on the slopes seem to be hard alkaline red soils and neutral red soils (Dr2.33, Dr2.23, and Dr2.22). Associated are (Dy3.81), (Um5.2), and (Uc5.11) soils on the slopes; and (KS-Uc2.12) soils on the mesa crests. Occurs on sheet(s): 5"
"Oc37"
"Gently undulating valley plain with terraces and levees; some mesas and buttes of unit AC9 and its erosion products are included: chief soils are hard alkaline red soils (Dr2.33) on the plain and some terraces and with areas of cracking clays (Ug5.2) and low gilgais in some localities. Associated are (Dr2.23) soils on some high terraces; (Uc1.43 and Uc1.42) soils on sandy levees; (Dy3.43) soils on terraces of tributary streams; (Dr3.22) and (Dr2.42) soils on levees and their back slopes; some plain areas of (Gn2.12 and Gn2.13) soils; and some (Dd1.33) soils on slopes below mesas. Occurs on sheet(s): 5"
"Oc38"
"Undulating to strongly undulating slopes studded with mesas and buttes of unit AC9 and its erosion products: chief soils are hard alkaline red soils (Dr2.33) in association with cracking clays (Ug5.2 and Ug5.3). There is a mild gilgai microrelief. Other soils are likely. Occurs on sheet(s): 5"
"Oc39"
"Generally relatively narrow valley side slopes and terraces: chief soils seem to be hard alkaline red soils (Dr2.33) in association with (Dd1.32) soils and probably other similar soils. Occurs on sheet(s): 5"
"Oc40"
"Alluvial plains, which are frequently badly surface-eroded, and levees associated with prior streams: chief soils are hard alkaline red soils (Dr2.33) and (Dr2.13), together with various sandy alkaline red soils including (Dr4.43) and (Dr4.33). There are small areas of sandy (Uc) soils on levees and prior stream channels, and also small areas of red dune soils (Uc5.11); and some sandy red earths (Gn). In places erosion has removed the sandy surfaces, and the resulting clay pans have sandy clay (Uf1.43) soils. Occurs on sheet(s): 6,10"
"Oc41"
"Alluvial plains with extensive clay-pan formation and some parallel sand dunes: chief soils are hard alkaline red soils (Dr2.33) with sandy clay (Uf1.43) soils in the clay pans. There are red sandy soils (Uc5.11) as parallel dunes and as lunettes surrounding the clay pans. Occurs on sheet(s): 6"
"Oc42"
"Alluvial plains with extensive clay-pan formations and with many parallel sand dunes: as in unit Oc41, the chief soils are hard alkaline red soils (Dr2.33) and sandy clays (Uf 1.43), but there is a considerably greater area of red sand dune soils (Uc5.11). Occurs on sheet(s): 6"
"Oc43"
"Gently sloping pediplains with some silcrete-capped residuals, occasional red sand dunes, and calcrete (kunkar) around drainage lines. Surface deposits of quartz pebbles are common: chief soils appear to be hard alkaline red

soils with thin (2 4 in.) A horizons (Dr2.33, Dr2.23) occasionally overlying red-brown hardpan. Associated are (Uc5.11) sands on the dunes and various (Um) soils on calcrete. Occurs on sheet(s): 6"
"Oc44"
"Steep and stony areas on Permian sedimentary rocks around the Kennedy Range: chief soils are probably hard alkaline red soils (Dr2.33), with considerable rock outcrop, and shallow (Um) soils on rock. Occurs on sheet(s): 6"
"Oc45"
"Dissected pediments and valley plains on Cretaceous sedimentary rocks near the Kennedy Range: chief soils are probably hard alkaline red soils with thin (2 4 in.) A horizons (Dr2.33), with (Dr) and (Gn) soils of unit Oc46, which sometimes overlie red-brown hardpan, on the valley plains. Occurs on sheet(s): 6"
"Oc46"
"Gently sloping pediplains with some rock outcrop and occasional red sand dunes: chief soils appear to be hard alkaline red soils (Dr2.33) with some areas of red earths (Gn2.11), both of which overlie red-brown hardpan in some places; with (Uc5.11) soils on the dunes. Occurs on sheet(s): 6"
"Oc47"
"Alluvial flats that are frequently saline and flank river courses in areas of units Mz23 of Sheet 6 and My5O: chief soils are hard alkaline and hard neutral red soils (Dr2.33), (Dr2.43), (Dr2.13), and (Dr2.73), with (Dr2.12) and (Dr2.32). There are some extensive areas of saline red soils (Dr1) and various (Gn2) soils associated with surrounding units; brown calcareous soils (Um5.11) and (Gc1.12) are associated with calcrete (kunkar). Occurs on sheet(s): 6,10"
"Oc48"
"Partly dissected pediments and breakaways capped by red-brown hardpan, with some low stony ridges and largely developed on fine-grained sedimentary and basic igneous rocks; hard alkaline red soils (Dr2.33) are dominant. Other soils include (Um5.1) on calcrete and (Uc5.32) and (Uc1.22) on narrow zones of stream deposits. (Um5.3) soils occur above breakaways capped by red-brown hardpan. Shallow stony (Um5.41) soils occur on the steeper slopes. Occurs on sheet(s): 6"
"Oc49"
"Partially dissected pediments with some low stony hills on fine-grained sedimentary rocks and basic dykes, frequently flanking areas of unit Fa8: hard alkaline red soils (Dr2.33) are dominant along with some areas of (Dr2.32), (Dr2.52), and (Dr2.72) soils. Shallow stony soils (Um5.41) and (Uc5.1 l) occur on the steeper slopes, and (Um5.3) and (Gn2.12) soils with red-brown hardpan occur on the lower slopes and on small areas of valley plains. Occurs on sheet(s): 6,10"
"Oc50"
"Dissected pediplain with occasional small steep stony hills frequently flanking areas of unit Fa5. Shales and greywackes along with some volcanics and dolomites form the country rock: hard alkaline red soils (Dr2.33) are dominant. Associated are areas of (Dr2.43), (Uc5.22), and (Um5.5) soils. Occurs on sheet(s): 6"
"Oc51"
"Gently undulating pediplain on granite with occasional low granite bosses and tors: hard alkaline red soils (Dr2.33) are dominant. (Dr2.32) soils also occur along with (Gn2.12) soils while (Um5.1) soils overlie calcrete (kunkar) zones adjacent to creeks. There is little or no red-brown hardpan in this unit. Occurs on sheet(s): 6"
"Oc52"
"Partially dissected pediplain on gneiss with some quartz dykes; and low stony ridges of gneiss and quartz dykes. Surface quartz gravels are extensive: hard alkaline red soils (Dr2.33) are dominant along with (Dr2.32) on the steeper slopes. (Um5.3) and (Gn2.12) overlying red-brown hardpan are also present. Occurs on sheet(s): 6"
"Oc53"
"Partially dissected pediplains on gneiss with a few low breakaways that are often capped by red-brown hardpan. There may be occasional low stony ridges comprising gneiss outcrops and quartz dykes. Surface quartz gravels occur extensively: hard alkaline red soils (Dr2.33) are dominant along with (Dr2.32) soils on steeper slopes. There are some areas of (Gn2.11, Gn2.12) underlain by red-brown hardpan. Occurs on sheet(s): 6"
"Oc54"
"Partially dissected pediplains on gneiss. Low stony ridges associated with quartz dykes occur and there are minor occurrences of breakaways and mesas. Surface quartz gravels are extensive. Hard alkaline red soils (Dr2.33) are dominant along with (Dr2.32) soils on steeper slopes. There are small areas of (Gn2.12) soils on outwash areas. The red-brown hardpan rarely occurs and when present lies beneath the (Gn2.12) soils. Occurs on sheet(s): 6"
"Oc55"
"Alluvial plains dominated by hard alkaline red soils (Dr2.33): narrow zones of (Um5.12) (Uc5.32), and (Uc1.22) soils occur along streamlines as well as occasional patches of (Um5.11) soils on calcrete (kunkar). Occurs on sheet(s): 6"
"Oc56"

"Plains dominated by hard alkaline red soils (Dr2.33) but with quite large areas of (Ug5.37) soils in lower situations. Other soils include (Um5.12), (Uc5.32), and (Uc1.22) occurring close to streamlines. Occurs on sheet(s): 6"
"Oc57"
"Partially dissected pediments and breakaways on Permian sedimentary rocks; quartz gravels are widespread: hard alkaline red soils (Dr2.33) are dominant along with some (Dr2.53) soils. (Gn1.12) and (Um5.11) soils occur on exposed Permian limestone and on calcrete (kunkar). Small areas of (Um5.3) occur on red-brown hardpan, which frequently caps the breakaways. Occurs on sheet(s): 6"
"Oc58"
"Broad alluvial plains with a few clay pans and red sand dunes; some areas of cracking clays along creek lines: chief soils are hard alkaline red soils (Dr2.33) and (Dr2.13). Associated are (Uf) soils in clay pans; red sands (Uc1.23) on dunes; and areas of cracking clays (Ug5.38) along creeks. This unit grades northwards into unit Oc72. Occurs on sheet(s): 6"
"Oc59"
"Foothill pediments with occasional rock outcrops and extensive stony gravel deposits: chief soils are hard alkaline red soils (Dr), probably (Dr2.33), with some (Um), (Gn), and possibly (Ug) soils adjoining unit MM17. Occurs on sheet(s): 6"
"Oc60"
"Hilly areas on bentonitic siltstones and other marine sedimentary rocks; rock outcrop is frequent: chief soils are hard alkaline red soils (Dr2.33) and other (Dr) soils, with some loamy (Um) soils on shallow rock. Occurs on sheet(s): 6"
"Oc61"
"Dissected pediments and steep residual hills with iron formations: chief soils are hard alkaline red soils, probably (Dr2.33). Associated are various (Um) and (Uc) soils on the residual hills. Occurs on sheet(s): 6,10"
"Oc62"
"Very gently undulating pediplain with low granite outcrops and tors; occasional basic dykes occur as low elongate ridges: chief soils are hard alkaline red soils (Dr2.33) and (Dr2.43) having coarse-textured A horizons up to 18 in. thick. Associated are occasional patches of calcrete (kunkar) with (Um5.11) soils as well as some (Gn2.12) soils. Occurs on sheet(s): 6"
"Oc63"
"Pediplains on granite; more dissected than unit Oc62 and usually occurring as a zone flanking the main stream courses: chief soils are hard alkaline red soils (Dr2.33) and (Dr2.43). There are more areas of (Um5.11) soils on calcrete (kunkar) than in unit Oc62 and some (Uc5.11) and (Uc1.22) soils occur along creeks. Occurs on sheet(s): 6"
"Oc64"
"Low stony hills and dissected pediments on granite with occasional basic dykes: chief soils are hard, alkaline red soils (Dr2.33) having shallow stony A horizons. Associated are shallow stony (Uc5.11) soils on steep slopes; (Uc1.22) soils along creek lines; and (Um5.11) soils on patches of calcrete (kunkar). Occurs on sheet(s): 6,10"
"Oc65"
"Low stony hills and steeply dissected pediments in areas of fine-grained sandstone, shale, and dolomite. There may be small areas of ferruginous duricrust and Robe pisolite as a capping. The soils are often shallow and stony: chief soils are hard alkaline red soils (Dr2.33) with some (Uc5.11) soils. (Um5.11) soils may occur on calcrete (kunkar) in the narrow valley plains and on exposures of calcareous rocks. (KS-Gn2.11) soils occur on the small area of ferruginous duricrust and Robe pisolite. Occurs on sheet(s): 6"
"Oc66"
"Gently undulating pediplains extending out from breakaways capped by Robe pisolite deposits and other related formations. There may be a few small flat-topped residuals rising above the pediplains: chief soils are hard alkaline red soils (Dr2.33). Small areas of (Um5.11) soils may be associated with occasional patches of calcrete (kunkar). Minor soil occurrences include (Uf6.71), (Ug5.37), (Gn2.13), and stony (Gn2.12) soils. Occurs on sheet(s): 6"
"Oc67"
"Plains: dominant soils are hard alkaline red soils (Dr2.33). Associated are extensive areas of (Um5.52) soils with (Ug5.38) soils in central landscape positions. Small areas of (Gn2.12) soils also occur as well as (Um5.11) on calcrete (kunkar). Occurs on sheet(s): 6"
"Oc68"
"Dissected stony pediments with some steep stony hills: chief soils are hard alkaline red soils (Dr2.33) but quite large areas of hard neutral red soils (Dr2.32) occur too. There are also significant areas of (Um5.5) soils. Occurs on sheet(s): 6"
"Oc69"
"Valley plains with occasional low flat-topped residuals that are often capped by iron ore formations but sometimes by calcrete (kunkar): hard alkaline red soils (Dr2.33) are dominant with some areas of (Dr2.32) soils. Significant

areas of (Uf6.71) and (Um5.52) soils also occur. Minor soil occurrences include (Ug5.38) soils in central landscape positions; (Uc1.22) along creek channels; (KS-Gn2.11) on the iron ore formation; and (Um5.11) on the calcrete (kunkar). Occurs on sheet(s): 6"
"Oc70"
"Dissected pediments and low stony hills associated with cherts, jaspilites, and iron ore formations; much coarse surface gravel: chief soils are hard alkaline red soils (Dr2 33) along with some (Dr2.32) and (Um5.52) soils. Occurs on sheet(s): 6,10"
"Oc71"
"Outwash plains with much coarse surface gravel: chief soils are hard alkaline red soils (Dr2.33) but (Uf6.71), (Ug5.38), and (Gn2.12) soils also occur. There are areas of (Gc) soils in proximity to unit Lb12. Occurs on sheet(s): 6,10"
"Oc72"
"Plains dominated by hard alkaline red soils (Dr2.33) with some areas of (Gn2.12), (Uf6.71), and (Ug5.38) soils. Occurs on sheet(s): 6"
"Oc73"
"Partially dissected pediments with some low stony hills. This unit usually flanks areas of unit Fa1O or unit Fa11: chief soils are hard alkaline red soils (Dr2.33) along with some areas of (Dr2.32) soils. Shallow stony (Uc5.11) soils occur on the steeper slopes. (Um5.3), (Gn2.11), and (Uc5.21) soils, with a red-brown hardpan beneath, occur on the lower slopes and on small areas of valley plains. Occurs on sheet(s): 6"
"Oc74"
"Dissected pediments with low stony hills as in unit Oc70, and with some residuals capped by ironstone gravels and underlain by pallid zones to 30 ft; pediments have a gravel veneer of coarse rock fragments: hard alkaline and neutral red soils (Dr2.33 and Dr2.32) are dominant with some (Um5.52) on pediments and rock outcrop, and there are gravelly loams (KS-Um5.51) and sands (KS-Uc5.21) overlying duricrust at shallow depths on the residuals. Occurs on sheet(s): 6"
"Oc75"
"Dissected pediments associated with dolomites and some chert breccias: chief soils are shallow and stony varieties of hard alkaline red soils (Dr2.33) along with some (Um5.51) soils. Occurs on sheet(s): 10"
"Oc76"
"Alluvial valley plains, often with numerous braided stream channels: dominant are loamy red duplex soils (Dr2.33) and (Dr2.13), occasionally (Dr2.43), with important areas of deep brown cracking clays (Ug5.34). Many areas away from stream channels have a scalded surface and the soils are tending to (Dr1.33). Associated soils occurring at the margins of the valley are loamy red earths (Gn2.13) and red calcareous earths (Gc2.21). Data are limited. Occurs on sheet(s): 10"
"Oc77"
"Level to gently undulating plains: dominant are loamy red duplex soils (Dr2.33) in some areas with very gravelly-surfaced horizons. Associated are a range of loamy duplex soils (Dr1.33), (Dy2.33), (Db1.43), (Db0.33), and (Db0.43), with lesser areas of deep cracking clays (Ug5.38, Ug5.34) and (Ug5.24) and gravellysurfaced uniform clays (Uf6.31). Deep loamy earths, chiefly (Gn2.42) but also (Gn2.45), (Gn2.12), and occasional (Gn2.13), occur on present and relict stream levees. Occurs on sheet(s): 10"
"Oc78"
"Undulating very low dissected plateaux or broadly undulating ridges; surface soil is usually strewn with chert gravel: dominant are thin-surfaced loamy red duplex soils (Dr2.33), with (Dr2.43) and (Dr2.13) soils occasionally associated. Adjacent to more calcareous outcrops are shallow calcareous loams (Um5.11), (Um5.61), and (Um1.3). On some slopes there are small areas of red calcareous earths (Gc1.22) and (Gc2.21), and in broad valley floors are loamy red earths (Gn2.13) or occasionally deep red sands (Uc1.23). Data are fairly limited. Occurs on sheet(s): 10"
"Oc79"
"Gently undulating to undulating plains; the soils always have a gravel or stone-strewn surface: dominant are thin-surfaced loamy red duplex soils that become highly gypseous at moderate depths. The chief form is (Dr2.33), with occasional (Dr2.32); in some areas the soils are tending to (Dr1) with a weak surface crust. Locally there are some undulating stony ridges with shallow gravelly loams (Um1.43) and (Um5.51). Occurs on sheet(s): 10"
"Oc80"
"Gently undulating plains with some low limestone ridges; the surface soil is usually strewn with chert gravel: dominant and associated soils are the same as unit Oc78. Occurs on sheet(s): 10"
"Oc81"
"Undulating lands with broad ridge crests and long gentle slopes; the soils are usually strewn w.the billy gravel and there are often scalded areas: dominant are loamy red duplex soils with 3-4 in. A horizons; the chief form is (Dr2.33) but (Dr2.13), a similar neutral soil, also occurs. On some higher ridges loamy red earths (Gn2.11, Gn2.12) or shallow gravelly loams (Um1.43) occur. In lower sites there are often areas of red or brown cracking clays

(Ug5.38, Ug5.37, Ug5.34, and Ug5.32). Small alluvial plains adjacent to streams have scalded deep loamy red duplex soils (Dr2.33) and (Dr2.13) or brown cracking clays (Ug5.34). Occurs on sheet(s): 10"
"Oc82"
"Undulating plains with occasional low stony ridges; dominant are probably gravel-strewn loamy red duplex soils (Dr2.33), with lesser (Dr2.13), (Dr2.32), and similar (Dr1) soils. On the ridge crests are shallow stony loams (Um1.43, K-Um1.43), or occasionally shallow calcareous loams (Um5.61). In some areas there are sandy plains with deep (Uc1.23) soils or sandy red earths (Gn2.13, Gn2.12). Data are limited. Occurs on sheet(s): 10"
"Oc83"
"Undulating to gently undulating pediments and outwash fans resulting from the dissection of lateritic mesas and plateaux; numerous small mesas and their eroded remnants are included in the unit: dominant soils of the pediments and fans are gravel-strewn thin-surfaced (1-3 in.) loamy red duplex soils which often have a scalded surface. The chief form is (Dr2.33), but (Dr2.13) and (Dr2.32) also occur together with some similar brown duplex soils (Db1.33, Db1.13). Closely associated are gravel-strewn red or red-brown uniform clays (Uf6.31), with some lower plains of red or brown cracking clays (Ug5.37, Ug5.38, and Ug5.32). Scalded deep brown cracking clays (Ug5.34) occur on small alluvial flood-plains of associated drainage lines. The small mesas and their eroded remnants are part of unit Fz35, too small to be mapped separately. Occurs on sheet(s): 10"
"Oc84"
"Very gently undulating or level alluvial plains: dominant are loamy red duplex soils (Dr2.33), with occasional (Db1.33) soils. Adjacent to streams and in lower sites there are small areas of deep cracking clays (Ug5.38, Ug5.34). Slightly higher areas throughout the unit have loamy red earths (Gn2.12) or earthy loams (Um5.51). Data are limited. Occurs on sheet(s): 10"
"Oc85"
"Plains and terraces flanking main drainage-ways; commonly with a stone and gravel mantle: chief soils are hard alkaline red soils (Dr2.33), also with (Dr2.13, Dr2.12). Associated are cracking clays (Ug5.2) and (Ug5.3), including (Ug5.38), often in gilgai depressions through the areas of (Dr) soils. Other soils include (Dy2.12, Dy2.13) on sandy creek flats and (Gn2.1) soils on low rises. Occurs on sheet(s): 10"
"Oc86"
"Valley plains: chief soils are hard alkaline red soils (Dr2.33), sometimes with (Dr1.33), but a variety of similar (Db) and (Dy) soils such as (Db1.32) and (Dy2.33) occur also. Associated are cracking clays (Ug5.2). Occurs on sheet(s): 10"
"Od1"
"Undulating to low hilly areas: upper slopes of hard acid red soils (Dr2.61) and hard neutral yellow soils (Dy2.42) with rock outcrops; middle slopes and crests of undulating areas of hard alkaline red soils (Dr2.43) and (Dr3.13); lower slopes and flatter situations generally of hard neutral and alkaline yellow mottled soils (Dy3.42 (3); ironstone and quartz grav common on and in the upper and mid slope soils. Occurs on sheet(s): 2"
"Od2"
"River terraces: chief soils are hard alkaline and neutral red soils (Dr2.43 and Dr2.42) with some areas of red earths (Gn2.15). Included are some basaltic ridges and knolls of various soils but probably similar to those of unit Mu9 (i). Compare unit Qd1. Data are limited. Occurs on sheet(s): 3"
"Od3"
"Undulating "high"plain (?remnant of old terrace formation) with large amounts of waterworn gravels: chief soils are shallow and often stony forms of hard alkaline and neutral red soils (Dr2.43), (Dr3.42). Compare units Qd1 and My15. Other small unmapped areas of this unit may occur. Data are limited. Occurs on sheet(s): 3"
"Od4"
"Plain with low sandy rises: chief soils are hard alkaline red soils (Dr2.43 and Dr2.33). Associated are areas of dark cracking clays (Ug5.15 and Ug5.16) in the lower-lying sites. Occurs on sheet(s): 3"
"Od5"
"Low hilly to rolling lands on sediments, sandstones, and volcanic rocks--moderate to gentle slopes; some rock outcrops: chief soils are hard alkaline red soils (Dr2.43) with some (Db1.43) and (Dy2.43). Associated are (Um2.12) and (Um4.1) soils on crests and upper slopes and (Ug5.13 and Ug5.15) soils on colluvial slopes. Occurs on sheet(s): 4"
"Od6"
"Small level plains: dominant are sandy or loamy-surfaced red duplex soils (Dr2.43) with lesser (Dr2.33) and (Dr2.13). Closely associated are similar (Dy2), (Dy3), and (Db1) soils together with small areas of grey cracking clays (Ug5.24). Also occurring are small areas of sandy or loamy red and yellow earths (Gn2.12, Gn2.13, and Gn2.22) and occasional low sand dunes (Uc1.23) and (Uc5.11). Occurs on sheet(s): 4"
"Od7"
"Undulating terrain traversed by numerous streams, many of which exhibit features of salinity; some gneissic rock outcrops: chief soils seem to be hard alkaline red soils and neutral red soils (Dr2.43 and Dr2.42), (Dr3.43 and Dr3.42), and (Dr2.33) with hard alkaline yellow soils (Dy3.43 and Dy3.42) and (Dy2.43). Associated are (Dr2.32)

soils on ridge slopes; some areas of (Dr5.42) and (Dy5.42) soils; and (Uc1.2) soils on sandy deposits in some of the larger stream valleys. As mapped, areas of unit Oc32 are included; and small ridges of the dominant soils of unit Uf3 may be included. Data are very limited. Occurs on sheet(s): 5"
"Od8"
"Undulating to rolling valley slopes with gneissic rock outcrops; some saline drainage-ways: chief soils of the slopes seem to be hard alkaline red soils (Dr2.43). Associated are a variety of similar (Dr) and (Dy) soils. As mapped, areas of unit Uf3 are included. Data are limited. Occurs on sheet(s): 5"
"Od9"
"Valleys: chief soils on river terraces and flats are hard alkaline red soils (Dr2.43); some flats show evidence of resalinization. Associated are deep cracking clays, such as (Ug5.29) and (Ug5.3), on some terraces; and various undescribed soils of recent alluvial deposition. As mapped, areas of unit MM15 may be included. Occurs on sheet(s): 5"
"Od10"
"Undulating to moderately undulating lands with some rock outcrop: dominant soils are shallow very gravellysurfaced bleached loamy red duplex soils (Dr2.43), with associated (Dr2.13). On the crests and upper slopes shallow gravelly loams (Um1.43), (Um5.51), (K-Um1.43), and (K-Um5.51) occur, with some very gravelly red earths (Gn2.1) and (K-Gn2.1) associated. Loamy red earths (Gn2.1) occur on small stream levees. Data are limited. Occurs on sheet(s): 7,10"
"Od11"
"Gently undulating plains with some rock outcrop, occasional low rocky rises: dominant soils are gravelly shallow to moderately deep bleached red duplex soils (Dr2.43), with associated (Dr2.13), (Dy3.43), (Dy2.43), and (Dy2.13). Small areas of deep grey-brown cracking clays (Ug5.24, Ug5.25) also occur. On the low rises are shallow gravelly loams (Um5.51) and (Um1.43). Occurs on sheet(s): 7,10"
"Od12"
"Gently undulating to undulating lands with rock outcrop common: dominant soils are very gravelly-surfaced shallow bleached red duplex soils (Dr2.43), (Dr3.42, Dr3.43), and (Dr2.42), with associated (Dr2.13, Dr2.12). On low rocky rises are very shallow gravelly loams (Um1.43), (Um5.51), while some loamy red earths (Gn2.11, Gn2.12) occur on lower slopes and outwash fans. Data are limited. Occurs on sheet(s): 10"
"Od13"
"Gently undulating to undulating lands with low rises with rock outcrop: dominant soils are very gravellysurfaced shallow bleached red duplex soils (Dr2.43, Dr2.42), with associated (Dr2.13, Dr2.12). Adjacent to outcrops are very gravelly shallow loams (Um1.43), (Um5.51), and (Um2.12). Loamy red earths (Gn2.13) occur on stream levees. Small inclusions of unit Fz41 occur throughout the unit. Occurs on sheet(s): 10"
"Od14"
"Gently undulating lands with occasional granite outcrop: dominant soils are gritty shallow bleached red duplex soils (Dr2.43) and (Dr2.33), with lesser (Dr2.13) and occasional similar (Dr3) soils. Associated are shallow sandy red earths (Gn2.12, Gn2.11) and some shallow coarse loamy sands (Uc4.12). Occurs on sheet(s): 10"
"Og1"
"Low very gently undulating pediplain and plains on Permian sediments, with occasional low dunes; surface quartz gravels are widespread: hard alkaline red soils (Dr2.73) are dominant along with some (Dr2.13), (Dr2.23), and (Dr2.33) soils. (Uc1.23) soils occur on the low dunes. Occurs on sheet(s): 6"
"Ok1"
"Moderate to strongly undulating lands dissected by many small streams; rock outcrop is frequent: dominant are red loamy duplex soils (Dr3.33) with lesser (Dr3.13) and (Dr3.43). Associated are similar (Dr2) and (Dy2) soils with lesser (Db1.13) and (Db1.33). Very small clay plains occur locally with (Ug5.22), (Ug5.24), or (Ug5.13) soils. Occurs on sheet(s): 4"
"P1"
"See Oc1. Occurs on sheet(s): 1"
"P2"
"Undulating--ridge and valley topography: hard alkaline red soils (Dr2.33) in association with a great variety of other D soils including (Dy3.43), (Dr3.43), and (Dr2.23) and small but frequent areas of grey cracking clays (Ug5.2) which may be co-dominant locally. Incomplete data. Occurs on sheet(s): 1"
"Pa1"
"Gently undulating to undulating broad valleys with some scree slopes marginal to unit Fx1: dominant soils are moderately deep gravelly-surfaced red duplex soils (Dr2.11), with associated (Dr2.41, Dr2.42). Smaller areas in valley floors have bleached mottled duplex soils (Dy3.43, Dy3.42). Loamy red earths (Gn2.11) occur on stream levees; these often have water-worn gravels and some ironstone nodules at depth. Outwash fans of red earths (Gn2.11) and extremely gravelly loams (Um4.1) and (Um4.21) occur near the scree slopes. Moderately deep gravelly-surfaced red duplex soils (Dr2.13) occur on small areas of limestone. Occurs on sheet(s): 7"
"Pa2"

"Moderately to strongly undulating lands with occasional low hilly areas; dominant are loamy red duplex soils (Dr2.11) overlying weathered gneiss at shallow to moderate depth (15-20 in.). The A horizons are thin (3 4 in.), sometimes gravelly, and show a clear change to the strongly structured B horizons. Similar (Dr2.12) and (Dr2.21) soils are occasionally associated. On some lower slopes and adjacent to drainage lines bleached duplex soils (Dy2.43) and (Dy3.43) occur, with lesser (Dy2.23, Dy2.22). The alkaline soils frequently have a scalded surface. Throughout the unit small areas of (Gn3.12, Gn3.11) soils occur on basic dykes. On the more stony hills shallow loams (Um4.1) and (Um4.21) occur with shallow red duplex soils. Occurs on sheet(s): 7"
"Pa3"
"Moderately to occasionally strongly undulating elongate valleys bordered by high hills: dominant are shallow to moderately deep loamy red duplex soils (Dr2.11), with lesser areas of red friable earths (Gn3.11). Occasional yellow duplex soils (Dy2.21) and (Dy2.11) also occur. At the northern end of the unit small alluvial plains have (Dr2.21), (Dy2.42, Dy2.43), and occasionally (Ug5.24) soils. The hills bordering the unit have shallow stony loams (unit LL16); small areas of these hills may be included in the unit as mapped. Occurs on sheet(s): 7"
"Pa4"
"Extremely stony hills with undulating marginal slopes; the hills consist entirely of piled granodiorite boulders with no soil present. The lower marginal slopes have moderately deep, mainly stone-free loamy red duplex soils (Dr2.11), with lesser (Dr2.21). On more acid rocks near the margin small areas of (Dy3.41) and (Dy2.21) soils occur. Occurs on sheet(s): 7"
"Pb1"
"Dissected plateaux and their escarpments at moderate elevation: undulating to low hilly plateau tops of hard acidic red soils (Dr2.21) in association with hard acidic yellow mottled soils (Dy3.41) in areas of relatively restricted drainage, rock outcrops; flanked by steep hilly, stony, escarpments of rock outcrops with siliceous sands (Uc1.2) and leached sands (Uc2.3) on colluvial deposits at the base of the slopes and in association with (Dr2.21), (Dy3.41), and other (D) soils on the hill slopes. Occurs on sheet(s): 2"
"Pb2"
"Steep hilly to hilly: steep hill slopes of hard acidic red soils (Dr2.21) with rock outcrops; middle and lower slopes of hard acidic yellow mottled soils (Dy3.41); smaller areas of other soils including (Um4.2) and (Uc6.11); dissected by small valley plains of (Dy) and other undescribed soils. Occurs on sheet(s): 2"
"Pb3"
"Hilly to mountainous at low to moderate elevation: moderate to steep hill slopes of hard acidic red soils (Dr2.21) with various (Dy) and (Dr) soils, including hard acidic yellow mottled soils (Dy3.41) on the more exposed ridges and slopes, and with various (Uc) and (Um) soils and rock outcrops; small areas of red earths (Gn2.14), red friable porous earths (Gn4.14), friable acidic red soils (Dr4.21), and friable acidic yellow soils (Dy4.21) occur also; dissected by stream valleys of undescribed soils. Occurs on sheet(s): 2"
"Pb4"
"Mountainous at low to moderate elevation: moderate to steep hill slopes of hard acidic red soils (Dr2.21) with hard acidic yellow mottled soils (Dy3.21) and other (Dy) soils including (Dy2.2, Dy2.41, Dy2.71, Dy3.81) and (Dr) soils including (Dr2.61); in association with loamy soils with an A2 horizon (Um4.2) and (Um4.1), shallow grey-brown sandy soils (Uc6.11), and rock outcrops; small areas of soils of unit Mh4 at the higher altitudes; small areas of (Dy3.41) soils in areas of restricted drainage at low altitudes; dissected by stream valleys, soils not described. Results of field traverses suggest that (Dr) soils are dominant, as recorded, north of the ranges but that (Dy) soils could be dominant in some areas south of the ranges. As mapped on Sheet 3 (north of the Murray River), areas of unit Pf1 are included. Occurs on sheet(s): 2,3"
"Pb5"
"Mountainous to steep hilly: moderate to steep slopes of hard acidic red soils (Dr2.21) with loamy soils having an A2 horizon (Um4.2) and in association with various (Dr) and (Dy) soils, including hard acidic yellow mottled soils (Dy3.41) in exposed situations, also (Uc6.11) and rock outcrops; smaller areas of (Gn) soils in moist situations; undescribed soils in the stream valleys. Occurs on sheet(s): 2"
"Pb6"
"Hilly to steep hilly country of an irregular ridge and valley form: chief soils are hard acidic red soils (Dr2.21) and hard acidic yellow and yellow mottled soils (Dy2.21) and (Dy3.41) with (Um4.1) soils and rock outcrops. Associated are small areas of milder relief of unit Pd1 soils. Data are limited. Occurs on sheet(s): 3"
"Pb7"
"Rolling to steep hilly country: chief soils are hard acidic red soils (Dr2.21) and (Dr3.21), shallow loamy soils (Um4.1) with rock outcrops, and hard acidic yellow mottled soils (Dy3.41) with some (Gn2.9) soils in low-lying sites. Associated are areas of unit Mw20 where the relief is milder. Occurs on sheet(s): 3"
"Pb8"
"Hilly to mountainous country with narrow stream valleys: slopes of hard acidic red soils (Dr2.21 and Dr2.41) and hard acidic yellow mottled soils (Dy3.21 and Dy3.41), in association with (Um4), (Um5), and/or (Uc4) soils (as for

unit Fa3), rock outcrops, and some red earths (Gn2.14) often with clay D horizons. Soil dominance is doubtful--(Dy3.41) soils are common in the areas of milder relief. Occurs on sheet(s): 3"
"Pb9"
"Area of subdued relief (?dissected terrace formations): chief soils are hard acidic red soils (Dr2.21) and possibly some (Dy) soils on the hillocky areas on which waterworn stones are common. Associated are (Gn2.14) soils on flatter areas, and (Uc) and (Um) soils on the flood-plain of present streams. Occurs on sheet(s): 3"
"Pb10"
"Scarpland: chief soils are hard acidic red soils (Dr2.21) on colluvial and slump slope deposits with siliceous sands (Uc1.2) on, or adjacent to, steep to rugged slopes with tors and rock walls. Occurs on sheet(s): 3"
"Pb11"
"Steep hilly ranges with undulating to low hilly valleys: chief soils are hard acidic and neutral red soils (Dr2.21), (Dr2.41), (Dr2.42), (Dr3.41), and hard acidic and neutral yellow mottled soils (Dy3.21, Dy3.41, Dy3.42) with (Um4.1) and possibly other soils. Data are limited. Occurs on sheet(s): 3"
"Pb12"
"Gently rolling to rounded hilly country with some steep slopes and broad valleys: chief soils are hard acidic red soils (Dr2.21) with hard neutral and acidic yellow mottled soils (Dy3.42 and Dy3.41) on lower slopes and in valleys. Associated are small areas of various soils including (Gn3.54) on some ridges, (Dr3.31) on some slopes; (Dr2.23) in saddles and some mid-slope positions, and some lowlying swampy areas of (Uf6) soils and (Uc1.2) soils with peaty surfaces. Small areas of other soils such as (Db1.2) are likely throughout. Occurs on sheet(s): 3"
"Pb13"
"Ridge and valley country of gently undulating ridge tops and steep side slopes often with slumping, also rounded hilly to steep hilly areas and relatively narrow valleys: chief soils are hard acidic red soils (Dr2.21) with hard acidic yellow mottled soils (Dy3.41); in places some ironstone gravels occur in both these soils. Associated are hard neutral and alkaline red soils (Dr2.22 and Dr2.23) in saddles and some mid-slope positions; (Dy3.42 and Dy3.43) soils, usually in depressions; and small areas of undescribed soils in wet soaks and valley areas. Small areas of other soils are likely throughout. Occurs on sheet(s): 3"
"Pb14"
"Hilly with rock outcrops and very steep slopes in some areas: chief soils are hard acidic red soils (Dr2.21); hard acidic yellow mottled soils (Dy3.41); and shallow loamy soils, such as (Um4.1). Associated are various (Gn2) soils, such as (Gn2.14), (Gn2.24), and (Gn2.74), especially in "fill"situations; and undescribed soils (a) associated with serpentine and related rock types and (b) of the narrow stream valleys. As mapped, areas of unit Tb50 are included. Occurs on sheet(s): 3"
"Pb15"
"Hilly to steep hilly ridges with rock outcrops flanking narrow stream valleys: moderate to steep slopes of hard acidic red soils (Dr2.21) and (Dy3.21), (Dy3.41) and (Um4.2) soils flanking small, but significant, areas of acid leached red and yellow earths (Gn2.14 and Gn2.24) on undulating areas close to the streams. Occurs on sheet(s): 3"
"Pb16"
"Ridge and valley complex of moderate to steep hill slopes and variable terrace formations along the major stream valleys (similar to unit Ta7): chief soils of the hill slopes are hard acidic red soils (Dr2.21) in association with hard acidic yellow mottled soils (Dy3.21), and loamy soils having an A8 horizon (Um4.2) on mid and upper slopes, and (Dy3.41) and (Dr3.41) soils on lower slopes. The terrace soils belong to unit Mj2 and, as with that unit, considerable local variation of terrace age and therefore soil occurs. As mapped, areas of unit Ps1 and unit Mj5 as in the Gleniffer-Valery localities are included. Occurs on sheet(s): 3"
"Pb17"
"Hilly areas alternating with small wet flats: hilly areas of hard acidic red soils (Dr2.21 and Dr2.11) possibly with other (D) soils, and small wet flats of such soils as (Gn3.94). Soils data are limited. Occurs on sheet(s): 3"
"Pb18"
"Undulating to low hilly: ridges and low hills of hard acidic red and red mottled soils (Dr2.21) and (Dr3.21) and hard acidic yellow mottled soils (Dy3.41) with intervening low-lying areas of sandy acidic yellow mottled soils (Dy5.81). Some river terraces of (DrS.21) and (Um6.11) soils (similar to unit Mj2) occur along the streams. Occurs on sheet(s): 3"
"Pb19"
"Hilly to steep hilly with some rock outcrops: chief soils are hard acidic red soils (Dr2.21) and hard acidic yellow mottled soils (Dy3.21). Associated are variable occurrences of red friable earths (Gn3.14) and other (Gn3) soils; (Um4.2) soils; and some areas of soils of unit Tb56. Occurs on sheet(s): 3"
"Pb20"
"Low rounded limestone hills with gentle side slopes and shallow open valleys: chief soils are hard acidic and neutral red soils (Dr2.21 and Dr2.22) on crests and slopes. Associated are (Gn3.42) and (Gn3.12) soils in some

localities. Other soils include (Um6.21) on crests, (Db1.41) on slopes, (Ug5) and (Dy2.12) on stream flats, and (Dr3.41) on some included shale areas. Occurs on sheet(s): 4"
"Pb21"
"Low hilly country on granitic rocks with long gentle slopes rising to rounded crests with some rock outcrops, and studded with many stripped lateritic mesas surrounded by prominent scarps 10 50 ft high and formed in flat-lying sandy sediments: chief soils are hard acidic red soils (Dr2.21) on both sedentary and colluvial slopes. Associated are: shallow (Dr2.11) and (Dy2.11) and (Gn3.13) and (Gn3.23) soils on mid and upper slopes of igneous rocks; (Dy2.43), (Dy3.43), and (Dd1.33) soils on lower slopes and some flats; (Dy3.41), (Dy2.42), and related soils on altered rocks and lateritic residuals; and stony and gravelly (Uc4.12 and Uc4.2) soils on stripped mesas. Minor soil occurrences include (Gn3.43) under brigalow on low gentle slopes. Occurs on sheet(s): 4"
"Pb22"
"Low hilly country on granitic rocks; mainly smooth broad low crests, some with rock outcrops; a few scattered residuals of stripped mesas: chief soils are hard acidic red soils (Dr2.21) and (Dr2.11) with some (Dr2.22) and (Dr2.12). Associated are (Dy2.21), (Dy2.43), (Dy3.43), (Gn3.12), (Gn3.23), (Db1.33), and (Dd1.33) soils on mid to lower slopes; and (Gn3.43), (Ug5.4), and (Ug5.15) soils on lower slopes and slight depressions. Minor soil occurrences include (Dy3.41) with (Um2.12), (Uc2.12), and (Dr2.41) soils on mesa crests. Occurs on sheet(s): 4"
"Pb23"
"Steep hilly to mountainous land derived largely from greywacke--slopes are steep to moderate and rise to narrow ridge crests with rock outcrops: chief soils are hard acidic red soils (Dr2.21), (Dr2.11), and (Dr2.41) with some (Dr2.12) and (Dr2.22). Associated are (Um4.1) and (Um2.12) soils on crests; (Dy2.41) and (Dy3.42) soils on slopes; and (Gn3.11) and (Gn3.21) soils on patches of basalt. Minor soil occurrences include (Db1.22) and (Dy3.43). Occurs on sheet(s): 4"
"Pb24"
"Moderate to low hilly country on mixed parent rocks including conglomerates, lithic sandstones, and mudstones--slopes are moderate and rounded, valleys are narrow: chief soils are hard acidic red soils (Dr2.21) with some (Dr2.22), (Dr2.41), (Dr2.11), and (Dr2.12) on all crests and slopes. Associated are other (D) soils including (Db1.21) and (Dy2.21) on mid slopes and (Dy3.42) and (Dd1.43) on lower slopes. Other soil occurrences include (Um4.1) on crests, some (Gn3.11 and Gn3.12) on slopes, and (Gn3.43 and Gn3.49) and (Ug5.15 and Ug5.16) on valley floors and minor terraces. Occurs on sheet(s): 4"
"Pb25"
"Low hilly granitic lands with gentle to moderate slopes and some colluvial accumulation at their base: chief soils are hard acidic red soils (Dr2.21) and (Dr2.11). Associated are (Dy2.22) and (Dy2.41) soils on slopes, (Dr2.41) and (Dr2.81) soils on colluvium, and (Uc2.12) soils on some crests. Minor soil occurrences include (Dy4.41), (Gn2.24), (Uc2.21), and (Ug5.15). Occurs on sheet(s): 4"
"Pb26"
"Hilly, low hilly, or strongly undulating lands: dominant are shallow often stony loamy red duplex soils, chiefly (Dr2.21), but (Dr2.11), (Dr3.21), (Dr4.21), and (Dr4.11) also occur. Associated are mottled grey-brown and red loamy duplex soils (Dy3.21) and (Dy3.31). Friable earths (Gn3.14) and (Gn3.24) occur on some higher hills, and associated narrow valley floor flood-plains have deep loamy duplex soils (Dy3.42), (Dy3.32), and less commonly (Dd1.12) and (Dd1.32). Occurs on sheet(s): 4"
"Pb27"
"Extremely steep dissected mountain scarps and steep-sided high hills; rock outcrop may be common: dominant are strongly acid loamy duplex soils (Dr2.21) with associated (Dy3.21), (Dy3.41), and similar (Db1) soils. Most are shallow and stony. On higher slopes friable earths (Gn3.14) and (Gn3.24) are common, with lesser (Gn3.54) and (Gn3.74). Small areas of coarse sandy or gritty earths (Gn2.14), (Gn2.24), and (Gn2.44), also occur and in more stony sites shallow loams (Um4.1) and (Um1.43) are common. Occurs on sheet(s): 4,7"
"Pb28"
"Incised valleys with moderate to steep hilly slopes, some narrow tributary valleys and valley basins; granitic rock outcrops common on slopes: chief soils seem to be hard acidic red soils (Dr2.21) and (Dr2.61) with hard acidic yellow mottled soils (Dy3.21) on the slopes. Associated are neutral red earths (Gn2.15) on colluvial fills; and some siliceous sands (Uc1.2) sometimes overlying ironstone gravels in the narrow tributary valleys. As mapped, areas of adjoining units are included. Occurs on sheet(s): 5"
"Pb29"
"Generally rolling but sometimes undulating or hilly terrain on granulite; some rock outcrops; some mesas and buttes of unit Uc2: chief soils are hard acidic red soils and neutral red soils (Dr2.21, Dr2.22, and Dr2.62). Associated are (Um4.1) and (Uc4.11) soils on upper slopes; (Dr3.22) soils on mid slopes; (Dr3.42 and Dr3.43) soils on lower slopes in places; and some sand fills of (Uc1.22) and (Uc5.22) soils. Occurs on sheet(s): 5,6"
"Pb30"
"Gently undulating to undulating lands with some isolated low hilly areas: dominant are shallow to moderately deep loamy red duplex soils (Dr2.21). Associated are other loamy duplex soils (Dy2.31), (Dy2.42), and (Dy3.42),

which occur on lower slopes and in drainage lines. Some shallow gravelly sands (Uc4.21) and loams (Um4.2) occur on ridge crests and higher slopes or adjacent to rock outcrop. Also included are small areas of deep cracking clays (Ug5.17), and other soils of unit Kb30. Occurs on sheet(s): 5,7"
"Pb31"
"Low hilly to hilly lands: dominant and associated soils are similar to those of unit Pb30 but the shallow gravelly sands (Uc4.21) and loams (Um4.2) are the chief associates. Data are very limited. Occurs on sheet(s): 7"
"Pb32"
"Moderately to strongly undulating lands with occasional low hilly areas: dominant are shallow to moderately deep loamy red duplex soils with gravelly A horizons; the most common soil is probably (Dr2.21), but neutral forms also occur widely. Associated are similar (Dr2.12, Dr2.11) soils and important occurrences of red friable earths (Gn3.12, Gn3.11) on more basic rocks. Areas of stronger relief have shallow stony loams (Um4.21) and (Um4.1) and similar (Uc4) soils. Minor areas of yellow duplex soils (Dy3.21), (Dy3.22), (Dy2.22), and (Dy3.43) also occur, mostly on lower slopes. Occurs on sheet(s): 7"
"Pb33"
"High hilly lands with very steep slopes and deeply incised minor drainage lines: dominant are moderately deep to deep loamy red duplex soils (Dr2.21), with lesser (Dr3.21). The soils have variable amounts of coarse detrital gravel throughout the profile. Deep gravelly red earths (Gn2.14) are common on the lower colluvial slopes. Shallow loams (Um4.1) and (Um4.21) and occasionally sands (Uc2.12) and (Uc4.22) occur on the steeper slopes and adjacent to rock outcrop. A range of loamy duplex soils (Dy3.41), (Dy3.43), (Dy3.21), and (Dr3.41) occur on lower slopes in areas of lesser relief. Occurs on sheet(s): 7"
"Pb34"
"Gently undulating to undulating lands with some low very rocky granite knolls: dominant are moderately deep loamy red duplex soils (Dr2.21), with lesser (Dr2.11). Major and minor associated soils are similar to those of unit Mu16. Occurs on sheet(s): 7"
"Pb35"
"Undulating lands with some low hilly areas. The unit is similar to unit Pb32 but is less dissected; ridge crests are rounded and long slopes are common: dominant and associated soils are probably the same as unit Pb32 but there are greater areas of red friable earths (Gn3.12, Gn3.11). Data are extremely limited. Occurs on sheet(s): 7"
"Pb36"
"Low hilly to hilly lands with steep slopes; schist outcrop is common: dominant soils on higher landscape sites are shallow to moderately deep gravelly loamy red duplex soils, chiefly (Dr2.21) but (Dr2.41) and (Dr2.61) are commonly associated. On lower slopes similar yellow duplex soils (Dy3.21), (Dy2.21), and (Dy3.41) usually occur. On higher rocky hills shallow stony loams (Um4.12) and (Um4.21) occur, and there are also small inclusions of granite with shallow bleached sands (Uc2.12) and (Uc2.21). Occurs on sheet(s): 7"
"Pc1"
"Strongly undulating to low hilly dissected gravelly fans and terraces: dominant soils are gravel-strewn with a thin loamy surface overlying acid red clay (Dr2.31). Neutral forms (Dr2.32) and (Dr2.42) also occur. Commonly associated are similar brown soils (Db1.11), (Db1.31), and (Db1.32). Small flood-plains adjacent to drainage lines have alkaline loamy duplex soils (Dy2.33) and (Dy2.43). Occurs on sheet(s): 4"
"Pc2"
"Hilly to low hilly terrain on phyllites--convex hills with moderate side slopes, small slope fans, and relatively narrow stream valleys: chief soils are hard acid red soils (Dr2.31), (Dr3.31), (Dr2.21), and (Dr2.41) on the slopes. Associated are (Um2.12) soils on hill crests and (Gn3.71) soils on lower slopes and fans. Other soils encountered are: (Um4.1) on hill crests; (Dr3.41) on crests and upper slopes; (Gn3.41) on young fans; (Gn2.64) and (Gn2.94) along stream valleys; (Gn3.74) on benches; and (Gn2.14) on terraces in some localities. Occurs on sheet(s): 4"
"Pd1"
"Undulating to rolling terrain: chief soils are hard acidic red and red mottled soils (Dr2.41), (Dr2.21), (Dr3.41) with hard acidic yellow and yellow mottled soils (Dy2.41) and (Dy3.41). Associated are red and yellow earths (Gn2.14), (Gn2.15), and (Gn2.24), and some (Gn2.94) soils in wet sites. Data are limited. Occurs on sheet(s): 3"
"Pd2"
"Undulating to rolling and hilly with some steep slopes in a general ridge and valley terrain, tors: chief soils are hard acidic red soils (Dr2.21), (Dr2.61) on upper slopes, (Dr2.41) on mid and upper slopes, with hard acidic yellow and yellow mottled soils (Dy2.21) on upper and mid slopes and (Dy2.41), (Dy3.41) on mid and lower slopes. Associated are red earths (Gn2.14) on upper and mid slopes; yellow earths, such as (Gn2.34) on lower slopes; and (Dd3.12), (Ug5.13), (Db3.12), (Dr4.12) soils on steep and sometimes bouldery slopes of serpentine rocks. Data are limited. Occurs on sheet(s): 3"
"Pd3"
"Mountainous: chief soils on the steep slopes are hard acidic and neutral red soils (Dr2.41 and Dr2.42) with rock outcrops. Associated are: some siliceous sands (Uc1.2) on colluvial deposits; some undulating areas on narrow ridges and hill-tops of undescribed soils; minor areas of various soils, including (Uf6.31), where special parent

materials (e.g. limestones) are exposed; and narrow floodplains of undescribed soils along some streams. Occurs on sheet(s): 3"
"Pd4"
"Steep and often very rugged ranges: chief soils are shallow and stony hard acidic red soils (Dr2.41) and possibly (Dr2.21) with shallow stony loams (Um4.1) and rock outcrops. Associated are various other (D) soils, especially (Dy) soils, and small areas of many diverse soils, including (Gn3.16) and (Gn2) soils on flanking slopes and other sites of accumulation. Occurs on sheet(s): 3"
"Pd5"
"Range country with scarps, steep slopes, undulating ridge crests and hilly tracts, narrow undulating valleys, rock outcrops: chief soils seem to be hard acidic red and yellow mottled soils (Dr2.41), (Dr2.21), and (Dy3.41) often of shallow depth and stony with (Um4.1) also stony, on slopes, and (Dy3.4) soils with other (undescribed) soils in areas of milder relief. Associated are small areas of a variety of soils including (Dr4.12) and (Db1.2). As mapped, areas similar to unit Mr5 could be included, but available data, which are very limited, do not indicate. Compare unit Pd4. Occurs on sheet(s): 3"
"Pd6"
"Dissected low plateau or old coastal plain on shales (less than 400 ft above sea level), low hilly to hilly relief: chief soils are hard acidic red soils (Dr2.41) and shallow leached loams (Um2.12) often in an intimate microassociation on the slopes and convex hill crests. Associated are (Gn2.14) and probably (Gn2.11) soils on flat remnants of the old plateau; (Dy3.41) and (Dy2.41) soils on lower hill slopes and along narrow drainage lines; and (Dr3.41) soils on crests of inselbergs standing above the old plateau level. Other soils included are (Uc5.21), (Uc2.12), and (Db2.31). Occurs on sheet(s): 4"
"Pd7"
"Low hilly terrain on shales; gentle side slopes to shallow open valleys with narrow alluvial flats: chief soils are hard acidic red soils (Dr2.41) and (Dr2.31) on slopes and crests. Associated are (Dy3.41) soils on lower slopes and (Um2.12) soils on crests. Other soils include: (Dy3.41), (Gn3.14),and (Gn2.34) on slope fans; (Dy3.31), (Dy3.42), (Dd1.22), (Uc1.23), and (Uc1.4) on stream terraces and flats; and (Dr2.12), (Gn3.12), and (Gn3.42) on andesitic dykes on some slopes. Occurs on sheet(s): 4"
"Pd8"
"Low to moderately hilly land of narrow rounded crests with narrow incised valleys and some short moderate colluvial slopes; derived from lithic sandstones and some shales: chief soils are hard acidic red soils (Dr2.41) with some (Dr2.21) on the upper, mid, and colluvial slopes. Associated are: (Dy3.41), (Dy2.41), and sometimes (Dy2.43) and (Dy3.43) soils on the gentler and lower slopes; gravelly (Gn2.14) soils on upper slopes; and (Um2.12) soils on some crests. Minor soil occurrences include (Db1.41), (Db1.33), (Db1.43), (Dr3.41), (Dd1.41), and (Dy3.33) on lower slopes and along valleys, and (Dd3.13) and (Ug5.14) under brigalow on bench formations. Occurs on sheet(s): 4"
"Pd9"
"Small valley plains and their marginal slopes; derived from lithic sandstones and some shales: chief soils are hard acidic red soils (Dr2.41) and (Dr2.21). Associated are variable areas of the soils recorded for unit Pd8. Occurs on sheet(s): 4"
"Pd10"
"Rolling to smooth low hilly country on volcanic rocks and boulder beds, some poorly drained flats; relief increases to moderately hilly on margins of unit: chief soils are hard acidic red soils (Dr2.41) with some (Dr2.42). Associated are (Dy2.41 and Dy2.42) soils on slopes; some (Gn3.22) and (Gn3.11); and in bottoms and flats (Ug5.16) with (Gn3.43) and (Ug5.4) soils with gilgai microrelief. Minor soil occurrences include (Db1.11), (Db1.21), (Dd1.11), and (Dd1.21) on slopes. Occurs on sheet(s): 4"
"Pd11"
"Low to moderately hilly lands on metamorphic rocks with smooth rounded crests at 360-400 ft above sea level (dissected former level) forming a close pattern with short moderate slopes straight to the drainage-ways: chief soils are hard acidic red soils (Dr2.41) and (Dr3.41) with some (Dy3.41) and (Dy2.41). Associated are: (Gn3.12) soils on crests and slopes; (Um2.12) and (Um4.1) soils, often very shallow and gravelly, on crests; and (Db2.42) soils on slopes. Occurs on sheet(s): 4"
"Pd12"
"Moderately hilly lands on metasediments, stony crests and moderate slopes; some alluvial plains and terraces: chief soils are hard acidic red soils (Dr2.41), (Dr2.21), and (Dr2.11), often gravelly. Associated are: (Dy2.41), (Db1.21), and (Db1.41) soils on crests and slopes; (Um4.1) and (Um6.22) soils, often gravelly, on crests; and (Dy2.43) and (Dd1.43) soils on lower slopes and drainage-ways. Minor soil occurrences include (Ug5.16), (Gn3.43), (Gn3.12), and (Gn3.13). Occurs on sheet(s): 4"
"Pd13"

"Low hilly terrain on metamorphic rocks but with some hilly inclusions: chief soils seem to be hard acidic red soils (Dr2.41) and (Dr2.21) with (Dy3.41) and (Dy3.21). Associated are (Ug5.12) soils, (Dy2.42), (Dy2.43), and (Dy3.43) on lower slopes, and (Uc2.12) and (Um4.1) soils on crests. Data are very limited. Occurs on sheet(s): 4"
"Pd14"
"Low hilly lands with undulating marginal slopes: dominant soils are moderately deep loamy red duplex soils (Dr2.41), with other duplex soils (Dr2.21) and (Dy3.41) associated. On lesser slopes are small areas of red friable earths (Gn3.11, Gn3.14). On higher hills shallow stony loams (Um4.21) occur, and also included in the unit are occasional hills of granite with shallow to moderately deep sandy soils (Uc2.21), (Uc2.12), and (Uc4.21). Occurs on sheet(s): 7"
"Pd15"
"Hilly to low hilly lands, often with igneous rock outcrop: a range of shallow to moderately deep stony loamy duplex soils occur but bleached red soils (Dr2.41) are probably most common. Closely associated are (Dr3.41) and (Dr2.21) and yellow mottled duplex soils (Dy3.41). On steeper slopes shallow gravelly red earths (Gn2.14) and shallow massive red duplex soils (Dr2.61) are common. Moderately deep gravelly red friable earths (Gn3.14) occur on areas of more basic rocks. Occurs on sheet(s): 7"
"Pf1"
"Steep hilly: moderate to steep hill slopes of hard acidic red soils (Dr2.61) in association with hard acidic yellow mottled soils (Dy3.81), rock outcrops, and various (Uc) and (Um) soils; dissected by narrow stream valleys of undescribed soils. Occurs on sheet(s): 2,3"
"Pf2"
"High hills with steep marginal slopes and much rock outcrop: dominant are shallow to moderately deep gravelly red duplex soils (Dr2.61), with lesser (Dr2.21). Loamy red earths (Gn2.14) and lesser yellow earths (Gn2.24) are common on the lower pediment slopes. Minor associated soils include shallow friable loams (Um4.41) and (Um4.12), with some shallow sands (Uc4.12) and loamy duplex soils (Dy3.41) on small granite inclusions. Occurs on sheet(s): 7"
"Pf3"
"Strongly undulating or low hilly lands with large granite tor outcrop: dominant are shallow to moderately deep sandy or loamy red duplex soils (Dr2.61). Associated are sandy or loamy red earths (Gn2.14), with shallow sands (Uc4.12) and (Uc4.22) occurring near some areas of granite outcrop. Data are fairly limited. Occurs on sheet(s): 7"
"Ph1"
"High hills with steep slopes and much large granite tor outcrop: dominant are gritty duplex soils with red clay loam or light clay massive subsoils. The chief form is (Dr2.81) with (Dr2.82), (Dr2.61), (Dr2.62), and lesser similar (Dr4) soils all occurring. In more stony sites shallow sands (Uc2.21) and (Uc4.2) occur together with some gritty gradational soils (Gn2.14). Similar deeper soils occur on outwash fans. On low foothill slopes there are some areas of yellow-grey sandy duplex soils (Dy3.42). Occurs on sheet(s): 4"
"Ph2"
"River levees and terraces: chief soils are hard acidic red soils (Dr2.81) on the levees. Associated are upper terraces of neutral red and yellow earths (Gn2.15) and (Gn2.25); lower terraces of (Um6.11) soils; and smaller areas of other soils. Occurs on sheet(s): 5"
"Pj1"
"Hilly: chief soils are hard acidic red mottled soils (Dr3.21). Associated are some (Gn2) and (Gn3) soils containing lateritic nodules along the hill crests, and (Dy2.23) soils on slope positions. Occurs on sheet(s): 4"
"Pk1"
"Generally rounded hills with gentle slopes: chief soils seem to be hard acidic red mottled soils (Dr3.31). Associated are a variety of (Dr), (Dy), and (Gn) soils, notably (Dy3.4), (Db2.1), and (Dr2.4); and shallow sandy soils (Uc4) on crests. Occurs on sheet(s): 4"
"Pl1"
"Hilly country of sandstones and intruded intermediate and basic rocks, rising to 800 ft above sea level: chief soils on the moderate to steep slopes are hard acidic red and yellow soils (Dr3.41), (Dr2.41), and (Dy3.41) with some areas of (Dy3.43) and (Dr3.43) soils. Associated are (Dy5.81) soils containing nodular ironstone material and covering considerable areas in some localities. Minor soil occurrences are (Uc1.21) sands on steep slopes associated with sandstones; (Uf6.12) and (Ug5.15) soils on basic rocks; (Gn2.14), (Gn2.34), and (Gn2.24) soils on gently undulating areas about the 600-ft contour level; and some (Db4.11) soils. As mapped, small valleys of unit Kd6 are included in places. Occurs on sheet(s): 4"
"Pl2"
"Low hilly to hilly terrain on fine-grained sandstones and shales with gentle to moderate side slopes: chief soils are shallow hard acidic red mottled soils (Dr3.41) and leached loams (Um2.12). Associated are shallow (Dr2.41) and (Um4.1) soils. Other soils include (Dy3.41) on lower hill slopes and (Gn2.94) and (Gn2.54) along stream valleys. Occurs on sheet(s): 4"
"Pl3"

"Low hilly to hilly land on siltstones and shales--generally small hilly summits with moderate side slopes to low hilly terrain; some low flat-topped platform remnants: chief soils are hard acidic red mottled soils (Dr3.41), (Dr3.21), and (Dr3.31) on hill slopes and some crests. Associated are (Gn3.94), (Gn3.04), and (Gn3.64) soils on slopes and some crests. Other soils include (Um2.12) on some crests; (Dy3.41) and (Gn3.81) on slopes; (Gn3.12) and (Gn3.23) on basalt inclusions; and (Gn2.14) on low platform remnants. Occurs on sheet(s): 4"
"Pl4"
"Hilly dissected erosion scarp mainly in phyllites but with some greenstones, granites, and sandstones-convex hills with narrow spurs and moderate to steep side slopes; V-valleys with narrow alluvial flats; some low hilly areas along eastern margin: chief soils are hard acidic red mottled soils (Dr3.41) with some (Dr2.21) and (Dr2.31). Associated are: (Um4.1) soils on hill crests; (Gn3.74), (Gn3.54), and (Gn3.84) soils on lower hill slopes and fans; and (Dy3.41) soils on mid and lower slopes. Minor soil occurrences include: (Um2.12) on hill crests; (Ug5.16) and (Gn2.9) soils on flats; (Dy3.31) soils on granite; (Dy5.21) and (Uc4) soils on sandstone; and (Gn3.11) soils on greenstones. Occurs on sheet(s): 4"
"Pl5"
"Hilly to low hilly lands on metasediments with gentle to moderate side slopes to open shallow valleys with alluvial flats: chief soils are hard acidic red mottled soils (Dr3.41). Associated are (Dy3.42) and (Dr3.42) soils on mid slopes and (Um2.12) and (Dy3.41) soils on crests and upper slopes. Minor soil occurrences include (Dy3.43) on flats, (Gn2.14) on some platforms, and gravelly (Um4.2) on fans. Occurs on sheet(s): 4"
"Pl6"
"Dissected plateau of hilly relief, on metasediments; moderate side slopes, fans, and valley flats: chief soils are hard acidic red mottled soils (Dr3.41) with (Dy3.41). Associated are: (Gn3.14) soils on crests of low rises; (Gn4.14) soils on older fans; (Gn2.14) soils on younger fans; and (Gn2.91), (Gn2.94), and (Gn3.04) soils on valley flats. Minor soil occurrences include (Um2.12) on hill crests and (Gn3.42) and (Gn2.54) on some fans. Occurs on sheet(s): 4"
"Ps1"
"Steep hills and ridges: chief soils are friable acidic red soils (Dr4.21) and hard acidic red soils (Dr2.21) probably with other (D) soils, not described at present. Associated are (Um4.2) (Gn2.24), and (Gn2.44) soils on the steeper and relatively drier slopes; and (Gn4.14) and (Gn3.14) soils on the relatively more humid slopes. Occurs on sheet(s): 3"
"Pu1"
"Strongly hilly to mountainous country on metasediments and granites with andesites; narrow ridge crests and short moderate to steep slopes to vallevs: chief soils are friable acid red soils (Dr4.41) with (Dr5.41), (Dr4.21), and (Dr4.11). Associated are: gritty (Um2.12), (Um4.1), and (Uc2.12) soils on crests and upper slopes; some (Gn3.11) and (Gn3.71); some (Dy5.21), (Dy5.41), (Dy4.41), and (Dy4.21) soils; and some (Dy3.41), (Dy2.41), (Db1.41), and (Dr2.41) soils on exposed slopes and around the margins of the unit. Occurs on sheet(s): 4"
"Q1"
"Hills and hill slopes: hard neutral red soils (Dr2.22) with small areas of shallow dense loamy soils (Um5.41) and smaller areas of red and brown shallow loamy soils (Um6.42 and Um6.43) on slopes, and also (Dy3.61) on the crests of some hills and ridges. Minor areas of soils common to adjacent map units. Occurs on sheet(s): 1"
"QM1"
"Very gently undulating plains with numerous sandy rises and relic channels and levees adjacent to functional streams: dominant soils are deep sandy or occasionally loamy mottled grey earths (Gn2.84), with closely associated (Gn2.94), (Gn2.81), and (Gn2.91) soils; neutral forms occasionally occur. Ironstone nodules often occur and may become prominent at depth. Other associated soils are sandy or loamy mottled yellow earths (Gn2.61). On the sandy rises are deep earthy sands (Uc5.23, Uc5.22) and (Uc4.2); sandy yellow, red, or grey earths (Gn2.21), (Gn2.24), (Gn2.15), (Gn2.81), and (Gn2.82); and occasionally extremely nodular sands (Uc5.11). On relic channels and levees are deep sandy yellow earths (Gn2.21, Gn2.24) and (Gn2.61) and deep earthy sands (Uc5.22) and (Uc2.22, Uc2.23). Occurs on sheet(s): 7"
"QM2"
"Gently undulating plains with many low areas subject to seasonal inundation: dominant soils are deep loamy grey earths (Gn2.84), with similar loamy yellow earths (Gn2.24) and lesser red earths (Gn2.14) occurring on better-drained low rises. Loamy duplex soils (Dy3.41) and (Dy2.41) with deep organic A horizons are common in the wet depressions and other loamy duplex soils (Dy3.21), (Dy2.21), (Dy3.41), and (Dy2.41) occur on better-drained areas. Moderately deep loamy red (Gn2.14) or yellow (Gn2.24) earths occur on the low granite rises that are included in the unit. Occurs on sheet(s): 7"
"QM3"
"High hilly lands with high very steep scarp margins; much large granite tor outcrop: dominant soils are shallow to moderately deep loamy mottled grey earths (Gn2.84), with lesser yellow earths (Gn2.24). Loamy red earths (Gn2.14) are common on the lower slopes and shallow gritty sands (Uc4.21) and (Uc4.12) occur adjacent to rock outcrop. Occurs on sheet(s): 7"

"QM4"
"Strongly undulating or low hilly dissected sandstone mesas: dominant soils are shallow sandy or loamy mottled grey earths (Gn2.84), with lesser (Gn2.44). On outwash slopes and valley floors nodular sandy yellow earths (Gn2.34) and (Gn2.24) are common, with some deep sands (Uc4.21) and (Uc2.21) and occasional areas of sandy red earths (Gn2.11, Gn2.14). Data are fairly limited. Occurs on sheet(s): 7"
"Qa1"
"More or less rounded hills with stony, gentle to steep slopes of hard neutral red soils (Dr2.12) in association with hard alkaline red soils (Dr2.13) and minor areas of dark cracking clays (Ug5.14 and Ug5.13). Occurs on sheet(s): 2"
"Qa2"
"Hilly: as for Qa1 but also with gentle to moderate slopes of sandy acidic yellow mottled soils (Dy5.81) and hard acidic yellow mottled soils (Dy3.41). Occurs on sheet(s): 2"
"Qa3"
"Hilly: as for Qa1 but with unit Ke5 dominant in the eastern portion of the area. Occurs on sheet(s): 2"
"Qa4"
"Generally gently sloping rolling to low hilly land with broad crests and some alluvial plains and terraces; generally derived from granite: chief soils are hard neutral and acid red soils (Dr2.12) and (Dr2.22) and (Dr2.11) and (Dr2.21) on upper slopes. Associated are a range of (D) soils including (Dy3.42), (Dy3.43), (Dd2.43), and (Db1.43) on mid and lower slopes. Other soils include: (Dy2.43), (Dy3.43), (Db1.43), and (Dd1.43) on alluvial plains with (Gn2.1) soils on terraces; patches of (Gn3.43) soils under brigalow on lower slopes and plains; and shallow (Um4.1) soils on hill crests near rock outcrops. Occurs on sheet(s): 4"
"Qa5"
"Strongly rolling to low hilly country on granodiorite and diorite rocks; little rock outcrop, some long gentle slopes: chief soils are hard neutral red soils (Dr2.12) with some (Dr2.21). Associated are: (Db1.11) and (Db1.21) soils on slopes; some (Ug5) soils with weak linear gilgai on colluvial slopes; (Dy3.43) soils on some lower slopes; and (Gn3.12) soils on rounded slopes. Minor soil occurrences include (Dr2.81), (Dr2.41), and (Dr3.41). Occurs on sheet(s): 4"
"Qa6"
"Low hilly to gently rolling country with very narrow valley plains: hard neutral red soils (Dr2.12) occur in association with cracking clays (Ug5.13 and Ug5.14) showing linear gilgai formation, or with (Ug5.3) on most slopes. Other soil occurrences include: (Um4) and (Uf6) including (Uf6.31) soils on crests; (Dy2.43) and (Dd1.33) on slopes; and (Dd1.43) in valley plains. Small areas of unit Fz9 are included in places. Occurs on sheet(s): 4"
"Qa7"
"Moderately high hills with rounded crests and straight often gentle side slopes; narrow valley plains: the hard neutral red soils (Dr2.12) covering the hills are dominant. Minor soil occurrences include (Dy2.43) on lower slopes, (Ug5.12) on slopes, and (Dd1.43) and (Ug5.16) in valley plains. Occurs on sheet(s): 4"
"Qa8"
"Moderately hilly land on granodiorite and diorite rocks; mainly broad rounded crests but some rather high and sharp, some rock outcrops: chief soils are hard neutral red soils (Dr2.12) with some (Dr2.21). Associated are: (Db1.11) and (Db1.21) soils on slopes; some (Ug5) soils; some (Dy3.43) soils; and some (Gn3.12) soils. Occurs on sheet(s): 4"
"Qa9"
"Strongly undulating or rolling lands with some low hills and occasional small gently undulating plains: dominant are fairly shallow red loamy duplex soils (Dr2.12), with lesser (Dr2.13). Occasional areas of coarse gritty sands (Uc1.21) and (Uc4.12) occur, and on lower slopes or adjacent to drainage lines are areas of yellow-grey loamy duplex soils (Dy2.42 and Dy2.43) and (Dy3.42 and Dy3.43). Included in the unit as mapped are small conical basalt hills with shallow very stony soils. Occurs on sheet(s): 4"
"Qa10"
"Undulating lands with wide shallow valleys; the soils alternate rapidly over short distances and are usually aligned in linear bands: dominant are fairly shallow (12-18 in.) loamy red duplex soils (Dr2.12), often with rock outcrop. The chief associated soils are dark cracking clays (Ug5.12, Ug5.13, Ug5.15, Ug5.22, and Ug5.25) often with linear gilgai. Other commonly occurring soils include various shallow duplex soils with thin A horizons and often with rock outcrop. The chief forms are (Db1.12), (Db1.13), (Db1.33), (Db1.32), (Dr2.13), (Db1.43), and (Dy2.43). Occurs on sheet(s): 4"
"Qa11"
"Low hilly to hilly lands with some strongly undulating marginal slopes; hill crests are often rounded and slopes are moderate; rock outcrop is common throughout: dominant are mostly shallow and often stony loamy red duplex soils (Dr2.12) with lesser (Dr2.33) and (Dr2.62). Occasional areas of red friable earths (Gn3.12 and Gn3.15) also occur. On higher and more stony hills shallow loams (Um1.43) and (Um4.1), with (Uc4.2) less often, are common.

On some lower slopes and valley floors yellow or brown loamy duplex soils (Dy3.42), (Db1.12), and (Dy2.42) often occur. Occurs on sheet(s): 4"
"Qa12"
"High hilly lands with some mountainous areas; nearly all hills have steep slopes but crests are often rounded. Marginal to the unit topography may be strongly undulating; rock outcrop is common throughout: dominant are shallow stony loamy red duplex soils (Dr2.12), with lesser (Dr2.22) and (Dr2.62). Other duplex soils also occur, chiefly (Db1.12), (Dy2.22), (Dy2.33), (Dy2.43), and similar (Dy3) soils. Small areas of red friable earths (Gn3.12, Gn3.14, and Gn3.15) are associated in some areas. Higher hill crests and more stony sites have shallow stony loams (Um1.43), (Um4.1), and (Um2.12) or sands (Uc2.12), (Uc4.1), and (Uc4.2). Occurs on sheet(s): 4,7"
"Qa13"
"Undulating to strongly undulating lands with occasional high isolated hills: dominant are shallow to moderately deep loamy red duplex soils (Dr2.12) that occasionally are stony. Associated soils include (Db1.12), (Db1.32), (Dr3.12), (Gn3.12), and occasionally (Dy2.42 and Dy2.43). On flatter lower slopes dark clays (Ug5.12, Ug5.14, and Ug5.16) or brown to red-brown clays (Ug5.32, Ug5.37, and Ug5.38) are common. In some localities mottled loamy duplex soils (Dy3.42 and Dy3.43) are common in lower sites. Occurs on sheet(s): 4"
"Qa14"
"Moderately or, less commonly, strongly undulating lands with occasional isolated hills surrounded by strongly dissected steep slopes; limited rock outcrop may occur throughout: dominant are loamy red duplex soils (Dr2.12) of shallow to moderate depth (18-30 in.). Commonly associated are (Dr2.11), (Dr2.21), (Dr2.22), (Gn3.12), and less often (Dr2.13). Some similar (Db1) soils occur and in some areas yellow loamy duplex soils (Dy2.21 and Dy2.22) are locally dominant. Also often closely associated, particularly on lower slopes, are mottled yellow duplex soils (Dy3.42), (Dy3.43), and (Dy3.32). The hilly areas have very shallow stony duplex soils (Dr2.12), (Dy2.12), and (Db 1.12); stony loams (Um 1.43) and (Um4.2); or gritty sands (Uc4.2) and (Uc2.12). Very occasional small areas of dark clays (Ug5.13) or red-brown clays (Ug5.37) may also be included in the unit. Occurs on sheet(s): 4,7"
"Qa15"
"Level or very gently undulating alluvial plains that are often dissected by older channels: a complex range of soils is present but probably dominant are soft loamy red duplex soils with moderately deep A horizons (12-15 in.). The chief form is (Dr2.12), with (Dr2.22, Dr2.13, and Dr2.23) also present. Closely associated are soft loamy or occasionally sandy red earths (Gn2.12, Gn2.13, and Gn2.16). Low sand dunes and slightly elevated sand-filled prior stream channels are a prominent feature of the unit. These have deep sand soils (Uc1.23), (Uc1.22), (Uc1.21), (Uc5.11), and (Uc5.21). The margins of the alluvial plains often have other loamy duplex soils, chiefly (Dy2.43) and (Dy2.33), occasionally (Db1.33). Small areas of gilgaied grey clays (Ug5.24) occur in some lower sites, and areas of non-gilgaied grey clays (Ug5.24) occur in and adjacent to active stream channels. Occurs on sheet(s): 4"
"Qa16"
"Moderate to strongly undulating lands with much granite tor outcrop: dominant are sandy or occasionally loamy red duplex soils (Dr2.12) with (Dr3.22), (Dy2.22), (Dy3.42), and (Dy2.62) commonly associated. On some ridge crests very gritty red earths (Gn2.12 and Gn2.15) occur. Shallow gritty sands (Uc4.Z) often occur in the vicinity of major rock outcrop. Occurs on sheet(s): 4"
"Qa17"
"Strongly dissected hilly lands with short steep slopes and much rock outcrop: dominant are shallow stony red duplex soils (Dr2.12) but other duplex soils commonly occur, chiefly (Dy3.42) and (Dy2.43). More stony areas have shallow loams (Um4.1), (Um2.12), or sands (Uc4.2) and (Uc2.12). Data are limited. Occurs on sheet(s): 4,7"
"Qa18"
"Narrow valley plains with terraces, valley side slopes, and some undulating to low hilly portions; derived from sandstones, shales, and limestones: chief soils are hard neutral, and also alkaline, red soils (Dr2.12 and Dr2.13) on the valley plains and terraces, some of which are stone-covered. Associated are (Dr2.43) and (Dr2.33) soils on some plain areas; stony varieties of (Dr2.11) and (Dy2.22) on valley side slopes; and some small areas of unit CC53 in the valleys. Minor soil occurrences are likely and include (Uf6.21) on lower slopes. This unit is typically flanked by the ranges and hills of unit BA6. As mapped, small areas of other adjoining units may be included. Occurs on sheet(s): 8"
"Qa19"
"Strongly undulating to low hilly lands with much rock outcrop and steep gravel-strewn slopes: dominant are shallow to moderately deep gravelly-surfaced loamy red duplex soils (Dr2.12), with occasional (Dr2.11). Shallow gravelly loams (Um1.43) and (Um5.51) are important associated soils occurring on the steep slopes and crests and adjacent to rock outcrop. Some small areas of friable red earths (Gn3.12) may occur on broad crests. Occurs on sheet(s): 7"
"Qa20"
"Undulating to moderately undulating lands with broad crests and slopes and some rock outcrop: dominant are shallow to moderately deep gravelly loamy red duplex soils (Dr2.12, Dr2.13). Associated soils are moderately deep

gravel-strewn loamy friable red earths (Gn3.13, Gn3.12) and small areas of cracking clays (Ug5.1, Ug5.2, and Ug5.3). Shallow loams (Um5.51) occur near rock outcrop and deep loamy red earths (Gn2.12, Gn2.13) occur on stream levees. Occurs on sheet(s): 7,10"
"Qa21"
"Undulating or gently undulating lands: dominant are loamy red duplex soils (Dr2.12) of moderate depth. Also occurring are similar (Dr2.11) and occasionally (Dr2.22) soils. Closely associated, particularly on flatter sites and lower slopes, are loamy mottled duplex soils (Dy3.22), (Dy3.32), and (Dy3.42), together with similar alkaline forms. Limited areas of dark duplex soils (Dd1.12, Dd1.13) may also occur. On some higher ridge crests shallow stony (Dr2.12) soils occur adjacent to rock outcrop. Occurs on sheet(s): 7"
"Qa22"
"Hilly to high hilly lands with some mountainous areas; slopes are very steep and gravelly but there is only limited rock outcrop: dominant are shallow to moderately deep loamy red duplex soils (Dr2.12). Associated are other loamy duplex soils (Dr2.11) and (Db1.11, Db1.12), with (Dy2.22) and (Dy2.32) on lower slopes. Shallow stony loams (Um4.1) and (Um1.43) occur on some steep slopes and hill crests. Occurs on sheet(s): 7"
"Qa23"
"Moderately or strongly undulating plateau: dominant are shallow stony red duplex soils (Dr2.12). Other duplex soils commonly occur, chiefly (Dy3.43), (Dy2.43), and (Dy3.22) with some acid equivalents. Shallow loams (Um4.1) and (Um2.12) or sands (Uc4.2) and (Uc2.12) are common on higher slopes and adjacent to rock outcrop. Data are limited. Occurs on sheet(s): 7"
"Qa24"
"Very Gently undulating lands with some level plains: dominant are moderately deep or deep loamy red duplex soils (Dr2.12), with red friable earths (Gn3.12) and (Gn3.22) also common. Associated are a range of loamy duplex soils, chiefly acid, neutral, and alkaline forms of (Dy3.2), (Dy2.2), (Dy3.4), (Db1.3), and (Dr2.2). Small areas of loamy earths (Gn2.25, Gn2.24) and (Gn2.14) also occur. Small areas of deep cracking clays (Ug5.13, Ug5.15), (Ug5.23), and (Ug5.32) with well-developed linear gilgai are common throughout the unit. Occurs on sheet(s): 7"
"Qa25"
"Strongly undulating to low hilly lands with fairly short slopes: dominant are shallow to moderately deep loamy red duplex soils with gravelly A horizons; the most common form is (Dr2.12) with lesser (Dr2.22). Similar acid soils also occur widely. The low hilly areas mostly have shallow stony loams (Um4.21) and (Um4.1), with lesser similar (Uc4) soils. Red friable earths (Gn3.12, Gn3.11) occur in small areas on more basic rocks, and on some lower slopes yellow duplex soils (Dy3.22), (Dy2.22), and (Dy3.43) occur. Occurs on sheet(s): 7"
"Qa26"
"Gently undulating lands: dominant soils are gravelly-surfaced moderately deep to deep red duplex soils (Dr2.12, Dr2.13), with occasional (Dr2.43) and (Dr2.33). Associated are loamy red earths (Gn2.11, Gn2.12) that often have gravel and ironstone nodules in the profile. Other duplex soils (Db1.13), (Dy2.13), (Dy2.33), and (Db1.33) also occur, associated with small areas of deep cracking clays (Ug5.24, Ug5.25). Occurs on sheet(s): 10"
"Qa27"
"Gently undulating to undulating lands with some granite tor outcrop: dominant are gravelly-surfaced shallow red duplex soils (Dr2.12, Dr2.11), with lesser (Dr2.13). Associated are sandy red earths (Gn2.11) and shallow loamy sands (Uc4.22) and (Uc4.11, Uc4.12). Occurs on sheet(s): 10"
"Qb1"
"Plain: undulating plain of hard neutral red soils (Dr2.22) in association with hard acidic red soils (Dr2.21) and hard neutral yellow mottled soils (Dy3.42); other undescribed soils possibly occur; layering of soil materials probably an important factor in soil variability and distribution. Occurs on sheet(s): 2"
"Qb2"
"Hilly with some rounded slopes: moderate hill slopes of hard neutral red soils (Dr2.22) and possibly Dr2.32) in association with dark cracking clays (Ug5.13); and also small areas of soils from adjoining units. Occurs on sheet(s): 2"
"Qb3"
"Plains: undulating plains of hard neutral red soils (Dr2.22) on very low broad rises in association with hard neutral yellow mottled soils (Dy3.42) on the flatter, less well-drained portions and with some gilgais of grey clays (Ug5.2) and hard alkaline yellow mottled soils (Dy3.43) in the lower-lying situations Soil variations on the plain included (Dr3.23 and Dy3.22) in areas with intermediate drainage characteristics, and areas of (Dr2.41) on well-drained sites above some river valleys; plains are traversed by river valleys with flood-plains of various (Gn) soils. Prior stream activity and layering of soil materials seem important factors in soil variability. Occurs on sheet(s): 2,3"
"Qb4"
"Undulating to low hilly area with rock outcrops: slopes of hard neutral red soils (Dr2.22) with some areas of siliceous sands (Uc1.2) in association with hard alkaline yellow mottled soils (Dy3.43) on lower slopes and extending out on to the surrounding plains. Occurs on sheet(s): 2"
"Qb5"

"Hilly to steep hilly with convex slopes; boulders and rock outcrops: chief soils are hard neutral red soils (Dr2.22) on the slopes, with some (Dd) and (Um6.11) soils in the valleys. Data are limited. Occurs on sheet(s): 3"
"Qb6"
"Hilly with some steep slopes: chief soils are hard neutral red and red mottled soils (Dr2.22), (Dr2.42), and (Dr3.42) and hard neutral yellow mottled soils (Dy3.42). Associated are shallow red earths (Gn2.15) and possibly other (Gn2) soils. Data are limited. Occurs on sheet(s): 3"
"Qb7"
"Hilly with some steep hilly to rugged areas, narrow valleys; some small areas of conical hills towards the mountains (compare unit Qb8): chief soils are hard neutral and acidic red soils (Dr2.22, Dr2.42, and Dr2.21), sometimes of very shallow depth, with (Um4.1), (Dy3.4), and shallow (Gn2.15) soils. Associated are some undulating areas of (Dy3.42) soils; narrow valleys of unit Va15; and (Dd3.12), (Ug5.13). (Db3.12). (Dr4.12) soils on steep, sometimes bouldery, slopes of serpentine rock. Data are limited. Occurs on sheet(s): 3"
"Qb8"
"Sugarloaf country: generally conical hills of hard neutral and/or acidic red soils (Dr2.22 and Dr2.21 with some (Um4) soils and rock outcrops on mid to upper slopes and with (Dr2.42) and (Dy3.4) soils on mid to lower slopes. Associated are red earths (Gn2.1) on the slopes; undulating to hilly areas in the vicinity of ridge and range crests of (Dy3.42 and Dy3.41) soils; and narrow stream valleys with flood-plains of (Um1) soils and terraces of (Um6.11) soils. Occurs on sheet(s): 3"
"Qb9"
"Low hilly to hilly areas with some steeper slopes, rock outcrops: chief soils on the slopes are hard neutral red soils (Dr2.22), often stony, possibly other (Dr2) soils, and with shallow loams (Um4.1). Associated particularly in fill positions are (Gn2) soils, such as (Gn2.12). Data are limited. Occurs on sheet(s): 3"
"Qb10"
"Strongly undulating to hilly country with some steep slopes and rock walls, tors: chief soils are hard neutral red soils (Dr2.22) and (Dr2.62) and occasionally (Dr2.63) with red earths (Gn2.12) often gritty; some (Gn2.15) soils in the more easterly occurrences of the unit. Associated are some siliceous sands (Uc1.2) on ridges and slopes, and (Dy2.4) in valleys. The eastern occurrences of this unit and its companion unit My10 have, taken together, features in common with unit Mu1. As mapped, small areas of units Qc4, Qc3, and My9 are included. Data are limited. Occurs on sheet(s): 3"
"Qb11"
"Steep to very steep and rugged hills and mountains: chief soils are hard neutral red soils (Dr2.22, Dr2.62, Dr2.42) and (Um4.1) and (Dy3.4) soils, and rock outcrops. Occurs on sheet(s): 3"
"Qb12"
"Rounded hilly to steep hilly with some steep scarps, tors: chief soils are hard neutral and acidic red soils (Dr2.22, Dr2.42, Dr2.21, Dr2.41) with hard neutral and acidic yellow mottled soils (Dy3.41), (Dy3.42), and (Dy3.2). Associated are siliceous sands (Uc1.2) and leached sands (Uc2.2) on or adjacent to the steeper portions of the area. As mapped, areas of unit Qb13 and possibly unit Gb7 are included. Data are limited. Occurs on sheet(s): 3"
"Qb13"
"Rolling country: chief soils are hard neutral red soils (Dr2.22 and Dr2.42) in association with hard neutral yellow mottled soils (Dy3.42 and Dy3.22). As mapped, areas of units Gb7 and Qb12 are included. Data are limited. Occurs on sheet(s): 3"
"Qb14"
"Steep ranges: steep slopes of hard neutral and alkaline red soils (Dr2.22 and Dr2.23) with shallow (Um4.1) soils. Data are limited. Occurs on sheet(s): 3"
"Qb15"
"Rolling: chief soils seem to be hard neutral red soils (Dr2.22 and Dr2.42). Associated are (Dy) soils such as (Dy3.42), and areas similar to unit Mo3. Data are limited. Occurs on sheet(s): 3"
"Qb16"
"Rolling to steep hilly with rock outcrops: chief soils are hard neutral red soils (Dr2.22) with various other (D) soils including (Dr2.21), (Dy3.42), (Dy3.41), (Dy3.2), (Dy2), and (Um4.1) soils. Shallow stony varieties of all these soils are common. Associated are small areas of other soils and especially those of units Qr1 and Mo3. Occurs on sheet(s): 3"
"Qb17"
"Undulating country with gravelly and/or stony ridges: chief soils of the undulating terrain are hard neutral red soils (Dr2.22) with variable areas of friable neutral red soils (Dr4.12), (Dy3.4) and other (Dy) soils, and (Gn3.12) and (Gn2.12) soils. The undulating terrain is broken by ridges of gravelly or stony and often shallow (Dr2.22) and (Um4.1) soils. As mapped, small areas of unit Ms1 are included in areas neighbouring that unit. Occurs on sheet(s): 3"
"Qb18"

"Gently undulating with hillocks and tors: chief soils are hard neutral red soils (Dr2.22); possibly (Dy) soils are associated. Data are limited. Occurs on sheet(s): 3"
"Qb19"
"Hilly: chief soils are hard neutral red soils (Dr2.22). Associated are: (Db1.22 and Db1.23) on slopes; (Dr2.23), usually on lower slopes; shallow loams, such as (Um4.1), usually in steep situations; and small areas of other soils including (Dy2.43) in low-lying positions and (Gn2.14) on steeper colluvial slopes especially in eastern occurrences of the unit. As mapped, areas of units Gb12, Ob14, and Qb20 are included. Occurs on sheet(s): 3"
"Qb20"
"Steep hilly with rock outcrops: chief soils are hard neutral red soils (Dr2.22). Associated are: shallow loams such as (Um4.1) on steeper slopes; (Db1.22) on slopes; some (Uc) and (Um) soils on alluvial fans; and small areas of many other soils including (Gn2.14) on steeper colluvial slopes especially in eastern occurrences of the unit. As mapped, areas of unit Qb19 are included. Occurs on sheet(s): 3"
"Qb21"
"Hilly to steep hilly terrain with rock outcrops: chief soils are hard neutral red soils (Dr2.22) with shallow loamy soils such as (Um4.1). Associated are: (Dr2.21) soils on slopes; (Dy3.4) soils generally on flatter areas and in valleys; (Dr2.4) soils on lower slopes and in valleys; undescribed soils along the narrow stream valleys; and undescribed soils associated with areas of serpentine and associated rock types. Occurs on sheet(s): 3"
"Qb22"
"Rolling country: hard neutral red soils (Dr2.22) in association with (Db1.42) and (Dy3.4) soils; other soils including some areas of (Ug5.1) are likely along stream valleys. Occurs on sheet(s): 3"
"Qb23"
"Low round hilly to strongly rolling country on fine-textured lithic sandstones, mudstones, basic lavas and tuffs, and limestones; generally narrow concave valleys: chief soils are hard neutral red soils (Dr2.22), (Dr2.12), and (Dr2.42) with hard neutral brown soils (Db1.22), (Db1.12), and (Db1.42). Associated are: (Dy2.42), (Dy3.42), (Dy2.43), and (Dy3.43) soils on mid and lower slopes; (Gn3.12 and Gn3.13) soils on some slopes; (Dd1.43) and (Db1.43) soils on gentle slopes; and (Um4.1) and (Um2.12) soils on some crests and upper slopes. Occurs on sheet(s): 4"
"Qb24"
"Moderately hilly country on shaly rocks; close pattern of hills with rounded stony crests and strong parallel strike ridge pattern, and short slopes straight to drainage lines, or grading into concave colluvial slopes and wider drainage bottoms: chief soils are hard neutral red soils (Dr2.22) with some (Dr2.42). Associated are: (Dy2.22) and (Dy2.42) and (Db1.11) and (Dr2.11) soils on slopes; (Um4.1) and (Um2.12) soils on crests; (Dy3.43) soils in concave drainage flats; and some (Gn3.11) and (Gn3.21) soils on slopes. Minor soil occurrences include (Gn3.42), (Dd1.43), and (Dy3.22). Occurs on sheet(s): 4"
"Qb25"
"Moderately hilly country on volcanic rocks and boulder beds; generally smooth convex crests with short moderate slopes to drainage lines, but including some low hilly areas; some concave valley bottoms: dominant soils are hard neutral red soils (Dr2.22), (Dr2.42), and (Dr2.12) with (Dy2.22), (Dy2.42), and (Dy2.12). Associated are: (Dr2.11), (Dr4.11), (Dr3.42), and (Dr3.43) on upper slopes and toe slopes; (Db1.21), (Db1.11) and (Um4.2) on crests; some (Db3.11) and (Dd3.13) soils; and some (Ug5.13 and Ug5.14) with linear gilgai microrelief on colluvial slopes. Minor soil occurrences include (Dy2.43) on terraces, (Dy3.43) in depressions of valleys, and (Gn3.12 and Gn3.13) on some ridges. Occurs on sheet(s): 4"
"Qb26"
"Strongly undulating rolling or low hilly lands: dominant are loamy red duplex soils (Dr2.22) of moderate depth (2430 in.); the A horizons usually contain much quartz gravel; lesser areas of (Dr2.12) soils also occur. In lower landscape sites yellow loamy duplex soils are common, chiefly (Dy2.33), (Dy2.43), (Dy2.32), and similar (Dy3) soils. The higher, steeper hills have shallow stony loams (Um4.1) and some areas of shallow stony sands (Uc4.v. Included in the unit as mapped are small areas of loamy yellow earths (Gn2.22). Occurs on sheet(s): 4"
"Qb27"
"Gently undulating alluvial flood-plains, often with marked terraces, levees, and shallow drainage depressions. The dominant soils are those of the older terraces and levees; they have deep sandy or sandy loam A horizons (12-24 in.) with a clear change to reddish brown clay or sandy clay. The chief form is (Dr2.22), with associated (Dr4.22), (Dy2.22), (Dy2.33), (Dy3.33), (Db1.13), and (Dr2.23). In the shallow drainage depressions loamy duplex soils (Dy2.43) and (Dy3.43) occur, with uniform loams (Um6.11) on the most recent terraces which may be subject to flooding. Occurs on sheet(s): 4,7"
"Qb28"
"Low hilly terrain on gabbro or diorite rocks with gentle side slopes to narrow alluvial flats: chief soils are hard neutral red soils (Dr2.22) with shallow variants of neutral friable earths (Gn3.12). Associated are (Um4.1) soils on hill crests. Minor soil occurrences include (Dy2.43) and (Ug5.1) soils on the flats; and (Ug5), (Um6), and (Uf6) soils on included serpentine. Occurs on sheet(s): 4"

"Qb29"
"Rolling to hilly with some steep slopes; gneissic rock outcrops common: chief soils are hard neutral red soils (Dr2.22) with others such as (Dr2.62) and (Dr3.42). Associated are (Dy3.42) soils on slopes; patches of (Ug5.37) and (Ug5.2) soils with some gilgai also on slopes; colluvial slopes of (Gn2) soils such as (Gn2.12) and (Gn2.45); and variable areas of other soils seem likely. As mapped, areas of unit Uf1 and small areas of unit Oc30 may be included. Occurs on sheet(s): 5"
"Qb30"
"Rolling to hilly with some steep slopes; gneissic rock outcrops common; some lateritic mesas and buttes on drainage divides: chief soils are hard neutral red soils and acidic red soils (Dr2.22), (Dr3.42 and Dr3.41), and possibly similar related soils. Associated are (Dy3.42 and Dy3.41) soils; (Dy3.82 and Dy3.81) soils containing ironstone gravels; and smaller areas of other soils including those of the lateritic mesas and buttes. As mapped, areas of adjoining units may be included. This unit has similarities with both units Qb29 and Ub90. Occurs on sheet(s): 5"
"Qb31"
"Hilly to steep hilly terrain of rather broken relief: chief soils are hard neutral red soils and acidic red soils (Dr2.22 and Dr2.21) with hard neutral, and also acidic, yellow mottled soils (Dy3.22 and Dy3.21). Associated are colluvial slump areas of (Gn2.45) and other soils on the slopes; narrow terrace and mass movement deposits of (Gn2.15 and Gn2.14) soils, and possibly other soils similar to those of unit Mu12, along some valleys; some siliceous sands (Uc1.21) on dunes in the main valleys; and remnants of the main soils of units Tf5 and JZ1 on some interfluve ridges. As mapped, areas of adjoining units are included. Occurs on sheet(s): 5"
"Qb32"
"Moderate to steep valley side slopes on basic igneous and associated rocks; gentle colluvial slopes and small to moderate valley floors; some rock outcrops: chief soils on the valley side slopes are hard neutral red soils (Dr2.22) and neutral red friable earths (Gn3.12) with some shallow (Uc) and (Um) soils. Associated are various (Dy), such as (Dy5.8), and (Dr), such as (Dr3.32), soils on the colluvial slopes; and (Um5.5) soils on the valley floors with some clay flats of (Uf) or (Ug5.2) soils. Occurs on sheet(s): 5"
"Qb33"
"Laterite plateaux and scattered granite hills with gently undulating broad valley floors: chief soils are gritty neutral hard red soils (Dr2.22) and (Dr2.42) developed on the valley plains. They are often eroded. Associated soils are red earths (Gn2.11) on plateau remnants where laterite and rock outcrops on upper slopes. Small areas of (Ug5.3) soils are associated with basic gneisses. Occurs on sheet(s): 9"
"Qb34"
"Stony undulating country with scattered granitic residuals: this unit is very variable but apparently the chief soils are neutral hard red soils (Dr2.22), (Dr2.32) with some associated (Dy3.32). On pediment slopes and plains are alkaline hard yellow mottled soils (Dy3.43). In other places the red earths (Gn2.12) are very common. There is much bare rock on the residuals, often with sandy detritus (Uc4.2) around their bases. All of the preceding soils are gritty. Some drainage lines have brown cracking clays (Ug5.38). Occurs on sheet(s): 9"
"Qb35"
"Undulating to strongly undulating lands: dominant are loamy red duplex soils (Dr2.22), with (Dr2.12) soils commonly associated and occasionally locally dominant. The soils are moderately deep (24 30 in.) and normally have quartz gravel throughout the A horizons. Other loamy duplex soils (Dr3.43), (Dy2.23), (Dy2.43), (Dy3.43), and (Db1) equivalents, together with occasional red friable earths (Gn3.11), occur chiefly on the lower slopes. Shallow gravelly loams (Um4.21) or sands (Uc4.21) are common on the higher slopes and the occasional low hills included in the unit. Dark cracking clays (Ug5.12) occur on the alluvium of some of the major streams. Occurs on sheet(s): 7"
"Qb36"
"Gently or occasionally moderately undulating lands: dominant are moderately deep loamy red duplex soils (Dr2.22). The chief associated soils are shallow gravelly loams (Um4.21) occurring on higher slopes and ridge crests. Lesser areas of other loamy duplex soils also occur, chiefly (Dy3.42), (Dy3.32), (Dy2.22), (Dr3.31), (Dr3.41), and (Db2.32). Loamy red or yellow earths (Gn2.14, Gn2.15) or (Gn2.25) occur on some of the more recent alluvium. Occurs on sheet(s): 7"
"Qb37"
"Gently undulating to undulating lands: loamy red duplex soils (Dr2.22) are probably dominant but important areas of (Dy3.43, Dy3.42), (Dr2.12), and (Dy2.22) soils also occur. Other loamy duplex soils (Db1.23), (Db1.43), (Db2.43), (Dy3.32), (Dy3.41), and occasional (Dr3) equivalents occur as minor associates. Loamy earths (Gn2.25, Gn2.24) and (Gn2.14) occur on lower outwash slopes and recent alluvium of minor streams. Shallow gravelly loams (Um4.22, Um4.21) and (Um3.21) and sands (Uc4.12) and (Uc4.21) occur on higher slopes adjacent to rock outcrop. Deep cracking clays (Ug5.16) and (Ug5.24) with strong linear gilgai occur on some lower gentle slopes. Occurs on sheet(s): 7"
"Qb38"

"Moderately to strongly undulating lands with short steep slopes: dominant are shallow to moderately deep loamy red duplex soils (Dr2.22), but closely associated are other duplex soils (Dy2.22) and (Dy2.32). Although there is very little rock outcrop, all soils have gravelly A horizons. Shallow gravelly sands (Uc4.21), (Uc2.12), and (Uc2.22) occur on some higher ridge crests. Minor associated soils include (Dy3.43), (Dy2.43), and (Db2.33) in the drainage lines and shallow friable clays (Uf6.31) on small areas of limestone. Also included are small low basalt mesas with soils of unit Mo30. Occurs on sheet(s): 7"
"Qb39"
"Gently undulating plains with small areas of strongly undulating to low hilly lands: dominant are moderately deep to deep loamy duplex soils (Dr2.22), with lesser (Dr2.12) soils. Associated soils are similar to those of unit Qb41. Occurs on sheet(s): 7"
"Qb40"
"Gently undulating to undulating lands with broad rounded ridge crests and long even slopes; only occasional rock outcrop: dominant are moderately deep to deep loamy red duplex soils (Dr2.22), but closely associated and locally dominant are similar (Dy3.22) soils. Other loamy duplex soils (Dy2.22), (Dy2.32), (Dy2.43), and (Dy3.43) occur on lower slopes and in drainage lines. Areas of deep cracking clays (Ug5.15, Ug5.17, Ug5.13), (Ug5.23), and (Ug5.32) with well-developed linear gilgai are common throughout the unit in drainage lines and on long gentle basal slopes. Occurs on sheet(s): 7"
"Qb41"
"Moderately to strongly undulating lands, often with many quartz reef outcrops; nearly all soils have extremely gravelly A horizons: dominant are loamy red duplex soils of shallow to moderate depth; chief form is (Dr2.22), but (Dr2.21), (Dr2.12, Dr2.11), and (Dr3.22) also occur. Closely associated and locally dominant are yellow duplex soils (Dy3.22, Dy3.21) and similar (Dy2) soils. Where acid rock outcrop is common shallow stony sands (Uc4.12) and (Uc4.2) occur, with lesser shallow stony loams (Um4.2). Throughout the unit are small inclusions of unit Mo29, with (Gn3.12) soils and with yellow or red earths (Gn2.22) and (Gn2.12) of unit MS13. Occurs on sheet(s): 7"
"Qb42"
"Low hilly lands with some strongly undulating marginal slopes. The soils are as for unit Qb41, but yellow duplex soils are less common. Occurs on sheet(s): 7"
"Qc1"
"Hilly to undulating: upper hill slopes of hard neutral red soils (Dr2.32) with some rock outcrops and shallow (Um) soils, in association with hard yellow mottled soils (Dy3.42, Dy3.41, and Dy3.43) on the lower, less well-drained portions of the slopes; some small valley plains with (Dr3.42 (3) soils on the higher sites and (Dy3.4) soils in the less well-drained situations. Occurs on sheet(s): 2"
"Qc2"
"Hilly to steep hilly: upper hill slopes of hard neutral red soils (Dr2.32) with rock outcrops and shallow (Um) soils, in association with hard yellow mottled soils (Dy3.4) on the middle and lower slopes, and in small valley plains. Occurs on sheet(s): 2"
"Qc3"
"Hills and/or undulating ridges often characterized by chips of shaly rock: chief soils are hard neutral red soils (Dr2.32), (Dr3.42), (Dr2.22), (Dr2.42), and (Um4.1) soils with other (D) soils, such as (Db2.4) and (Dy3.42). Associated are the soils of unit My9 in areas of milder relief. As mapped, small areas of unit Qb10 are included. There are similarities with unit Ta5 of Sheet 2. Data are limited. Occurs on sheet(s): 3"
"Qc4"
"Ridges and ranges--variable topography from stony ridges and hills to steep and rugged ranges with boulder-strewn slopes, the stronger relief being found on the more isolated ranges, e.g. Gunning Range: chief soils seem to be hard neutral red soils (Dr2.32), (Dr2.42), and (Dr2.22) and hard neutral yellow mottled soils (Dy3.42) with shallow loams (Um4.1), shallow sands, such as (Uc1.23), and small areas of other soils especially stony (Gn2.12) soils on flanking slopes. Data are limited. Occurs on sheet(s): 3"
"Qc5"
"Terraced valley plain area and including some valley side slopes, some mesas and buttes of unit Uc2, and some hills of unit Pb29: chief soils seem to be hard neutral red soils and alkaline red soils (Dr2.32 and Dr2.33) on the higher and broader terraces, with (Dr3.42) and possibly (Dr3.43) soils on poorly drained flat areas. Associated are deep red sandy soils (Uc1.43) on the lower terraces; (Gn2.12) soils, sometimes with a clay D horizon, on colluvial slopes and fills; (Dr) soils such as (Dr2.62) on hill slopes; and some (Dy) soils such as (Dy3.4) on slopes. Occurs on sheet(s): 5"
"Qc6"
"Hilly ranges and their flanking slopes; some rock outcrops: chief soils seem to be hard neutral red soils and alkaline red soils (Dr2.32), (Dr3.32), and (Dr2.33) with hard neutral yellow mottled soils (Dy3.42). Associated are shallow (Uc) and (Um) soils such as (Um4.1) on the steeper slopes; and some (Dd1.33), (Dy3.43), and (Ug5.2) soils on the flanking slopes. Occurs on sheet(s): 5"

"Qc7"
"Broken hilly terrain with some rock outcrops: chief soils seem to be hard neutral red soils (Dr2.32) and hard neutral yellow mottled soils (Dy3.42). Associated are small valleys and plains of (Dr2.33); eroded plateau ridges of (KS-Uc) soils; and soils of the adjoining units. Occurs on sheet(s): 5"
"Qc8"
"Gently undulating plains and gently sloping outwash fans; the soils are usually gravel-strewn: dominant are shallow to moderately deep loamy red duplex soils with thin A horizons (2-4 in.). The chief form is (Dr2.32), but (Dr2.12) and similar alkaline soils also occur, the latter being more common adjacent to drainage lines. Associated on higher sites are loamy red earths (Gn2.11, Gn2.12), while deep cracking red or brown clays (Ug5.38, Ug5.34) occur on small level plains in lower sites. Occurs on sheet(s): 10"
"Qc9"
"Moderately undulating or gently rolling lands with long gradual slopes to drainage lines; the soil surface has an almost continuous cover of billy gibbers (silcrete) up to 4 in. in diameter, occasionally larger: dominant are deep to moderately deep loamy red duplex soils with thin (1-3 in.) A horizons; the chief form is (Dr2.32) but (Dr2.33) and similar (Dr1) soils also occur. Closely associated are deep to moderately deep red-brown or red clays (Ug5.38), occasionally (Ug5.37, Ug5.34) and (Uf6.31) which are usually less stony. The clays commonly occupy the small depressions where a slight (few inches) gilgai microrelief is present. Associated drainage lines have small alluvial plains with scalded red-brown or brown deep cracking clays (Ug5.34), occasionally (Ug5.38); these soils are often stone-free. In parts of the unit are small low mesas of unit Qc1O, too small to map separately. This unit is very similar to unit MM53 but the red duplex soils are much more prominent. Occurs on sheet(s): 10"
"Qc10"
"Dissected mesas up to 150 ft high which may have steep-scarped or benched margins; the soil surface of the level crests has an almost continuous cover of billy gibbers (silcrete) from 1 to 4 in. in diameter with some larger masses: dominant are deep loamy duplex soils with thin A horizon (1-4 in.); the chief form is (Dr2.32), but (Dr2.33) and occasional (Dr1) soils also occur. A shallow (48 in.) gilgai microrelief is common in most areas and the depressions have less stony-surfaced red or red-brown cracking clays (Ug5.38). On some broader plateau surfaces the clays may be locally dominant. The more gently sloping margins of the mesas also have stony (Dr2.32) soils, but where steep benched slopes or scarps occur the soils are shallow very stony loams (Um5.51), (Um1.43), and similar (K-Um) soils. Occurs on sheet(s): 10"
"Qd1"
"Very gently rolling plains, probably old (upper) river terraces (tertiary): chief soils are hard neutral red soils (Dr2.42) with some areas of (Dy3.4) and (Gn2.15) soils. As mapped, areas of unit Ob9 and narrow ridges of unit Pd4 are included. Data are limited. Occurs on sheet(s): 3"
"Qd2"
"Hilly to steep hilly terrain with narrow ridges and their steep to rugged side slopes: chief soils are hard neutral red soils (Dr2.42) on mid and lower slopes and undulating portions of ridge crests; and hard neutral red soils (Dr2.22) with (Um4.1) soils and rock outcrops on the narrow parts of ridges and the steeper slopes. Stream valleys are narrow and soils are not known but may include red earths (Gn2.1). Data are limited. Occurs on sheet(s): 3"
"Qd3"
"Hilly country: chief soils are hard neutral red soils (Dr2.42) with (Dy) soils, and possibly some (Gn2) soils. Narrow terraces and flood-plains of undescribed soils, probably including (Um6.11), occur along the streams. Occurs on sheet(s): 3"
"Qd4"
"Hilly with some broken rocky slopes: chief soils are hard neutral and alkaline red and red mottled soils (Dr2.42), (Dr3.42), and (Dr2.43). Associated are (Um4) soils and possibly other (Um) soils and rock outcrops on slopes; and (Dy3.4) soils in valleys. Small areas of unit Pd4 are included. Data are limited. Occurs on sheet(s): 3"
"Qd5"
"Hilly: hill slopes of hard-setting loamy soils with red and red mottled clayey subsoils (Dr2.41 and Dr2.42). Associated are: (Um4.2) and (Dr2.21) soils and rock outcrops on upper slopes; (Dy3.2 and Dy3.4) and less commonly (Dy5.4 and Dy5.6) soils on mid and lower slopes; scattered areas of various friable soils, such as (Db3.12), (Dr4.12), (Um6.2), (Uf6), and (Ug5.12) soils on rounded hills and slopes; occasional pockets of red earths (Gn2.1); narrow stream valleys of soils of unit Kd6; and broader undulating valleys of (Dy3.42) soils. Occurs on sheet(s): 3,4"
"Qd6"
"Hills with rounded crests, smooth slopes, and few rock outcrops developed on granites and granodiorites: chief soils are neutral red and yellow soils (Dr2.42), (Dr3.42), (Dy2.42), and (Dy3.42) high in the landscape with alkaline red and yellow mottled soils (Dr3.43) and (Dy3.43) in lower topographic situations. As mapped, narrow terraced valleys of unit MM9 are included in places. Occurs on sheet(s): 4"
"Qd7"

"Undulating shale country with broad drainage floors: chief soils are shallow neutral hard red (Dr2.42) and yellow (Dy2.42) soils with some very shallow (Um5) soils over shales. Interfluves have shallow (Um5) soils with much loose rock. There are minor areas of (Ug5.35) soils. The (Dr) soils are often severely eroded. Occurs on sheet(s): 9"
"Qd8"
"Gently undulating sandy alluvial plains with active drainage: main soils are shallow neutral hard red (Dr2.42) and yellow (Dy2.42) soils. They are much eroded and have a heavy surface layer of stone and gravel. Associated are elongated dunes of red sands (Uc1.23). Deeper dissections have variable sandy (Uc) deposits broken by many channels. There are some extensive (Ug5.24) soil plains. Occurs on sheet(s): 9"
"Qd9"
"Low hilly to hilly lands with much rock outcrop on siltstones, shales, and sandstones; steep rocky slopes and narrow valleys: dominant soils on slopes and valley floors are moderately deep (2436 in.) loamy red duplex soils (Dr2.42) with associated (Dr3.42), (Dr2.43), and (Dr3.43); the loamy A horizons are very gravelly. Associated soils are shallow stony loams (Um1.43), (K-Um1.43), deeper loams (Um4.21). and on the low-grade iron ore deposits are extremely shallow red loams (Um1.43) and (K-Um1.43). Occurs on sheet(s): 7,8"
"Qd10"
"Gently undulating lands: dominant are gravelly-surfaced moderately deep loamy red duplex soils (Dr2.42), with lesser (Dr2.12), (Dr2.43), and (Dr2.13). Associated are moderately deep loamy red earths (Gn2.12, Gn2.15, and Gn2.13). Data are limited. Occurs on sheet(s): 10"
"Qj1"
"Low hilly to hilly lands with much gravel on the surface and through the A horizons of the soils: dominant are shallow loamy red duplex soils (Dr3.22) with lesser (Dr3.42, Dr3.41) and (Dr2.22). Other loamy duplex soils (Dy3.42, Dy3.41) and (Dy2) equivalents, together with loamy yellow earths (Gn2.21, Gn2.24), occur on the lower slopes, outwash fans, and in the drainage lines. Shallow gravelly loams (Um4.2) and sands (Uc4.2) and (Uc4.12) occur on the ridge crests. Data are fairly limited. Occurs on sheet(s): 7,10"
"Qr1"
"Flat to undulating ridges with moderate to steep side slopes; some streams with narrow flood-plains, others deeply incised: chief soils are friable neutral red soils (Dr4.12) with variable areas of other friable soils including (Gn3.12) and (Db3.13). Associated are: ridges of gravelly or stony and often shallow (Dr2.22) and/or (Dr2.12), and (Um4.1) soils; limestone areas of (Um6.43) and (Dr4.13) soils on the steeper sites, and (Uf6.11) soils in concave sites; (Um6.11) and possibly (Ug5.1) soils on flood-plains and terraces; and/or unit Tb31 on the steeper slopes above incised streams. Occurs on sheet(s): 3"
"Qr2"
"Basaltic knolls and ridges: chief soils are friable neutral red soils (Dr4.12). Associated are red earths (Gn2.1) and (Um6.13) soils. Compare unit Mu5 (iii). Occurs on sheet(s): 3"
"Qs1"
"Low to moderately hilly with rounded crests; some rock outcrop--generally short moderate slopes but grading to longer gentle slopes in small valleys; derived from soft sediments largely of sandstone and mudstone: chief soils are friable neutral red soils (Dr4.22) with (Dr4.42) and also (Dr2.42 and Dr2.41). Associated are (Um2.12) soils on crests and upper slopes, (Dr4.23) and (Gn3.13) soils on lithic sandstones, and (Gn3.92) soils on shales. Minor soil occurrences include (Ug5.14), (Ug5.16), (Gn3.45), (Dy2.43), and (Dy3.42). Occurs on sheet(s): 4"
"Ra1"
"Plain with occasional stony rises: hard neutral brown soils (Db1.22, Db2.22, and Db2.42) in association with hard neutral yellow mottled soils (Dy3.42) and all these in association with small areas of cracking grey clays (Ug5.2); minor soils include (Dr2.2), (Db1.4), (Dy2.4), (Dy5.4), (Dr4.1), and (Dd2.24) on the plains, and shallow friable loamy soils (Um6) associated with stony rises; dark cracking clays (Ug5.16) occur in most stream valleys. Ironstone gravels are common in A horizons of the D soils. Occurs on sheet(s): 1"
"Ra2"
"Undulating to hilly: hard neutral brown soils (Db1.22, Db2.22, and Db2.42) in association with hard yellow mottled soils (Dy3.4, Dy3.6, and Dy3.8)--some members of each of these groups contain ironstone gravels in their A horizons. Red friable earths (Gn3.11) also (Dr4.1) are conspicuous but minor components especially in the more hilly portions of the unit. Other soils (undescribed) are likely in this unit also. Occurs on sheet(s): 1"
"Ra3"
"Narrow flood-plains and terraces: chief soils are hard neutral and alkaline brown soils (Db1.22 and Db1.23). Associated are (Db2.42), (Dr2.42), and (Dy3.4) soils; and possibly (Um) soils on present flood-plains. Data are limited. Occurs on sheet(s): 3"
"Ra4"
"Undulating to low hilly: chief soils are hard neutral brown and red soils (Db1.22) and (Dr2.22). Associated are: (Db1.23) and (Dr2.23) on slopes; (Db1.43), (Dy2.43), and (Dy3.43) in valleys; stony ridge tops of shallow loamy soils, such as (Um4.1) and (Um6.21); and less commonly, (Dr4.12) soils on tops of knolls. Occurs on sheet(s): 3"

"Ra5"
"Hilly with some steep slopes, rock outcrops: chief soils are hard neutral brown and red soils (Db1.22) and (Dr2.22) with shallow loamy soils such as (Um4.1). Associated are small areas of various soils, including (Dy) soils. Occurs on sheet(s): 3"
"Rb1"
"Dissected plain with low stony rises: hard neutral brown soils (Db1.22 and Db1.42) with dark shallow porous loamy soils (Um6.21) associated with stony rises and other areas of shallow basalt; minor areas of (Db4.11) and (Dd2.32) on the plains; dark cracking clays (Ug5.16) and alluvial soils (unclassified) along the stream valleys. Ironstone gravels are common in A horizons of D soils except for (Db4). Occurs on sheet(s): 1"
"Rb2"
"Rolling to low hilly lands on serpentine; rounded crests with gentle to moderate side slopes; shallow open valleys with fan deposits and narrow alluvial flats: chief soils are hard neutral brown soils (Db1.22) with (Db1.23) and (Db1.4) on crests and upper slopes. Associated are (Gn3.42) soils, often shallow and gravelly, on mid and lower slopes and (Ug5.13) soils also on middle and lower slopes. Minor soil occurrences include: (Um2.12) on hill crests often in complex with the (Db) soils; (Db1.43) on hill slope fans; (Ug5.16) and (Dd1.32) with (Dd1.33) on flats; and (Uc2.12), (Um4.1), and (Dd1.41) on trachyte plugs and dykes in some localities. This unit is related to unit Kc9. Occurs on sheet(s): 4"
"Rc1"
"Peneplain remnants: gently undulating remnants of hard acidic brown soils (Db1.21 and Db2.21) in association with a variety of other (D) soils such as (Dy3.31) and (Dr2.11); with minor areas of red friable porous earths (Gn4.11) adjoining the peneplain remnants; traversed by narrow valley plains of dark cracking clays (Ug6.1) and minor areas of other undescribed soils. Occurs on sheet(s): 2"
"Rd1"
"Plain: gently undulating plain of hard acidic brown soils (Db1.61) characterized by large amounts of ironstone grav throughout the surface soil horizons; other soils not described. Occurs on sheet(s): 2"
"Re1"
"Hilly to steep hilly: hills and hill slopes of hard neutral brown soils (Db2.42 and Db1.42) in association with small areas of many other (D) soils such as (Dr2.12 and Dr2.13), (Db1.43 and Db1.81), (Dy3.41, Dy3.43, and Dy3.62), (Dy5.61, Dy5.81, Dy5.41, and Dy5.21), and G soils such as (Gn4.11 and Gn4.31) and (Gn3.94); small valley plains of (Dy3.4) and (Ug5.16 and Ug6.1); at the highest elevations small areas of unit KL1 may be present. Occurs on sheet(s): 2"
"Rf1"
"Undulating plateaux with major steps in them: plains of hard alkaline brown soils (Db1.13) with hard alkaline dark soils (Dd1.13), and also hard alkaline yellow mottled soils (Dy3.13) with cracking clays (Ug5.2) in gilgai microassociation; hard alkaline red soils (Dr2.13) on the slopes (steps) between the different plateau levels. Occurs on sheet(s): 2"
"Rf2"
"Moderate to gently undulating lands: dominant are thin-surfaced brown loamy soils (Db1.13 and Db1.33) but areas of brown or grey cracking clays (Ug5.32, Ug5.34, Ug5.22, and Ug5.24) are closely associated. On more sloping sites red duplex soils are common (Dr2.33, Dr2.13, and Dr2.12). Other alkaline duplex soils (Dy2.13 and Dy2.33) and (Dd1.13) and Dd1.33) also occur. Small areas of loamy red earths (Gn2.12) occur locally on ridge crests and there may be limited areas of shallow uniform clays (Uf6.32). Alluvial valley plains have mostly loamy duplex soils (Dy2.43). Occurs on sheet(s): 4"
"Rf3"
"Moderately undulating lands with some rounded low hills; occasional higher closely dissected hilly areas also occur: dominant soils are brown loamy duplex soils (Db1.13 and Db1.33), with closely associated loamy red soils (Dr2.33, Dr2.13, and Dr2.12). Important areas of sandy duplex soils (Dy3.42), (Dy3.32), and (Db2.42) also occur. Minor soils occurring include (Um5.2) and (Um4.12) and friable earths (Gn3.12, Gn3.32, and Gn3.23). Small stream flood-plains have loamy duplex soils (Dy2.43) and (Dd1.13 and Dd1.33).. Occurs on sheet(s): 4"
"Rf4"
"Gently undulating plains: dominant are brown thin-surfaced loamy soils (Db1.13 and Db1.12) which are often gravel-strewn. Associated are cracking clays (Ug5.34, Ug5.15, and Ug5.24). Small areas of red loamy duplex soils (Dr2.13 and Dr2.12) also occur. Occurs on sheet(s): 4"
"Rf5"
"Moderate or occasionally strongly undulating lands; some areas of gently sloping small plains: dominant are loamy-surfaced (46 in.) brown duplex soils (Db1.13 and Db1.33) which occur on all except the higher ridge crests where similar red soils (Dr2.12 and Dr2.13) are dominant. Local areas of friable earths (Gn3.23) and (Gn3.13) also occur and the gently sloping plains usually have areas of brown clays (Ug5.32) with, less commonly, grey clays (Ug5.22). Other loamy duplex soils occur chiefly in lower landscape sites; these include (Dy2.33), (Dy3.33), and (Dy3.43). Occurs on sheet(s): 4"

"Rf6"
"Level or very gently undulating alluvial plains fringing drainage-ways: dominant soils are loams with weakly developed brown clay subsoils (Db1.13) with (Db1.12) and (Db1.22). Associated are similar (Dd1) soils and less commonly (Dr2.12) or (Dy2.32 and Dy2.33). Some lower sites have cracking clays (Ug5.15), (Ug5.25), (Ug5.4), and (Ug5.5) or other fine-textured soils (Uf6.32). Slightly higher levees have uniform loamy soils (Um5.5). Occurs on sheet(s): 4"
"Rf7"
"Moderate to gently undulating lands with widely spaced shallow valleys: dominant are thin-surfaced loamy duplex soils (Db1.13), (Db1.33), and (Db1.43) often of shallow depth and with some rock outcrop. Similar (Dr2), (Dd1), and (Dy2) soils also commonly occur. Flatter slopes or low sloping plains have cracking clays (Ug5.22), (Ug5.32), (Ug5.13), and (Ug5.37) with some deeper clays (Ug5.16), (Ug5.25), and (Ug5.34) in lower sites. On many clay soil slopes a prominent linear gilgai is evident. Almost all soils are commonly strewn with small fragments of silicified wood, ironstone, and billy and small gravel. Occurs on sheet(s): 4"
"Rf8"
"Alluvial plains adjacent to major streams: dominant soils away from the stream levees are fine silty or loamy-surfaced brown duplex soils (Db1.13), (Db1.33), (Db1.32), and (Db1.43). The A horizon depth ranges from 8 to 15 in. in thickness. Associated are smaller areas of similar (Dd1) and (Dy2) soils. The low levees adjacent to streams are coarser-textured with (Uc5.21), (Gn2.42), and (Um5.4) soils. As mapped, the unit may include small areas of gilgaied clays (unit CC30). Occurs on sheet(s): 4"
"Rf9"
"Undulating to moderately undulating lands with a billy gravel layer (up to 4 in. diameter) that is often continuous covering many areas: dominant are brown loamy duplex soils (Db1.13) and (Db1.33) but brown clays (Ug5.32 and Ug5.34), often slightly gilgaied, are closely associated. Also occurring are grey duplex soils (Dy2.33) and (Dy2.43) and small plains of grey clays (Ug5.24). Occurs on sheet(s): 4"
"Rg1"
"Dissected plateau: ridges of friable acidic brown soils (Db3.21) surrounded by moderate to steep slopes of (Db3.2) and dark cracking clays (Ug5.13) often in microassociation; minor areas of red friable porous earths (Gn4.11) on ridge tops; dissected by narrow creek valleys with swampy areas, soils not described. Occurs on sheet(s): 2"
"Rh1"
"Ridge with moderate to steep slopes undulating ridge top of friable brown soils (Db3.12) and friable red soils (Dr4.12) with dark cracking clays (Ug5.13 (5) showing gilgais on the ridge slopes. Occurs on sheet(s): 2"
"Rh2"
"Strongly undulating basaltic ridges of friable neutral brown soils (Db3.12) with cracking clays (Ug5.15 and Ug5.16) on lower slopes and in valleys. As mapped, areas of unit Mu5 are included. Occurs on sheet(s): 3"
"Rh3"
"Dissected basaltic plateau remnants of variable area--flat-topped ridges and/or knolls and/or stony rises, some bouldery areas: chief soils seem to be friable brown soils (Db3.12 and Db3.11) and/or (Gn3.12) on ridges, knolls, and their slopes. Associated are: (Um6.2) and (Dr4.1) soils on ridges, knolls, and their slopes; cracking clays such as (Ug5.13, Ug5.15) at the base of ridges and knolls; (Ug5.16) soils--unit Kd4 in the valleys; and some (Dr2.21) and (Dy3.41) soils on mixed colluvial slopes. As mapped, areas of units Tb50 and Mw5 may be included. Variations exist between individual occurrences. Occurs on sheet(s): 3"
"Rh4"
"Dissected basaltic plateau--undulating to low hilly: chief soils are friable brown soils (Db3.12) with (Dr4.12) and shallow variants of (Gn3.12) on ridge crests, slopes, and undulating areas. Associated are (i) (Um6.2) soils on ridges; (ii) cracking clays such as (Ug5.13 and Ug5.14) on flanking slopes of ridges; and (iii) various (D) soils, such as (Dy3.2) and (Db1.2) often containing ironstone gravels, on the flatter areas. As mapped, areas of unit Kd4 are included. Occurs on sheet(s): 3"
"Rh5"
"Dissected basaltic plateau--hilly: chief soils are friable brown soils (Db3.12) and (Dr4.12) on ridge crests and slopes. Associated are: (Um6.2) soils on ridges; some (Gn3.12) soils on slopes; some (Gn2.1) soils, often containing ironstone gravels, on slopes; some cracking clays such as (Ug5.13) on slopes; small areas of soils common to unit Ub56 on slopes; and unit Kd4 along valleys. Occurs on sheet(s): 3"
"Rh6"
"Dissected basaltic plateau--low hilly to hilly: chief soils are friable brown soils (Db3.12) and hard neutral yellow mottled soils (Dy3.42). The area is essentially similar to unit Rh5 but with a much larger area covered by the soils of unit Ub56. Occurs on sheet(s): 3"
"Rh7"
"Low hilly with tors and flat-topped basaltic residuals: chief soils are friable brown soils (Db3.12) and red friable earths (Gn3.12). This area is similar to unit Rh4 but with a greater proportion of (Gn3.12) soils, a considerable area

of the soils common to unit Wa10, and the cracking clay soils of unit Kd4 along some valleys. Occurs on sheet(s): 3"
"Rh8"
"Mountainous--steep often rugged terrain with boulders: chief soils are friable brown soils (Db3.12) with variable areas of (Um6.2), (Ug5.12), and (Ug5.13) soils. Associated are red friable earths (Gn3.12) in areas of relatively gentle relief, and (Dy) soils in some valleys. Data are limited. Occurs on sheet(s): 3"
"Rh9"
"Steep hilly to mountainous: chief soils seem to be friable brown soils (Db3.12 and Db3.11) with friable red soils (Dr5.12 and Dr5.11) with other friable soils, such as (Gn3.22), (Gn3.43), (Dy5.12), and (Dd3.32). Associated are: shallow soils such as (Um4.2), rock outcrops, and bare rock faces on upper slopes and rugged ranges; scattered small areas of soils of unit Gd4; and narrow valleys with some soils of unit Kd6. The unit is a broad one and soil distribution is complex and not well known. Occurs on sheet(s): 3,4"
"Rh10"
"Rounded hilly to mountainous country on andesites and associated sedimentary rocks, rising to 2300 ft above sea level: chief soils are friable neutral brown soils (Db3.12) and dark friable clays (Uf6.22), both often stony and commonly occurring on upper slopes. Associated are: hard neutral and alkaline red and brown soils (Dr3.42) and (Db2.43); (Um6.33) soils on steep slopes; and small areas of unit MM9 soils in valley plains. Occurs on sheet(s): 4"
"Rh11"
"Steep hilly to mountainous land on volcanic rocks--soils generally shallow and gravelly: chief soils are friable brown soils (Db3.12) and dark friable earths (Gn3.42). Associated are shallow (Gn3.12) and (Dr2.12) soils. Other soils include (Db1.12) on slopes; (Ug5.15) on creek flats; (Um4.1) on crests; and (Um6.21) on steep slopes. As mapped, there are some inclusions of unit X13. Occurs on sheet(s): 4"
"Rh12"
"Steep hilly landscape mainly on basalts but including underlying sandstones and shales; steep slopes beginning at the plateau edge at an elevation of 1200 ft above sea level and descending to 500 ft; some small platforms and narrow alluvial fans and flats: chief soils are friable brown soils (Db3.12). Associated are dark friable earths (Gn3.42) on some slopes. Other soils include: (Dy4.12) on some slopes; (Gn3.94) on transported basaltic materials and platforms; (Gn3.22) on narrow alluvial flats; (Um6) on steep slopes; (Dy5) and (Uc4) on sandstone; and (Gn3.74) and (Uc4.11) on included tuffs and trachyte. Occurs on sheet(s): 4"
"Ro1"
"Plains: chief soils are hard alkaline brown soils (Db1.33 and Db1.43) and similar (Dy), (Dd), and less commonly (Dr) soils. Associated are: sandy neutral yellow mottled soils (Dy5.42); siliceous sands (Uc1.2) in the vicinity of creeks; and low irregular dunes and/or sand sheets of red earthy sands (Uc5.21) which may be extensive in some localities. As mapped, small areas of unit CC20 are included. Occurs on sheet(s): 3"
"Ro2"
"Plains: chief soils are hard alkaline brown soils (Db1.33 and Db1.43) and smaller areas of cracking clays such as (Ug5.15 and Ug5.16). These soils may form soil complexes locally. Associated are: (Dr2.33) on slightly elevated portions of the plain; (Um6.21) soils on low limestone ridges; and other undescribed soils. Occurs on sheet(s): 3"
"Ro3"
"Plains or low levee-type rises associated with both functional and non-functional drainage-lines: chief soils are hard alkaline brown soils (Db1.33 and Db1.43). Associated are: (Dy2.33 and Dy2.43) and smaller areas of (Dy3.33 and Dy3.43); some (Dr2.33) soils; (Dd1.33 and Dd1.43) soils in the more easterly areas of the unit; occasional sandy dunes (unit B10); and small areas of cracking clays (unit CC17). The N.S.W. occurrences are not well known. Occurs on sheet(s): 3,4"
"Ro4"
"Gently undulating plains: dominant soils are hard alkaline brown soils (Db1.33), (Db1.13), (Db1.23), or rarely (Db1.43). Similar (Dr), (Dd), and (Dy) soils are commonly associated. In many instances the deeper subsoils may be extremely acid. A slight (few inches) gilgai microrelief is often present and cracking clays (Ug5.3 and Ug5.2) may then occur as soil complexes. As mapped, small areas of units CC20, Wa13, Fz2, and MM2 are also included. Occurs on sheet(s): 3,4"
"Ro5"
"Undulating lands: dominant are brown loamy duplex soils (Db1.33), (Db1.23), and (Db1.43), often with gravelly A horizons. Associated are red duplex soils (Dr2.33) and (Dr2.23), and small areas of cracking clays (Ug5.32) and (Ug5.22). Other alkaline duplex soils with bleached A2 horizons also occur, chiefly (Dy2) and (Dd1). Occurs on sheet(s): 4"
"Ro6"
"Strongly undulating or low hilly lands with a low benched or scarped topography caused by more resistant horizontal rock outcrop: the soils are all shallow, sometimes gravel-strewn or with frequent rock outcrops; they often alternate over short distances. Dominant are brown loamy duplex soils (Db1.33), (Db1.43), and (Db1.13) but

closely associated are similar (Dd1) and (Dy2) soils. Small areas of similar (Dr2) soils also occur. Higher ridges and low hills often have shallow stony loams (Um2.12) and (Um1.43) while drainage lines in the unit have small flood-plains of deeper loamy duplex soils, chiefly (Dy2.43). Occurs on sheet(s): 4"
"Ro7"
"Undulating or small level plains dissected by many small drainage lines: dominant are brown loamy duplex soils (Db1.33) and (Db1.13), but similar (Dr2) soils are commonly associated. Many areas have been deflated by wind and water erosion. Also occurring are small areas of cracking clays (Ug5.34) and (Ug5.24) together with small areas of grey-brown loamy duplex soils (Dy2.33) and (Dy2.43). Included in the unit as mapped are small mesa-like lateritic residuals with shallow stony loams (Um1.43); the more extensive of these may be capped by loamy yellow or red earths (Gn2.22) and (Gn2.12). Larger streams within the unit have soft loamy (Gn2.12) alluvial flood-plains. Occurs on sheet(s): 4"
"Ro8"
"Level or very gently undulating plains with an occasional low dune: dominant soils have moderately deep (18 in.) sandy A horizons overlying brown clay (Db1.33) and (Db1.23). Associated are similar (Dr2.33) and (Dr2.43) soils together with areas of thin-surfaced loamy duplex soils (Dy2.43) and (Dy2.33), and similar (Dy3) soils. The occasional sandy dunes have deep sands (Uc1.23) and (Uc5.21), or sandy red earths (Gn2.12). As mapped, the unit also includes some of the clay pan soils of unit Sl13. Occurs on sheet(s): 4"
"Ro9"
"Undulating lands with some high flat-topped or steep stony ridges: dominant on the flatter areas are brown loamy duplex soils (Db1.33), (Db1.13), and (Db1.43) with commonly associated similar (Dy2) soils. Small areas of cracking clays (Ug5.22), (Ug5.24), and (Ug5.34) also occur in lower sites and occasionally are slightly gilgaied (1-2 ft). On some sloping sites red loamy duplex soils (Dr2.12) and (Dr2.33) may occur. The higher flat-topped ridges mostly have loamy nodular yellow earths (Gn2.22) and occasionally red earths (Gn2.12). These are remnants of unit My3. More-dissected steeper ridges have shallow stony loams (Um4.1) and (Um1.43); these are inclusions of unit LK16. Occurs on sheet(s): 4"
"Rp1"
"Generally rolling country in soft sedimentary rocks with alluvial terraces and flats; some low hilly granitic inclusions: chief soils are hard alkaline brown soils (Db1.43), (Db1.13), and (Db1.23) on slopes, pediments, and terraces. Associated are (Dy2.43) and (Dy3.43) soils on terraces and stream flats and (Gn3.23), (Gn3.43), and (Ug5.4) soils in brigalow areas. Minor areas of (Dd1.43) soils occur in slightly swampy areas on terraces and fringes of lower slopes. Small inclusions of (Gn2.11), (Dy3.42), and (Dr2.21) soils on low hilly portions. Occurs on sheet(s): 4"
"Rq1"
"Strongly undulating or low hilly lands: dominant are gravelly mostly shallow loamy duplex soils with mottled clay subsoils (Db2.33) and (Db2.43). A wide range of other shallow duplex soils are associated, chiefly alkaline (Dy3), (Db1), (Dr2), and (Dy2) forms. Associated drainage lines have small flood-plains with loamy (Dy2.43) or (Dd1.43) soils together with small areas of clays (Ug5.24 and Ug5.25). Occurs on sheet(s): 4"
"Rr1"
"Undulating terrain of sandy and clayey alluvia with alternate broad shallow open flats and low rises: chief soils are hard acid brown soils (Db1.41) on the broad flats with leached sands (Uc2.32) on the tops of the low rises. Associated are (Gn3.84) soils on the crests and slopes of included areas of old coastal plain remnants on which some (Gn2.14) soils may occur also. Other soils include (Dy3.41) on dissection slopes and (Gn2.74) soils on slopes of some sandy rises. Occurs on sheet(s): 4"
"Rs1"
"Low hilly to hilly country on volcanic rocks and boulder beds, with gentle to moderate slopes; open valleys with relatively wide stream flats: chief soils are hard neutral brown soils (Db1.12) in complex with friable neutral dark soils (Dd3.12) on crests and slopes. Associated are (Gn3.42), (Dr2.12), and (Gn3.12) soils on hill slopes. Other soils include (Dd1.33), showing very weak gilgai, along stream flats. Occurs on sheet(s): 4"
"Rt1"
"Level or very gently undulating alluvial plains fringing major drainage lines: level areas have brown loamy soils (Db1.32 and Db1.33) dominant but uniform deep sands (Uc1.21) and (Uc4.2) also occur. Occasional low dunes in the unit have red sands (Uc1.23). Adjacent to the drainage lines or in areas subject to flooding are silty loam duplex soils (Dd1.12) with some (Dy2.12 and Dy2.13). Occurs on sheet(s): 4"
"Rz1"
"Undulating sandy plains fringing drainage lines, and with prominent elongate sandy dunes: chief soils are sandy-surfaced (Db3.32) and (Dy4.42) soils that grade into the (Uc4.2) and (Uc1.2) soils of the dunes. Nearer the drainage lines hard-setting loamy soils (Db1.33) occur fringing the cracking clays (Ug5.2) (unit CC17) of the lowest areas. Occurs on sheet(s): 3,4"
"S1"

"Hilly to mountainous: hard acidic yellow soils (Dy2.21) in association with hard acidic red soils (Dr2.21) with rock outcrops and shallow grey-brown sandy soils (Uc6.11); small areas of friable acidic yellow soils (Dy4.21) on ridge tops at high altitudes; hard neutral yellow mottled soils (Dy3.42) in the valleys; in sheet2 only there are small patches of units Ta4 and Mg16 in the eastern portion of this unit. Occurs on sheet(s): 1,2"
"S2"
"Low, undulating tableland of hard acidic yellow soils (Dy2.41), in association with leached sands (Uc2.34) and sandy acidic yellow mottled soils (Dy5.41), sometimes with an organic pan between the A and B horizons, and also other leached sands (Uc2.3); small swampy areas of unclassified soils in which the small streams arise. Occurs on sheet(s): 2"
"SQ1"
"Gently undulating plains with block laterite and ironstone gravels flanked in places by steep dissection scarps: chief soils are ironstone gravels with a matrix of (D) soils (KS-Dy2.62), (KS-Dy3.62), and (KS-Dr2.62). Associated are shallow sands and loams (KS-Uc4.11), (KS-Uc4.12), (Uc4.1), and (K-Um1.4) on the scarps and steeper slopes. Minor occurrences include red and yellow earths containing ironstone gravels (Gn2.12) and (Gn2.22); the latter may flank shallow drainage floors of (Ug5.5) and or (Ug5.6) soils or small areas of unit II5 soils. Occurs on sheet(s): 8"
"SV1"
"Saline valleys and salt lakes--salt-lake channels, mostly devoid of true soils, and their fringing areas; few freshwater lakes: common soils are gypseous and saline loams (Um1.1 and Um1.2) on riverine wash and usually underlain by clayey or sandy strata by about 12 in. Associated are various resalinized (Dy) soils such as (Dy4.83) on fringe areas, and dunes and lunettes of various sandy (Uc), silty (Um), and clayey (Uf) soils of slight profile development. Deposits of common salt, gypsum, lime, and alunite occur as do remnants of the old lateritic profile and occasionally outcrops of country rock. Occurs on sheet(s): 5"
"SV2"
"Saline valleys with some dunes including barchan forms--salt lake channels, mostly devoid of true soils, and their fringing areas: common soils are gypseous and saline loams (Um1.1) and (Um1.2), together with grey-brown highly calcareous earths (Gc1.12). Associated on fringe areas are various (Dy) soils as for unit Ya28; siliceous sand (Uc1.2) on dunes and lunettes; and other undescribed soils. Deposits of common salt, gypsum, lime, and alunite may occur. Occurs on sheet(s): 5,10"
"SV3"
"Saline valleys of salt lakes, clay pans, kopi dunes, sand dunes, sometimes with tors and bosses of outcropping granites: common soils are gypseous and saline loams (Um1.1) and (Um1.2), together with the soils of the adjoining units, namely grey-brown calcareous earths (Gc1.12) and calcareous loams (Um5.11), and some (Uc1.2) sands on dunes. Data are limited. Deposits of common salt, gypsum, lime, and alunite may occur. There are larger areas of (Gc) soils than in unit SV2. Occurs on sheet(s): 5,10"
"SV4"
"Saline valleys and salt lakes--salt-lake channels, mostly devoid of true soils, and their fringing areas: common soils are gypseous and saline loams (Um1.1 and Um1.2) on riverine wash and usually underlain by clayey or sandy strata by about 12 in. Associated are small areas of the soils of the adjacent areas, in particular (Gn2.13 and Gn2.12) soils with some (Um5.11), (Gc1.12), and (Gc1.22) soils often underlain by calcrete (kunkar); dunes and lunettes of sandy (Uc) soils such as (Uc1.21); and some patches of (Dr) soils. Occurs on sheet(s): 5,10"
"SV5"
"Saline soils associated with salt lakes; sand and kopi gypsum dunes, and intervening plains: soils are mixed but chief soils are probably shallow (Um1), with various (Dr1) and (Dr2) soils, together with saline (Gn2.13), (Uc1.23), and (Um5.11) soils that sometimes overlie red-brown hardpan, and the soils of unit B39 in the area of Sheet 10. Occurs on sheet(s): 6,10"
"SV6"
"Saline flats and calcareous dunes flanking coastal marsh and tidal flats; and with some marl and shell beds: chief soils are probably calcareous loams (Um1.1, Um1.3), as in unit SV7, with minor areas of calcareous earths (Gc1.22) and clay soils (Uf1.3), overlying shell beds and marl. There is a variable proportion of calcareous sands (Uc1.11, Uc1.12) both on coastal dunes and as lunettes surrounding the coastal marshes. Occurs on sheet(s): 6"
"SV7"
"Extensive coastal saline flats subject to periodic inundation and with outcropping marl, shell beds, and gypsum deposits: chief soils are probably calcareous loams (Um1.1, Um1.3), with brown calcareous earths (Gc1.22), overlying marl. There are some shell beds and recent dunes (Uc1.12) adjoining units A18 and SV6, and small areas of cracking clay soils (Ug6.2). Occurs on sheet(s): 6"
"SV8"
"Salt flats, tidal swamps, and coastal dune sands: chief soils are saline loams (Um1.3) nad (Um1.4) with shelly sands (Uc1.11, Uc1.13). Small areas of calcareous earths (Gc) and shallow loams (Um) are associated with marls. Occurs on sheet(s): 6"

"SV9"
"Salt lakes, salt pans, and clay pans mostly devoid of true soils, covered with clays, silts, sodium chloride, calcium sulphate, and sodium sulphate, and underlain by brine; soft caliche and calcrete (kunkar) margin the lakes in places; shale cliffs 5O-lOOft high abut the eastern edges of the lakes in places; and broken and irregularly shaped sand dunes flank the lake systems: chief soils are probably shallow loams (Um1.1, Um1.2, and Um1.3). Other soils may include (Um5.11), (Gn2.13), and (Dr1) soils above the level of the (Um1) soils, together with (Uc1.23) soils on the dunes. Occurs on sheet(s): 10"
"SV10"
"Shallow valleys with lakes, clay pans, salt pans, calcrete (kunkar) platforms, sand dunes, kopi dunes, and calcareous dunes: chief soils are probably shallow loams (Um1.1), (Um1.2), and (Um1.3). Associated are (Um5.11) and (Gc) soils on the calcrete platforms and (Gn2.13) marginal to them; (Dr1.33) and (Dr1.43) with some low gilgai on flanking saline plains; and (Uc5.11, Uc5.12) sands on the dunes. As mapped, there may be inclusions of adjoining units. Occurs on sheet(s): 10"
"SV11"
"Plains studded with lakes, clay pans, and salt pans: chief soils are probably shallow loams (Um1.1), (Um1.2), and (Um1.3), with (Um5.11) and (Gc) soils on calcrete (kunkar). Associated are uneven and broken plains of (Dr) soils similar to those of unit Nb7. Occurs on sheet(s): 10"
"SV12"
"Plains studded with salt pans, seasonal lakes; calcrete (kunkar) platforms; and fringing dunes: chief soils are probably shallow loams (Um1.1), (Um1.2), and (Um1.3) and saline clays (Uf) and possibly (Ug). Other soils include (Um5.11) on calcrete; (Uc1.23) on the dunes; and various (D) soils, such as (Db0.43) and (Dr1.43) on pan margins. Other soils may occur. Occurs on sheet(s): 10"
"SV13"
"Saline plains with salt pans and lakes; some fringing dunes: chief soils are shallow loams (Um1.3), (Um1.1), and (Um1.2) and shallow sands (Uc1.3) often as plant-entrapped mounds on the loams. Other soils include (Uc1.23) on the dunes. Gypsum and sodium chloride are common in the pans and there are some gypsum (kopi) dunes in places. Occurs on sheet(s): 10"
"SV14"
"Plains of gypsiferous deposits: chief soils are probably (Um1.1), (Um1.2), and (Um1.3) but some (Uc) soils may occur. Both (Ug5.2) and (Ug5.3) soils are important associates. Data are very limited. Occurs on sheet(s): 10"
"SV15"
"Salt lakes and their associated areas: common soils are gypseous and saline loams (Um1.1), (Um1.2), and (Um1.3) together with gypseous and saline (Gn) soils on the lake beds. Associated are sandy red earths (Gn2.13) on lunettes; (Gc1.22) soils on plains; (Dr1.33) soils on eroded plains; and small areas of (Uf) soils on clay pans. Occurs on sheet(s): 10"
"Sc1"
"Gently undulating to undulating lands with long slopes and broad crests: dominant are loamy-surfaced duplex soils (Dy2.13) with some ironstone nodules in the upper B horizon. Associated are other loamy duplex soils (Dy3.13), (Db1.12, Db1.11), (Dr3.42), and (Dr2.13, Dr2.12, Dr2.11). In some depressions are loamy grey earths (Gn2.81). Some of the rises have a range of loamy earths (Gn2.22, Gn2.21), (Gn2.44, Gn2.43), and (Gn2.12), which have ironstone gravel on the surface and nodules at depth. Some bleached loamy duplex soils (Dy2.42) and (Db1.42) may occur near drainage lines. Important areas of grey-brown cracking clays (Ug5.24, Ug5.25, and Ug5.22) of unit CH10 occur throughout the unit. Occurs on sheet(s): 7"
"Sc2"
"Gently undulating plains: dominant are deep loamy duplex soils, chiefly (Dy2.13, Dy2.12), with lesser (Dy3.13), (Dr2.13), and (Db1.12) and loamy yellow and brown earths (Gn2.23) and (Gn2.43). Occurring throughout the unit are areas of deep grey-brown cracking clays (Ug5.25, Ug5.24) that may be locally dominant. Occurs on sheet(s): 7"
"Sc3"
"Narrow alluvial plains with braided stream channels: dominant soils are loamy grey duplex soils (Dy2.13), with associated (Dy2.33), (Db1.13), (Db1.33), and (Dy2.43) soils. Some deep cracking grey clays (Ug5.24, Ug5.25, and Ug5.28) also occur. Occasional small stream levees have loamy red earths (Gn2.12, Gn2.13). Data are limited. Occurs on sheet(s): 10"
"Sd1"
"Moderate to strongly undulating lands with some low hilly areas: dominant are shallow mostly stony loamy duplex soils with friable yellow-brown clay subsoils (Dy2.21) and (Dy2.41). Similar (Dy3) and (Db1) soils are closely associated. On higher hilly slopes brown friable earths (Gn3.24 and Gn3.21) are common together with smaller areas of (Gn3.14) and (Um1.43) soils. On flatter lower slopes or on small alluvial stream flood-plains deeper loamy duplex soils (Dy3.42) occur. Occurs on sheet(s): 4"
"Sd2"

"Rounded hills of the Darling scarp with gneissic rock outcrops; slopes are moderate to very steep: chief soils seem to be hard acidic, and also neutral, yellow and yellow mottled soils (Dy2.21 and Dy2.22) and (Dy3.21 and Dy3.22). Associated are hard acidic red soils and neutral red soils (Dr2.21 and Dr2.22) on the slopes; with some (Dy3.6) soils containing ironstone gravel and also small areas of unit JZ1 soils on ridge tops; and various unclassified soils in the narrow valleys. As mapped, areas of unit JZ1 may be included. Occurs on sheet(s): 5"
"Sd3"
"Strongly undulating lands, prominent linear strike ridges, and occasional low hilly areas; quartz-reef outcrop is common; all soils are gravelly, often with prominent quartz gravel between A and B horizons: dominant are probably yellow duplex soils (Dy2.21) and (Dy2.81) of shallow to moderate depth, but similar (Dr2) soils are also common. In parts of the unit, particularly on areas of lesser relief, deep loamy nodular earths (Gn2.64), (Gn2.74), and (Gn2.14) may be common. The low hills mostly have shallow stony loams (Um4.12) or sands (Uc4.12) and (Uc2.12). Data are fairly limited. Occurs on sheet(s): 7"
"Se1"
"Moderately hilly country on shaly rocks; close pattern of hills with rounded stony crests and strong parallel strike ridge pattern, and with short slopes straight to drainage lines, or grading into concave colluvial slopes and wider drainage bottoms: chief soils are hard neutral yellow soils (Dy2.22) with some (Dy2.42). Associated are: (Dr2.22), (Dr2.42), (Db1.11), and (Dr2.11) soils on slopes; (Um4.1) and (Um2.12) soils on crests; (Dy3.43) soils in concave drainage flats; and some (Gn3.11) and (Gn3.21) soils on slopes. Minor soil occurrences include (Gn3.42), (Dd1.43), and (Dy3.22). Occurs on sheet(s): 4"
"Se3"
"Gently undulating to undulating lands: dominant are moderately deep to deep loamy yellow-grey duplex soils (Dy2.22), with lesser (Dr2.12), (Dr2.22), and (Dy3.22). The unit also includes areas of bleached sands (Uc2.12) and (Uc2.22) or sandy yellow earths (Gn2.24), which overlie coarse water-worn gravels. Some small basalt mesas with soils of unit Mo31 also occur. Occurs on sheet(s): 7"
"Se4"
"Gently undulating to undulating lands with long gentle slopes and rounded ridge crests; some low granite tor rises and basalt mesa remnants are included: dominant are loamy yellow duplex soils (Dy2.22), with (Dy2.21) and similar red duplex soils (Dr2.22, Dr2.21) associated. Solum depth ranges from shallow to deep. Shallow bleached sands (Uc2.12) and (Uc2.21), with lesser (Uc4.12) and (Uc4.21), occur on ridge crests and adjacent to rock outcrop; alkaline loamy duplex soils (Dy3.43), (Dy2.43), and (Dy2.33) are common in the drainage lines. Friable red earths (Gn3.12) and shallow gravelly clays (Uf6.31) occur on the basalt mesa remnants. Occurs on sheet(s): 7"
"Sh1"
"Moderate to gently undulating lands with some small level gilgaied plains: dominant are sandy to loamy duplex soils with moderately deep A horizons (15 in.) overlying grey clay (Dy2.32). Closely associated are small level plains with grey and brown clays (Ug5.24), (Ug5.25), and (Ug5.34) that are moderately to strongly gilgaied (2-3 ft). Also occurring are small levees adjacent to drainage lines with sandy earth soils (Gn2.14), (Gn2.42), and (Gn2.45). Occurs on sheet(s): 4"
"Sh2"
"Gently undulating to undulating fool slopes and outwash fans and some isolated low hills: dominant soils are moderately deep to deep loamy yellow duplex soils (Dy2.32), with other loamy duplex soils (Dy2.22), (Dy3.32), (Dy3.22), (Dy3.41), (Dy3.42), (Db2.32), and (Dr3.32) closely associated. Stony uniform loams (Um4.2) and (Um4.12) are common on the hilly areas of unit LL12 that are included. Moderately deep to deep uniform sands (Uc4.21) and (Uc2.21) occur on some alluvial fans, and sandy red earths (Gn2.14) occur on occasional low granite hills included in the unit. Occurs on sheet(s): 7"
"Si1"
"Gently sloping plains of hard alkaline yellow and yellow mottled soils (Dy2.33) and (Dy3.43) and other similar (D) soils such as (Db1.33), with areas of cracking clays such as (Ug5.16). These soils may form soil complexes. Small areas of unit Sl2 soils are probably included. Occurs on sheet(s): 3"
"Si2"
"Plains or low levee-type rises associated with both functional and non-functional drainage lines: hard alkaline yellow soils (Dy2.33 and Dy2.43) are associated with (Dy3.33 and Dy3.43) and smaller areas of (Db1.33 and Db1.43); sometimes a minor (up to 6 in.) gilgai microrelief is present. As mapped, some areas of (Dr2.33) soils, occasional sandy dunes (unit B10), and small areas of cracking clays (unit CC17) are included. Many areas are deflated by wind. Occurs on sheet(s): 3,4"
"Si3"
"Moderately undulating lands with some small level flood-plains associated with minor streams: dominant soils are fairly shallow (18-24 in.) thin-surfaced loams or clay loams overlying dense grey clay subsoils (Dy2.33), (Dy2.13), and (Dy2.43). Associated are similar (Dd1) and (Db1) soils with some small areas of clays (Ug5.22), (Ug5.12), and (Uf6.32 and Uf6.33). On some ridges a surface gravel layer may be present. The soils of the small flood-plains are chiefly (Dy2.43) and (Dy3.43). Occurs on sheet(s): 4"

"Si4"
"Strongly dissected steep valley side slopes with strongly undulating to low hilly lower areas: dominant soils are gravelly loamy duplex soils (Dy2.33), (Dy2.13), and (Dy2.12) with some areas of (Dr2.32), (Dr2.31), and (Db1.33 and Db1.32). On steeper and higher slopes some (Um4.31) soils occur. Small flood-plains on flatter valley floors have loamy or sandy duplex soils (Dy2.33), (Dy2.43), and similar (Dy3) soils with small areas of clays (Ug5.24) and (Ug5.15). Occurs on sheet(s): 4"
"Si5"
"Alluvial flood-plains mostly associated with major streams; the area is sometimes dissected by broad shallow drainage lines and there are occasional old low levees: most common are loamy duplex soils of moderate A horizon depth (6-12 in.) and grey-brown clay subsoils (Dy2.33), much less commonly (Dy2.13) and (Dy2.43). The slightly higher areas have deeper sandier A horizons (12-15 in.) and brown or reddish brown clay subsoils (Db1.33), (Db1.13), and (Dr2.13 and Dr2.12). Marginal to the alluvial plains and particularly fringing depressed areas are thin-surfaced loamy duplex soils (Dd1.33) and (Dd1.43). In the associated broad drainage lines and depressions cracking clays occur, chiefly (Ug5.24), (Ug5.14), and (Ug5.15) and occasionally (Ug5.5 and Ug5.4). Adjacent to major stream banks a range of uniform-textured soils often occurs, chiefly (Uf6.32), (Um5.4), and (Uc5.11). Occurs on sheet(s): 4"
"Si6"
"Gently undulating lands with occasional higher gravelly ridges: the area is a complex of thin-surfaced loamy duplex soils and slightly gilgaied clays. Dominant are (Dy2.33), (Dy2.13), and (Dy2.43) with similar (Dd1) and (Dy3) soils associated. In lower sites and in the gilgai depressions cracking clays occur, chiefly (Ug5.16) and (Ug5.24). As mapped, there are inclusions of unit CC30. Occurs on sheet(s): 4"
"Si7"
"Undulating partly dissected old stream terraces and some alluvial valley floors: dominant are thinsurfaced often gravel-strewn loamy duplex soils (Dy2.33) and (Dy2.43). Closely associated are areas of cracking clays (Ug5.16) and (Ug5.24) that have a prominent linear gilgai on slopes. The valley floors have deeper-surfaced loamy duplex soils (Dy3.43) and (Dy2.43) and some areas of deep dark clays (Ug5.16). Occurs on sheet(s): 4"
"Si8"
"Broadly undulating lands in which the soils change rapidly across the strike of the underlying rocks. On most strike ridges and slopes fairly shallow loamy duplex soils (Dy2.33) and (Dy2.43) are dominant. Closely associated are other loamy duplex soils (Dr2.12), (Dr2.33), (Db1.13), (Db1.33), and (Dy3.43). Also prominent in the unit are linear bands of clay soils (Ug5.22) and (Ug5.32) which may be slightly gilgaied. Occurs on sheet(s): 4"
"Si9"
"Alluvial plains with slightly elevated old levees and shallow prior stream channels: dominant on the level plains are loamy duplex soils, chiefly (Dy2.33) but with (Db1.33) locally prominent. Smaller areas of similar (Dd1) and (Dr2) soils also occur. Many of the duplex soils may be wind-deflated. The old channels and depressed areas, some of which are subject to flooding, have grey clays (Ug5.24 and Ug5.29) with lesser brown clays (Ug5.34). The soils of the old levees are deep sands (Uc5.21) with some (Uc1.21) sandy levees adjacent to major stream channels. Occurs on sheet(s): 4,10"
"Si10"
"Level alluvial plains, often with a slight (6 12 in.) gilgai microrelief: dominant are loamy duplex soils with mottled and bleached A horizons (6-12 in. deep) overlying dark grey-brown heavy clay (Dy2.33) and (Dy2.43). Some similar (Dy3) soils are associated. Where gilgai microrelief is prominent, grey clays (Ug5.24) may occupy the puffs. On some more extensive clay plains, cracking clays occupy puff and depression sites. Associated in the unit are small areas with very thin-surfaced (2 4 in.) loamy duplex soils (Dy2.43) and (Dy2.33), and also areas of deeper-surfaced sandy duplex soils (Dy3.43) of unit Va57. Where levees of prior streams occur in the unit small areas of loamy red duplex soils (Dr2.22) occur. Occurs on sheet(s): 4,7"
"Si11"
"Small flood-plains largely derived from sandstones, quartzites, and limestones; occasional sandstone ridges are present: chief soils are hard alkaline yellow and brown soils (Dy2.33), (Dy2.43), and (Db1.43). Associated are areas of (Dr2.33), (Dr2.43), and (Dd1.43) soils. Some areas may have a surface covering of stones. Occurs on sheet(s): 8"
"Si12"
"Level to very gently undulating alluvial plains with numerous anastomosing old infilled channels: dominant soils are moderately deep-surfaced loamy duplex soils, chiefly (Dy2.33) but (Dy2.13), (Db1.33), (Dy2.43), (Dy3.33), (Db1.43), and (Dr2.33) also commonly occur. The chief associated soils in lower sites are massive mottled cracking clays (Ug5.5) and (Ug5.4) with, less commonly, (Ug5.24), (Ug5.6), and (Ug5.16), any of which may be locally dominant. On the levees the chief soils are stratified loamy brown earths (Gn2.41) and loams (Um5.52), with deep sands (Uc5.21) and (Uc5.11), less commonly (Uc2.34) and (Uc2.21), occurring on the old infilled channels. Occurs on sheet(s): 7"
"Si13"

"Gently undulating alluvial plains with many old stream levees: dominant are moderately deep-surfaced loamy duplex soils, chiefly (Dy2.33) but with associated (Dy2.13) and (Dy3.33). Scalded areas occurring on the back slopes of the old levees have deep loamy red earths (Gn2.13) and shallow-surfaced loamy duplex soils (Dr2.13) and (Db1.13). On the more recent stream levees are deep earthy fine sands (Uc5.21) and earthy loams (Um5.52), while sandy red earths (Gn2.14) are common to the older levees. Dark cracking clays (Ug5.5) and (Ug5.24) occur in slightly lower areas of the flood-plain. Marginal to the unit are areas of loamy mottled grey or yellow earths (Gn2.81), (Gn2.91), and (Gn2.61). Occurs on sheet(s): 7"
"Si14"
"Alluvial plains fringing major rivers, often traversed by old infilled stream channels and associated low levees: dominant soils of the level plains are silty or loamy surfaced grey-brown duplex soils (Dy2.33) that are strongly alkaline at shallow depths. Similar brown soils (Db1.33) are closely associated and locally dominant. The A horizon depth ranges from 3 to 6 in. and many areas have a scalded surface. Other similar duplex soils (Dy3.33), (Dy2.43), (Db1.43), and occasionally (Dr2.43) may occur locally. Small swampy depressions and lower plains have grey cracking clays (Ug5.5) and (Ug3.2). Slightly elevated old filled channels and associated levees have sandy and loamy red earths (Gn2.14, Gn2.15), occasionally (Gn2.16), and lesser yellow earths (Gn2.24, Gn2.22) and (Gn2.34). Adjacent to major streams are small lower terraces of uniform loams (Um5.52) or sands (Uc5.22). These areas are subject to flooding and the soils are usually stratified at depth. Occurs on sheet(s): 7"
"Si15"
"Level alluvial plains with slightly elevated old levees and shallow prior and present stream channels: dominant soils of the alluvial plains are loamy grey duplex soils (Dy2.33), with A horizon depth varying from 3 to 8 in. Closely associated are other loamy or occasionally sandy duplex soils, chiefly (Dy2.43) but with some areas of similar (Dy3) soils; occasional acid variants may also occur. Sandy red earths (Gn2.14) and deep sands (Uc5.11) and (Uc5.21) occupy the stream levees. Occurs on sheet(s): 7"
"Si16"
"Gently undulating plains: dominant are deep loamy duplex soils, chiefly (Dy2.33) but with areas of (Dy2.43), (Dy3.33), (Dy3.43), (Db1.33), and occasional (Db2) equivalents. Included in the unit are areas of deep grey-brown and brown cracking clays (Ug5.24, Ug5.25) and (Ug5.34) and deep sands (Uc5.22) and (Uc4.21, Uc4.22). Data are limited. Occurs on sheet(s): 10"
"Si17"
"Valley plains: chief soils are probably hard alkaline yellow soils (Dy2.33) but a variety of similar (Dr) and (Db) soils occur, including (Dr2.33), (Dr2.73), and (Db1.33, Db1.32). Associated are crusty loamy soils (Dy1.33) and (Dr1.33) and cracking clays (Ug5.2) and (Ug5.3). Occurs on sheet(s): 10"
"Sj1"
"Steep hilly, rock outcrops: chief soils are hard acidic yellow and yellow mottled soils (Dy2.41) and (Dy3.41). Associated are (Dy3.21) and various shallow soils, such as (Um5.41) and (Um6.21) on ridge crests and upper slopes; and (Dr4.21) and/or (Gn3.14) on lower slopes in some localities and (Uc) soils in others. As mapped, areas of units A9 and Ca7 may be included. Occurs on sheet(s): 3"
"Sj2"
"Plateau remnants in mountainous country at moderate to high elevation (>2000 ft): low hillocks with granitic tors have shallow forms of hard acidic yellow soils (Dy2.41) and the intervening lowlying swampy areas have sandy acidic gley soils (Dg3.81) and acid peats (O); leached sand (Uc2) soils may occur. Data are limited. Occurs on sheet(s): 3"
"Sj3"
"Moderately steep hills and ridges with pediments fringing the larger stream valleys: chief soils are hard acidic yellow soils (Dy2.41) with some (Dr2.41) soils on convex slopes. Associated are (Gn3.11) soils on almost flat-topped crests; (Gn3.9) and (Gn3.14) soils on the gentler pediment slopes; and (Dy) and (Dr) soils on the narrow alluvial valley plains. Minor areas of other soils may occur. Occurs on sheet(s): 4"
"Sj4"
"Low to moderately high hills with some steep slopes and scarps, some basaltic hill caps, and narrow valleys: chief soils are hard acidic and neutral yellow soils (Dy2.41 and Dy2.42). Associated are areas of (Dy2.8), (Dy3.4), (Dy3.3), and (Dr2.4) soils on slopes and ridges; (Um6.21), (Ug5.12), and (Ug5.13) soils on the basaltic caps; and some (Dd1.13) and (Ug5.16) soils along the valleys. Small areas of other soils may occur. Occurs on sheet(s): 4"
"Sj5"
"Low hills with some narrow ridges and basaltic knolls, and narrow flat-bottomed valleys: chief soils are hard acidic yellow and yellow mottled soils (Dy2.41), (Dy3.41), and (Dy2.31) with some (Dr2.21) soils on crests. Associated are some sandy-surfaced (D) soils, notably (Dr5.41), (Dy5.81), and (Dy5.84) on slopes and crests; (Um6.21), (Uf6.11), and (Ug5.12) soils on and around the basaltic knolls; and (Ug5.16) soils in the valleys. Occurs on sheet(s): 4"
"Sj6"

"Rolling to low hilly country: chief soils seem to be hard acidic and neutral yellow soils (Dy2.41 and Dy2.42). Associated are (Dy3.41), (Dr3.42), (Dr2.11), and (Dr3.12) soils on ridges and rounded hill tops; leached loams (Um2.12) on ridges; and (Dy3.43) soils on lower slopes and along major valleys. Minor soil occurrences include (Gn3.04), (Gn3.03), and (Ug5.15) on flats and lower slopes. Occurs on sheet(s): 4"
"Sj7"
"High steep and straight-sided ridges: chief soils are probably hard acidic yellow and yellow mottled soils (Dy2.41) and (Dy3.41) with leached loams (Um2.12) and some (Uc) soils. Data are very limited. Occurs on sheet(s): 4"
"Sj8"
"Moderately to strongly hilly dissection slopes below basalt plateau, on sandstones and mudstones: chief soils are hard acidic yellow soils (Dy2.41) on spur crests and slopes. Associated are (Gn3.11) on the steep slopes immediately below the scarp and (Uf6.31) and (Ug5.13) soils on basalt remnants. Occurs on sheet(s): 4"
"Sj9"
"Low hilly country on volcanic rocks and boulder beds--round crests and smooth slopes with narrow stream flats and terraces; some rougher crests with rock outcrops: chief soils are hard acidic yellow soils (Dy2.41) and (Dy3.41), often gravelly. Associated are: (Dr2.41) and other (Dr) soils on crests and upper slopes; (Db1.21) soils on slopes; (Um2.12) soils on crests; (Gn3.41) and (Gn3.93) on slopes; and (Dd1.41) soils on lower slopes. Minor soil occurrences include (Ug5.15) on creek flats and (Uf6.32) on crests of ridges. Occurs on sheet(s): 4"
"Sj10"
"Moderately to strongly hilly country on volcanic rocks and boulder beds with rough stony crests and moderate to steep slopes to narrow stream flats; some rock outcrop: chief soils are hard acidic yellow soils (Dy2.41), often gravelly. Associated are (Dr2.41), (Dr2.21), (Dr2.12), (Dy2.21), and (Db1.41) soils on slopes and (Um2.12) and (Um4.12) soils on crests and upper slopes. Minor soil occurrences include (Dy2.43) and (Ug5.15) on stream flats. Occurs on sheet(s): 4"
"Sj11"
"Low hilly lands on metamorphic rocks; low broad convex crests grading into long gentle slopes that grade into sandy fringing plains and flats; some rock outcrop: the dominant soils are hard acidic yellow and yellow mottled soils (Dy2.41) and (Dy3.41) with surface soils varying in depth from a few inches to 2 ft. Associated are (Dy2.43) and (Dy3.43) on lower slopes and plains; (Dy5.41), (Dy5.81), (Dy5.82), and (Uc2) on the fringing plains and flats; and (Gn3.12), (Dr2.12), and (Dr2.21) soils on slopes. Minor soil occurrences include (Uc2.12), (Uc4.2), and (Uc2.2) on sandy areas and (Gn3.96) in low sites. As mapped, steeper hilly areas as for unit Fu11 are included, as are some coastal dunes and swamps similar to units Cb37 and J4 respectively. Occurs on sheet(s): 4"
"Sj12"
"Lower to middle reaches of stream flood-plains: chief soils are hard acidic yellow and yellow mottled soils (Dy2.41) and (Dy3.41) with (Dd1.41) on the flat areas, together with leached sands (Uc2.33 and Uc2.32) on low broad sandy banks. Other soils include (Gn3.01) and (Uf6). Occurs on sheet(s): 4"
"Sk1"
"Gently rolling terrain subjacent to dissected plateau edges: chief soils are hard neutral yellow soils (Dy2.42) over the rolling terrain. Associated are: (Gn3.14) soils on some rounded crests; (Dy3.11) (Dy5.71), and (Dy5.81) soils in some localities; slopes of (Ug5.12) and (Gn3.11) soils where this unit joins the plateau; and (Gn3.91 and Gn3.92) soils on basins and slopes along the junction where some granitic bosses and tors occur also. Occurs on sheet(s): 4"
"Sk2"
"Strongly rolling to smooth low hilly country on volcanic rocks, many gentle slopes bordering narrow valley plains: chief soils are hard neutral yellow soils (Dy2.42) and (Dy2.22) with some (Dy2.41) and (Dy2.21). Associated are: (Ug5.12, Ug5.13, and Ug5.14) soils on the gentle slopes; (Dr2.11 and Dr2.12) with some similar (Db) and (Dd) soils on slopes; (Um4.1) soils on slopes; and (Ug5.16) with (Gn3.43) and some (Dd1.333 and (Dd2.33) soils in the valley plains. Occurs on sheet(s): 4"
"Sk3"
"Similar to unit Sk2 but the areas of the cracking clays (Ug5) are reduced to minor proportions; the areas of (Dr) and (Db) soils are smaller; and the soils of the valley plains are mainly (Dd1.33) and (Dd2.33). Occurs on sheet(s): 4"
"Sk4"
"Gently undulating river flats and terraces but including a few rounded hills, flat-topped high-terrace remnants, and dissected margins of the flanking coastal plain: chief soils are hard neutral yellow soils (Dy2.42) on the river flats with (Dy3.41) soils on the dissected remnants of higher country. Associated are: (Gn3.04) and (Dy3.31) soils in slightly depressed areas; (Gn3.74) soils on crests and (Gn3.81) soils on lower slopes of rounded hills; (Gn2.14) soils on flat-topped terrace remnants; and (Gn2.42) and (Uc1.4) soils on terraces close to the stream. Occurs on sheet(s): 4"
"Sk5"

"Gently undulating to rolling river flats and terraces but including a few low hilly areas, flat-topped high-terrace remnants, and dissected margins of the flanking coastal plain: chief soils are hard neutral yellow soils (Dy2.42) on the river flats with (Dy3.41) soils on the dissected margins of the coastal plain. Associated are (Dy2.41) soils on the lower margins of the dissected plain and (Gn3.22 and Gn3.23) soils on intermediate river terraces. Other soils include: (Um2.12) and (Dr2.41) soils on dissection scarps; (Db1.31) and (Db2.31) soils under vine scrub; (Gn2.14) soils on high-terrace remnants; and (Uc1.4) soils on the new river terraces. Occurs on sheet(s): 4"
"Sk6"
"Moderately hilly lands on conglomerates, sandstones and mudstones, trachyte, and some basalt caps-fairly steep and stony slopes and crests running down to colluvial fans, terraces, and flats: chief soils are hard neutral yellow soils (Dy2.42) and (Dy2.22). Associated are (Um4.1) soils on crests and upper slopes; (Db1.41) soils on moderate hill slopes; (Uf6.11), (Uf6.34), and (Gn3.24) soils on limestones; stony (Ug5.13) soils on basalt; and (Dd1.23) soils on terraces and flats. Minor soil occurrences include (Dy2.43) and (Gn3.43) on alluvium. Occurs on sheet(s): 4"
"Sk7"
"Low hilly lands: chief soils are hard neutral yellow soils (Dy2.42) with (Dy3.42). Associated are (Dr2.12), (Dr2.22), and (Dy3.41) soils on slopes; (Dy3.43) soils on lower slopes; and (Uc2.12) soils on crests. Minor soil occurrences include (Ug5.1) and (Ug5.5). Occurs on sheet(s): 4"
"Sk8"
"Hilly lands derived from sedimentary volcanic and ultrabasic rocks--generally steep side slopes rising above low hilly foothills: chief soils seem to be hard neutral yellow soils (Dy2.42) but there are important areas of (Gn3.12) and (Dr4.12) soils in the foothill areas. Associated are (Um2.12) and (Um4.1) soils on upper slopes and crests with some (Um6.41) and (Um6.21) soils. Minor soil occurrences include (Gn3.42), (Um6.33), (Dr2.12), and (Uc2.12). Occurs on sheet(s): 4"
"Sk9"
"Low hilly lands on tuffs, cherts, subgreywacke, and shales--generally convex hills with moderate to gentle side slopes, narrow alluvial flats, some coalescing fans, and some rock outcrop: chief soils are hard neutral yellow soils (Dy2.42) with (Dy3.42). Associated are (Dy2.43) and (Dy3.43) soils on basal slopes and (Um2.12) soils on hill crests. Minor soil occurrences include: (Dy3.41) and (Dr3.41) on crests and upper slopes; (Ug5.1) on fans; (Dy2.43) and (Ug5.2) in complex on some flats; and (Dd1.33) and (Ug5.2) in complex on other flats. Occurs on sheet(s): 4"
"Sk10"
"Hilly country on tuffs, cherts, subgreywacke, and shales; generally moderate side slopes with V-valleys and narrow alluvial flats; rock outcrops on the hills are common: chief soils are shallow and stony hard neutral yellow soils (Dy2.42) with (Dy3.42) on middle and lower hill slopes. Associated are (Um2.12) soils on hill crests and upper slopes, often in complex with shallow (D) soils, and (Dy3.41) soils on upper slopes. Minor soil occurrences include: (Dy2.43) on basal slopes and fans; (Dr2.41) on upper slopes; (Um4.1) on crests; and (Dr2.12) on basic dykes. Occurs on sheet(s): 4"
"Sk11"
"Gently sloping coalescing fans of middle and fan toe sediments; sandy banks cross the fans along the more active distributary channels: chief soils are hard neutral yellow soils (Dy2.42) but alkaline forms (Dy2.43) and possibly (Dy2.33) are codominant in places. Associated are: (Gn3.03) soils in complex with the last two soils in melon-hole fan toe sites. Minor soil occurrences include (Dy5.42), gritty (Dy3.41), and gravelly (Um) soils on sandy banks; (Gn3.83) and (Dd1.12) on flats along some channels; and (Gn2.34) and (Um2.12) on low trachyte hills. Occurs on sheet(s): 4"
"Sk12"
"Low hilly lands on metamorphic rocks--smooth convex but narrow crests and gentle to moderate side slopes, low spurs, and colluvial slopes: chief soils are hard neutral yellow soils (Dy2.42) with some (Dr2.42) and (Dy3.42) soils on the mid to lower slopes. Associated are: (Um2.12) and (Dr2.12) soils on upper slopes and (Dy2.43) and (Dy3.43) soils on colluvial slopes. Minor soil occurrences include gravelly (Um4.1) on crests. Occurs on sheet(s): 4"
"Sk13"
"Low hilly lands as for unit Sk12 with areas of hilly to steep hilly lands as for unit Fu13. Occurs on sheet(s): 4"
"Sk14"
"Low hilly to rolling granitic areas with narrow valley plains; some rock outcrops: chief soils are hard neutral and alkaline yellow and yellow mottled soils (Dy2.42) and (Dy3.42) on slopes, with (Dy2.43) and (Dy3.43) on valley plains. Associated are: (Dy2.21) and (Dy2.41) soils on upper slopes and crests; (Dr2.12) on upper slopes; (Dr2.13) on mid-lower slopes; and (Dd1.33) with (Ug5.15 and Ug5.16) on valley plains. Occurs on sheet(s): 4"
"Sk15"
"Low to moderately high hills with some rock outcrops: chief soils seem to be hard neutral and alkaline yellow soils (Dy2.42 and Dy2.43). Associated are various (Uc), (Um), and acid (Dy) soils on upper slopes and crests and various (Db), (Dy), and (Ug5) soils on the narrow floors of the valleys. Occurs on sheet(s): 4"

"Sk16"
"Moderate to steep hilly lands with some rock outcrops, narrow valleys: chief soils seem to be hard neutral and acidic yellow soils (Dy2.42 and Dy2.41). Associated are various (Uc), (Um), and shallow (Dy) soils on upper slopes and crests and (Dy2.43) soils on lower slopes. Minor soil occurrences include (Ug5.2) in the valleys and some (Dr2) soils on slopes. Occurs on sheet(s): 4"
"Sk17"
"Undulating terrain of colluvial foot-slopes, low hills, and extensive alluvial plains: chief soils seem to be hard neutral yellow and yellow mottled soils (Dy2.42), (Dy2.32), (Dy3.32), and (Dy3.42). Associated are: (Dy2.21), (Dy2.41), and (Dy3.41) with (Um) soils on the foot-slopes and the more hilly portions; (Dy3.33) and (Dy3.43) soils in lower sites generally; and (Dy2.43) soils on terraces. Minor soil occurrences include (Ug5.16) and (Ug5.2) with gilgais on the main alluvial areas. Occurs on sheet(s): 4"
"Sk18"
"Gently undulating country with scattered granite domes: chief soils are neutral hard yellow soils (Dy2.42) and gritty (Uc4.2) soils developed on plains. Associated are (Dy3.42 and Dy3.43) soils flanking stream courses. Granite domes are mainly bare rock with coarse-textured detritus (Uc1.22). Occurs on sheet(s): 9"
"Sk19"
"Outcrop plains with low lateritic rises and with some sand plain: main soils are neutral hard yellow soils (Dy2.42) and neutral yellow earths (Gn2.22). Associated are (Gn2.12) and (Uc1.23) soils, with some (Ug5.25) soils along streams. Occurs on sheet(s): 9"
"Sk20"
"Gently undulating plains with some low gravel-strewn rises: dominant are shallow to moderately deep loamy yellow-grey duplex soils, chiefly (Dy2.42) but with associated (Dy3.42), (Dy3.12), (Dy2.43), (Dy3.43), and (Dr2.13). The soils have much gravel in the shallow A horizons and usually have ironstone nodules in the upper B horizon. Occurring throughout the unit are lower areas of deep grey-brown cracking clays (Ug5.24) that may be locally dominant. On the low gravelly rises are very shallow loams (Um1.43), (Um2.12), and (Um4.1). Loamy red earths (Gn2.12, Gn2.13) occur on stream levees with some yellow earths (Gn2.22) at the rear margins of the levees. Occurs on sheet(s): 7"
"Sk21"
"Gently undulating to undulating lands: dominant are shallow to moderately deep loamy duplex soils (Dy2.42), but closely associated are other loamy duplex soils, chiefly (Dy2.43), (Dy3.43), (Dy3.42), (Dr2.22), and (Db1.43). Throughout the unit there are numerous small inclusions of the basaltic soils of units Mo31 and Kb30, particularly the shallow clays (Uf6.31) and deep cracking clays (Ug5.16). Occurs on sheet(s): 7"
"Sl1"
"River flood-plains and terraces: chief soils are hard alkaline and neutral yellow and yellow mottled soils (Dy2.43), (Dy2.42) and (Dy3.43), (Dy3.42), and some (Dr2) soils; possibly with (Um) soils on present flood-plains. Data are limited. Occurs on sheet(s): 3"
"Sl2"
"Plain: chief soils are hard alkaline yellow soils (Dy2.43) with pH 10.0 or higher below 10 in. and very high amounts of exchangeable sodium in the subsoil. Associated are (Dy3.43) soils which margin the area. Water and wind erosion have been severe. Occurs on sheet(s): 3"
"Sl3"
"Undulating lands with some low stony hills and mesas: dominant soils are sandy or loamy-surfaced duplex soils (Dy2.43), (Dy2.33), and (Dy2.32) with similar (Dy3) soils. Associated are deep sandysurfaced duplex soils (Dy5.42), (Dy5.41), and similar (Dy4) soils; these mostly occur on upper slopes. Other duplex soils and red earths (Gn2.12) also occur but data are limited. The hilly areas have mostly stony (Um1.43) soils (unit Fz3). Adjacent to large streams deep sands (Uc1.23) may occur. Occurs on sheet(s): 4"
"Sl4"
"Small stream flood-plains that rise gradually to moderately undulating marginal valley slopes: dominant soils of the level areas are loamy duplex soils (Dy2.43), (Dy2.33), (Dy3.43), and (Dy3.33). Associated are smaller areas of similar (Dd1) and (Db1) soils and local occurrences of clays (Ug5.24), (Ug5.14), and (Ug5.16). Some stream levees have deep sand soils (Uc1.21). The marginal valley slopes have alkaline (Dy2), (Dd1), and (Db1) soils with some uniform clays (Uf6.33 and Uf6.31). Upslope these soils merge into the cracking clays of unit CB3. Occurs on sheet(s): 4"
"Sl5"
"Moderate to strongly undulating lands: dominant are sandy to loamy-surfaced duplex soils (Dy2.43), (Dy2.42), (Dy2.33), (Dy2.32), and (Dy2.12). Closely associated are similar (Dy3), (Db1), and occasional (Dr2) soils. On some upper slopes deeper-surfaced sandy duplex soils (Dy5.41) and (Dy3.42) occur. In small valley flood-plains (Dd1.33) and (Dd1.43) soils occur. Small mesas of unit Bz4 are included. Occurs on sheet(s): 4"
"Sl6"

"Gently undulating lands with occasional low mesa-like residual hills: dominant are loamy duplex soils (Dy2.43) and (Dy2.33), associated similar (Dd1) and (Dy3) soils, and less commonly (Db1) and (Dr2) soils. Included in the unit as mapped are areas of grey gilgaied clays (Ug5.24) of unit CC22, more particularly in lower sites. Small areas of non-gilgaied clays (Ug5.24) and (Ug5.34) also occur. The mesa residuals have loamy red earths (Gn2.11 and Gn2.12) with some shallow stony (Um1.43) soils associated with the scarps. Occurs on sheet(s): 4"
"Sl7"
"Very gently undulating or level alluvial plains: dominant are loamy duplex soils (A horizon 48 in.) with grey or grey-brown heavy clay subsoils (Dy2.43) and (Dy2.33). Associated are similar brown soils (Db1.13) and (Db1.33) and occasionally red or yellow duplex soils (Dr2.13), (Dr2.12), (Dy3.43), and (Dy3.33). Small areas of gilgaied clays (Ug5.24) may occupy lower landscape sites. As mapped, the unit may include low ridges of loamy red or yellow earths (Gn2.12, Gn2.11, Gn2.22, and Gn2.21). Occurs on sheet(s): 4"
"Sl8"
"Low hilly lands on sedimentary rocks; moderate to gentle slopes, in places passing straight to the drainageways but elsewhere grading into concave lower slopes; some rock outcrop on higher hills: chief soils are hard alkaline yellow mottled soils (Dy2.43) with (Dy3.43). Associated are: (Db1.42 and Db1.43) soils on higher slopes and crests; (Dr2.42), (Dr2.12), (Dr3.33), and (Dr3.42) soils on upper slopes; (Dd1.33) and (Dd1.43) soils on lower slopes and terraces; and gritty (Dy3.41) soils on some crests. Minor soil occurrences on terraces and a few saddles are (Ug5.12), (Ug5.13), (Ug5.16), (Gn3.43), (Ug5.4), and (Dy2.82). Occurs on sheet(s): 4"
"Sl9"
"Gently to moderately undulating lands with some high ridges. The unit is a complex of loamy and often gravel-strewn loamy duplex soils (Dy2.43) and (Dy2.33); slightly gilgaied deep cracking clays (Ug5.24) and (Ug5.16); thin-surfaced loamy duplex soils (Dd1.13) and (Dd1.33); and less commonly similar (Db1) soils. On high ridges sandy duplex soils (Dy3.41 and Dy3.42) are most common but on some red earth remnants (Gn2.12) occur. Occurs on sheet(s): 4"
"Sl10"
"Level alluvial flood-plains that often have numerous braided stream channels; many areas are subject to flooding: dominant are loamy duplex soils (Dy2.43) and (Dy2.33) but closely associated are (Dd1.33), (Dd1.43), (Dd1.13),and (Db1.33); some areas are wind-deflated. Small areas of cracking clays (Ug5.24), (Ug5.25), and (Ug5.15) also occur together with other fine-textured soils (Uf6.32 and Uf6.33). Occasional old sand-filled channels or sandy levees near major streams have deep sand soils (Uc1.23), (Uc1.21), and (Uc5.21). Occurs on sheet(s): 4"
"Sl11"
"Strongly undulating or low hilly lands with some areas of flat-topped benched higher hills; the soils are mostly shallow and alternate over short distances depending on parent material lithology; rock outcrops are frequent; dominant are loamy duplex soils (Dy2.43) and (Dy2.33) but closely associated are (Db1.33), (Dr2.13), (Dr2.33), and (Dr2.12). Smaller areas of (Dd1.33), (Dd1.43), and (Ug5.22) occur on flatter sites. Associated drainage lines have small alluvial plains with deeper loamy duplex soils (Dy2.43) and (Dd1.43). The higher ridges and hills may have areas of shallow stony (Um1.41), (Um1.43), or (Um4.1) soils. Occurs on sheet(s): 4"
"Sl12"
"Low hilly lands consisting of undulating or level plateaux, often with steep-scarped margins, and lower dissected areas that are moderate to strongly undulating: a complex range of soils occurs--dominant are sandy to loamy duplex soils (Dy2.43) but closely associated are (Dy2.33), (Dy2.13), (Dy2.23), (Dy2.42), and similar (Dy3) soils. Nearly all the duplex soils are shallow and stony. The plateau surfaces mostly have loamy red earths (Gn2.12) with lesser yellow earths (Gn2.22). Some higher hills have shallow stony loams (Um1.43) or (Um4.1), sands (Uc1.21) and (Uc2.12), or shallow stony red duplex soils (Dr2.21) and (Dr2.32). Lower flatter areas mostly have brown or red loamy duplex soils (Db1.13), (Dr2.13), and (Dr2.12). Data are fairly limited. Occurs on sheet(s): 4"
"Sl13"
"Small plains or gently sloping fans often dissected by many small stream channels: dominant are highly alkaline loamy duplex soils (Dy2.43) and (Dy2.33).which in most areas are extremely eroded by wind and water so that only remnants of the bleached A2 horizon remain above the grey clay B horizon. Some wind-piled accumulations of A horizon sandy loam occur locally where trapped by shrubs. Associated are: other duplex soils (Db1.43), (Db1.33), and (Db1.23); occasional low sandy dunes (Uc1.23) or (Gn2.12); and small areas of grey clays (Ug5.24) in lower sites. Occurs on sheet(s): 4"
"Sl14"
"Alluvial plains dissected by numerous small irregular drainage channels; the entire area may be flooded: dominant are loamy duplex soils (Dy2.43) and (Dy2.33) with similar (Db1) soils. Nearly all areas have been severely eroded by wind and water so that only remnants of the bleached A2 horizon remain above the grey to brown B horizon clay. Some wind-piled accumulations of sandy loam A horizon material occur around shrubby vegetation. Associated soils include slightly gilgaied grey clays (Ug5.24 and Ug5.29); other clay soils (Uf6.51); and more

extensive areas of earths (Gn2.55), (Gn2.83), and (Gn2.93) which also may have a scalded surface. Occurs on sheet(s): 4"
"Sl15"
"Level alluvial plains which may be dissected by shallow drainage lines: dominant are grey loamy duplex soils (Dy2.43) and (Dy2.33), with lesser similar (Db1), (Dr2), and (Dy3) soils. Closely and often intimately associated are slightly lower areas of cracking clays (Ug5.29), (Ug5.24), (Ug5.28), and (Ug5.34). In some areas these may have a broad moderate gilgai microrelief (unit CC31). Also occurring are in-filled old stream channels or low rises with sandy or loamy yellow and red earths (Gn2.22), (Gn2.21), (Gn2.11), and (Gn2.12). Occurs on sheet(s): 4"
"Sl16"
"Level or very gently undulating alluvial plains: dominant are thin-surfaced (2 4 in.) loamy duplex soils (Dy2.43) and (Dy2.33). Similar (Dy3) soils are closely associated but these normally have a deeper A horizon (6 10 in.). In some areas a very slight (4 6 in.) gilgai microrelief is present and the puffs may have grey clays (Ug5.28, Ug5.29). Locally, slightly gilgaied clay plains (Ug5.28), and less commonly (Ug5.16), may be more extensive. Also occurring in small areas are clays (Ug5.28) with a stronger gilgai microrelief (12-18 in.). Occurs on sheet(s): 4,7"
"Sl17"
"Undulating or moderately undulating lands with occasional low hills: dominant are fairly shallow (18-24 in.) often stony loamy duplex soils. (Dy2.43) is most common but also occurring are (Dy2.42), (Dy2.43), (Dy3.43), (Dr3.43), (Dr2.42), (Dr2.43), (Dd1.43), (Db1.43), and (Db1.33). On higher ridges and low hills very shallow stony loams (Um4.1), (Um1.43),and (Um2.12) occur. As mapped, the unit may include very small areas of dark clays (Ug5.12). Occurs on sheet(s): 4"
"Sl18"
"Strongly undulating or dissected low hilly lands: dominant are shallow mostly gravelly loamy duplex soils (Dy2.43 and Dy2.42) with other duplex soils (Dy3.43), (Dy3.42), (Dr2.43), and (Dr2.12) associated. On steeper slopes and hill crests shallow stony loams (Um4.1), (Um2.12), and (Um1.43) commonly occur. Occurs on sheet(s): 4"
"Sl19"
"Moderate or occasionally strongly undulating lands: dominant are extremely gravelly (quartz) loamy duplex soils (Dy2.43) and (Dy2.33) with lesser (Dr2.43), (Dr2.33), (Db1.33), (Db1.13), and (Dy3.43) soils. On some higher ridges shallow gravelly loams occur (Um1.43) and (Um4.1), less common are gravelly sands (Uc2.12). Small areas of loamy red earths (Gn2.12) occur in the unit as mapped, and there may be small areas of gravel-strewn moderately gilgaied grey clays (Ug5.24) in lower sites. Occurs on sheet(s): 4"
"Sl20"
"Undulating to strongly undulating lands with some low hilly areas. The soils usually have a strongly linear distribution controlled by the strike of the parent sedimentary rocks. Rock outcrops are common. A complex array of soils is present but nearly all are shallow and stony. Dominant are highly alkaline loamy duplex soils (Dy2.43) and (Dy2.33) with closely associated (Dy3.43). Red loamy duplex soils (Dr2.43), (Dr2.33), and (Dr2.12) are common in many areas but other duplex soils (Dd1.43), (Dd1.33), and (Db1.33) are less common. On some flatter sites grey clays (Ug5.22) may occur and small alluvial flood-plains have deep loamy duplex soils (Dy2.43), (Db1.33), and (Dd1.43). Low hills and high ridge crests usually have shallow stony loams (Um1.41), (Um2.12). and (Um4.1). In some areas low plateau remnants of loamy yellow or red earths (Gn2.22) and (Gn2.12) occur. Occurs on sheet(s): 4"
"Sl21"
"Gently undulating plains: dominant are loamy duplex soils with a slightly gravel-strewn surface. The chief forms are (Dy2.43) and (Dy2.33) but (Db1.33), (Db1.13), (Db1.43), and similar (Dy3) soils are often closely associated. Also occurring are smaller areas of slightly gilgaied (1-2 ft) or non-gilgaied grey clays (Ug5.24), or less commonly brown clays (Ug5.34). In addition there are occasional low rises of loamy or sandy red earths (Gn2.12) and yellow earths (Gn2.22). In some localities there may be occasional high stony ridges with shallow stony soils (Uc1.21), (Uc2.12), (Um1.41), and (Um4.1). Occurs on sheet(s): 4"
"Sl22"
"Undulating lands with widely spaced shallow valleys and some small sloping plains; rock outcrop may occur on higher ridges: dominant are thin-surfaced (2-4 in.) grey loamy duplex soils (Dy2.43) of moderate to shallow depth but many other duplex soils are always associated. These include (Dy2.33), (Dy2.13), (Dr2.33), (Dr2.43), (Dr2.13), (Dr2.12), (Dd1.43), (Dd1.33), (Dd1.13), and similar (Db1) soils. The surface of most duplex soils is variably strewn with small gravel fragments. Cracking clays chiefly (Ug5.22) and (Ug5.14) are important on lower slopes and on the small plains. Some high stony ridges in the unit have shallow stony loams (Um4.1), (Um1.43), and (Um2.12). Occurs on sheet(s): 4"
"Sl23"
"Moderate to strongly undulating lands with an occasional low hill; the area is usually strongly dissected by many small streams and nearly all soils have a gravel-strewn surface and are often eroded; rock outcrops are common. A complex array of loamy duplex soils is present, most are shallow (18-20 in.). The dominant soil is (Dy2.43) but

commonly associated are (Dy2.33), (Dy3.43), (Dr2.33), (Dr2.43), (Dr2.31), (Dr2.12), (Dr2.13), (Db1.33), and (Dd1.33). Limited areas of cracking clays (Ug5.22), (Ug5.32), and (Ug5.15) also occur. The occasional hills have extremely stony shallow (Dy2.43), (Um4.1), and (Um2.12) soils. Occurs on sheet(s): 4"
"Sl24"
"Gently undulating plains with a complex pattern of soils: dominant are loamy duplex soils (Dy2.43) with closely associated (Dy3.43). Very low rises occurring throughout the unit have loamy red earths (Gn2.12) with lesser areas of yellow earths (Gn2.22) or grey earths (Gn2.85) and (Gn2.95). Small areas of moderately gilgaied grey clays (Ug5.24 and Ug5.28) also occur throughout, closely associated with thin-surfaced loamy duplex soils (Dy2.43) and (Dy2.33). Adjacent to some larger streams are small areas of (Db1.33), (Gn2.12), and (Um5.5) soils forming narrow alluvial plains often dissected by distributary channels. Occurs on sheet(s): 4"
"Sl25"
"Very gently undulating birds-foot fans: chief soils are hard alkaline yellow and yellow mottled soils (Dy2.43) and (Dy3.43) on broad low banks in "toe"and "medial"positions of the fans. Associated are (Gn3.05) soils in broad elongate flats and (Gn3.03) with (Ug5.24) soils in complex on the melon-hole depressional flats. Minor soil occurrences include (Dd1.41), (Dr2.22), and (Gn2.44). Occurs on sheet(s): 4"
"Sl26"
"Low to moderately high hills with gentle to moderate valley side slopes; some rock outcrop: chief soils are hard alkaline yellow soils (Dy2.43) on valley side slopes and valley plains. Associated are various (Uc), (Um), and (Dy) soils on crests and upper slopes. Occurrences of small areas of other soils are likely. Occurs on sheet(s): 4"
"Sl27"
"Low to moderately hilly lands with steep upper slopes and gentle lower slopes passing to narrow valleys; some rock outcrop on upper slopes: chief soils are hard alkaline yellow mottled soils (Dy2.43) on lower slopes and on valley floors. Associated are shallow (Uc) soils on the steep upper slopes, some (Dd1.23) soils on slopes, and some deep (Uc) and (Dy3.43) soils on alluvial flats. Minor soil occurrences include gilgai complexes of (Dy2.33) and (Ug5.2) soils. As mapped, small areas of unit Mo20 are included. Occurs on sheet(s): 4"
"Sl28"
"Broad flat valleys with small clay pans and salt-lake remnants in some localities: chief soils are hard alkaline yellow soils (Dy2.43 and Dy2.33) underlain by acid lateritic clays below depths of from 2 to 4 ft. Associated are small areas of (Dy5.43) soils in sandy localities; (Ug5.22) soils in areas where some low gilgai microrelief is present; some (Dy3.43) soils, especially in western valleys; and other soils on lunettes and dunes some of which are gypseous. As mapped, small areas of units Oc31, Vb2, DD9, and Va66 are included. Occurs on sheet(s): 5"
"Sl29"
"Plains flanking saline valleys; some local occurrences of small clay pans and lakes with dunes and lunettes: chief soils are hard alkaline yellow soils (Dy2.43) with low rises of sandy alkaline yellow mottled soils (Dy5.43). Associated are related (Dy) soils such as (Dy4.43) and similar (Dg) soils; some (Gc1.22) soils; and silty (Um) and clayey (Uf) soils on dunes and lunettes. This unit has similarities with unit Sl28 (the (Dy2.43) soils) and units Ya30 and Ya28 (the (Dy5.43) soils). As mapped, small areas of unit DD11 are included. Occurs on sheet(s): 5"
"Sl30"
"Gently undulating pediments with narrow ironstone gravel ridges; some swamps and lakes: chief soils are hard, and sandy, alkaline yellow and yellow mottled soils (Dy2.43), (Dy4.43), and (Dy5.43) with lesser areas of (Dg3.43), (Dg1.43), (Dr5.43), (Dy5.42), and (Dy2.42) soils. Acidic clayey materials are common at depths of about 3 ft. The more sandy-surfaced soils may show an increase in area from west to east across the unit. Associated are narrow ironstone gravelly ridges of variable frequency and soil composition, but generally with similarities to unit Ms8 soils in the northern portions of the area, and units Uf3 and Cz1 (to the east) in the southern portions of the area. Data are limited. Occurs on sheet(s): 5"
"Sl31"
"Level plains with numerous old stream channels: dominant are loamy yellow-grey duplex soils, chiefly (Dy2.43) but with (Dy3.43) also common. Associated are other loamy duplex soils (Dy2.33), (Dr2.13), and (Db1.13). Near old channels are loamy red or yellow earths (Gn2 12) and (Gn2.21, Gn2.22). Small areas of deep grey-brown and brown cracking clays (Ug5.25, Ug5.24) and (Ug5.34, Ug5.35) also occur; scalded areas associated with these have shallow-surfaced loamy duplex soils (Dy2.13), (Dy2.33), and (Db1.13). Occurs on sheet(s): 7"
"Sl32"
"Very gently undulating coastal plains merging into salt pans and mangroves; many relic stream channels with low levees occur: dominant soils are loamy grey duplex soils (Dy2.43), some of which have very thin (2-4 in.) A horizons. Associated soils are brown earths (Gn2.45) on the low levees and dark duplex soils (Dd1.43) and (Dd1.23) in the minor depressions. Saline clays (Uf6.61) occur on the small included areas of salt pans. Occurs on sheet(s): 7"
"Sl33"
"Level alluvial plains with some stranded channel meanders: deep-surfaced loamy yellow duplex soils (Dy2.43) are most common but other loamy duplex soils are closely associated, chiefly (Dy2.33) and (Dy3.43), with lesser

(Db1.33). Deep cracking clays (Ug5.17, Ug5.16) and (Ug5.26) are common on the back slopes of the flood-plain, particularly on streams draining basaltic country. Deep loamy red earths (Gn2.14) and brown earths (Gn2.44) usually occur on the stream levees. Occurs on sheet(s): 7"
"Sp1"
"Gently undulating plain usually with a surface scatter of ironstone gravel: chief soils are hard acidic yellow soils (Dy2.61) on flat-topped ridges and higher situations generally and hard acidic yellow mottled soils (Dy3.41) or (Dy3.81) in lower-lying situations. They all commonly contain ironstone gravel through the profile. Associated are (Dy5.41) or (Dy5.81) soils, containing ironstone gravels; and shallow (Gn2.1) gravelly soils also with indurated materials below the solum. Iron-cemented and/or silica-cemented strata have been recorded in many areas below the soils. As mapped, areas of units X9, Pb12, and Tb35 may be included. Occurs on sheet(s): 3"
"Sp2"
"Gently sloping bench or terrace--the Ridge Hill Shelf: chief soils are hard acidic yellow soils (Dy2.61) containing ironstone gravels. Associated are brown sands (Uc4.2) often containing ironstone gravels at depth and forming a western fringe to the bench; and some (Dy3.4) soils on dissected areas. As mapped, areas of units Wd6 and Gb16 may be included. Occurs on sheet(s): 5"
"TB"
"Low irregular plateau of highly vesicular basaltic lava (Toomba basalt) in which aa and pahoehoe structures and caverns are common. All drainage is subsurface and no soil is developed except for pockets of organic debris in rock crevices. Very small areas of stony red earths (unit My37) are mapped with the unit. Occurs on sheet(s): 4,7"
"TM1"
"Alluvial plains and broad drainage depressions; occasional low sandy rises and old sand-filled channels may occur throughout: dominant soils are sandy or loamy bleached grey earths (Gn2.95, Gn2.94, and Gn2.91), with other earths (Gn2.25), (Gn2.31), (Gn2.65), and (Gn2.85) also occurring. Closely associated in lower sites and adjacent to stream channels are loamy grey duplex, soils (Dy2.42, Dy2.43), (Dy3.43, Dy3.42), and (Dy3.22). The occasional low sandy rises and sand-filled channels have deep sands (Uc2.21) and (Uc4.21) and sandy earths (Gn2.21), (Gn2.34), and (Gn2.94, Gn2.95). Small areas of unit Mr11 are also included. Data are fairly limited. Occurs on sheet(s): 7"
"TM2"
"Very gently undulating or level plains: dominant soils are loamy bleached grey earths (Gn2.95), with lesser (Gn2.94). Associated are grey earths (Gn2.84) and occasionally bleached yellow earths (Gn2.74). In shallow broad drainage depressions loamy duplex soils are common, chiefly (Dy2.43) and (Dy3.82). On slight rises throughout the area and on stream levees are sandy or loamy red earths (Gn2.14). Adjacent to the sandstone ranges of unit Ca35 are outwash fans of sandy duplex soils (Dy5.43) and (Dy3.43). Data are fairly limited. Occurs on sheet(s): 7"
"Ta1"
"Mountainous: hard acidic yellow mottled soils (Dy3.21 and Dy3.41) with (Dy2.1), (Db3.21), (Dd1.11), (Db1.21), and possibly other (D) soils, also areas of leached sands (Uc2.2 and Uc2.3), yellow leached earths (Gn2.34 and Gn2.74) and red earths (Gn2.11) on slopes and lower hill-tops; friable earths (Gn4.31), (Gn3.11 and Gn3.21) are conspicuous at the higher altitudes with rock outcrops; various soils (unclassified) in the narrow stream valleys. Other (undescribed) soils probably occur also. Occurs on sheet(s): 1,2"
"Ta2"
"Undulating to hilly: hard acidic yellow mottled soils (Dy3.21 and Dy3.41) at the higher elevations; with hard alkaline yellow mottled soils (Dy3.43) in association with dark cracking clays (Ug5.16) on lower hill slopes; smaller areas of leached sands (Uc2.2 and Uc2.3) scattered throughout the unit; minor areas of (Dr4.13) on some hill slopes in the northern portion of the unit; areas of (Db1.42 and Db1.43) often containing ironstone gravels in the A horizons and minor areas of (Uf6.11) and (Gn3.12) in the southern portion of the unit. Occurs on sheet(s): 1"
"Ta3"
"Dissected tableland: hard acidic yellow mottled soils (Dy3.21) in association with pale-coloured earths (Gn2.95) on the slopes; smaller areas of (Dy5.21) (Dy3.41) pockets of leached sands (Uc2.33 and Uc2.31) throughout the unit; some ridge crests have black fibrous peats (O) 18 in. thick over a modified (Uc2.33) profile: Other (undescribed) soils occur. Occurs on sheet(s): 1"
"Ta4"
"Undulating with a few rounded hills and volcanic cones: hard acidic yellow mottled soils (Dy3.21) in association with friable neutral dark soils (Dd3.12) and dark cracking clays (Ug5.1) with gilgais in places; occasional stony rises of (Um6) soils; and dark cracking clays (Ug5.1) in the gullies. Occurs on sheet(s): 2"
"Ta5"
"Low hilly to undulating areas of shallow grey-brown sandy soils (Uc6.11) on the hill-tops and passing to stony hard neutral red soils (Dr2.22) on the upper hill slopes, with hard alkaline red soils (Dr2.23) on the middle slopes and on the better-drained portions of the undulating areas, and with hard acidic yellow mottled soils (Dy3.21, Dy3.41, and Dy3.61) wide-spread throughout the lower hill slopes and the less well-drained portions of the undulating areas. Occurs on sheet(s): 2,3"

"Ta6"
"Steep ranges with some undulating range crests: chief soils are hard acidic yellow and yellow mottled soils (Dy2.21), (Dy3.21), and (Dy3.41). Associated are: hard acidic and neutral red soils (Dr2.21), (Dr2.42); some red earths (Gn2.1), often quite shallow; and siliceous sands (Uc1.2). Small areas of units Qb14 and Tb25 are included. Data are limited. Occurs on sheet(s): 3"
"Ta7"
"Ridge and valley complex of moderately steep hill slopes and variable terrace formations in the major stream valleys: chief soils of the hill slopes are hard acidic yellow mottled soils (Dy3.21) in association with hard acidic red and red mottled soils (Dr2.21) and (Dr3.41), and also loamy soils having an A2 horizon (Um4.2) on mid and upper slopes and (Dy3.41) soils on lower slopes. Minor areas of other soils such as (Gn3.92) on limestone and (Gn3.42) on other basic rocks may occur. The terrace soils belong to unit Mj2. Occurs on sheet(s): 3"
"Ta8"
"Incised valley side slopes of moderate to very steep relief: chief soils are hard acidic, and also neutral, yellow mottled soils (Dy3.21 and Dy3.22) with hard neutral yellow mottled soils (Dy3.62) containing ironstone gravels. Associated are (Dr2.22 and Dr2.21) soils on slopes; some dunes of siliceous sands (Uc1.21) along valleys; some flats of (Dy3.42) soils in the valleys together with swampy areas of undescribed soils; and some ridges of soils of the adjoining units. Occurs on sheet(s): 5"
"Ta9"
"Valley side slopes, gentle to steep slopes where dissection has cut below the laterite level: the soils vary locally, although the hard yellow mottled soils such as (Dy3.21, Dy3.22, and Dy3.41) seem more common, with variable proportions of related (Dr) soils such as (Dr2.21, Dr2.22, and Dr2.41). Associated on the slopes are a great range of soils including (Gn3.12) and other (Dy) and (Dr) soils; and small flats and benches of unit Cd22 at the foot of the slope. As mapped, areas of unit Tf6 soils are included in upper slope positions. Occurs on sheet(s): 5"
"Ta10"
"Steep hilly to hilly terrain with rock outcrops and steep-sided valleys, some with swampy floors: chief soils seem to be hard acidic and neutral yellow mottled soils (Dy3.21 and Dy3.22) and hard acidic red soils (Dr2.21) some varieties of each of these have dark duffy Ao horizons. Associated on colluvial slopes are acid and neutral red earths (Gn2.14 and Gn2.15); (Uc2.34) and (Dy5.41) soils on quartzites; and leached sands (Uc2.33) and possibly acid peats (O) in valley flats and swamps. As mapped, areas of adjoining units are included. Occurs on sheet(s): 5"
"Ta11"
"Undulating to moderately undulating lands with long slopes and occasional steep rises with granite outcrop: dominant are moderately deep sandy duplex soils (Dy3.21) and (Dy3.41), often with gravel in the surface. Associated are red duplex soils (Dr2.22, Dr2.21) and moderately deep coarse sands (Uc4.2). Shallow coarse sands (Uc4.2) and (Uc4.1) occur on steeper rises and near granite outcrop. Other associated soils are sandy red or yellow earths (Gn2.11), (Gn2.21), and (Gn2.45), which occur on the very gently undulating lands o, the valley floors. Occurs on sheet(s): 7"
"Ta12"
"Low hilly lands with some marginal strongly undulating slopes; granite outcrop is very common: dominant soils are shallow stony sandy or loamy duplex soils (Dy3.21), but other duplex soils are closely associated, chiefly (Dr2.12), (Dr2.22), (Dr2.62), and (Dr3.21). Shallow stony sands are very common in most rock outcrop areas, chiefly (Uc4.2) and (Uc4.11, Uc4.12). Occurs on sheet(s): 7"
"Ta13"
"Moderately undulating plateau with many low knolls and granite tor outcrop: dominant are moderately deep sandy to loamy mottled duplex soils (Dy3.21). Bleached duplex soils (Dy3.41) are very closely associated and in some areas are locally dominant. Also associated are similar neutral duplex soils (Dy3.22) and (Dy3.42) and coarse sands, chiefly (Uc2.12) and (Uc4.2), with lesser (Uc2.21, Uc2.23). Occurs on sheet(s): 7"
"Ta14"
"Alluvial plains with many relic stream channel meanders: dominant are deep loamy duplex soils (Dy3.21), but there are important areas of deep friable earths (Gn3.74) and (Gn3.94) and smaller areas of deep grey cracking clays (Ug5.24). Included also are deep friable loams (Um6.34, Um6.33) of unit Gh1 on the higher stream levees and recent alluvium. Occurs on sheet(s): 7"
"Tb1"
"Hills and valley plains: hills and hill slopes of hard acidic yellow mottled soils (Dy3.41 and Dy3.42) in association with hard neutral red soils (Dr2.22 and Dr2.32), shallow grey-brown sandy soils (Uc6.11), and rock outcrops; smaller localized areas of (Dy3.61), (Dy3.81), (Dy3.21), (Dy4.21), (Dr2.11), (Dr2.41), also (Gn2.74) on hills and slopes; valley plains of hard neutral or alkaline yellow mottled soils (Dy3.42 and Dy3.43) with red mottled soils (Dr3.33) and others not described but including cracking clays (Ug5.1) and (Um) soils. Soils of low-lying wet situations generally not studied but (Uf6.41) has been recorded therein. Note in the smaller areas of this unit only the dominant soils of the unit may occur therein. Occurs on sheet(s): 1,2"
"Tb2"

"Hilly with some flat-topped knolls and ridges, gorges, some river flats: moderate to steep hill slopes of hard acidic yellow mottled soils (Dy3.41), some containing ironstone grav, with rock outcrops and various (Uc) and (Um) soils; flat-topped ridges and knolls of hard alkaline red soils (Dr2.13); some rocky gorges; lower hill slopes of various (D) soils including (Db2.22); and river flats of undescribed soils. Occurs on sheet(s): 2"
"Tb3"
"Undulating area of hard acidic yellow mottled soils (Dy3.41) dissected by small stream valleys of undescribed soils. Occurs on sheet(s): 2"
"Tb4"
"Undulating to hilly, dissected by streams with narrow to moderate expanses of flats: gentle to steep slopes of hard acidic ,yellow mottled soils (Dy3.41 and Dy3.81) with (Dy5.41 and Dy5.81), some areas of shallow grey-brown sandy soils (Uc6.11) on upper slopes and various (D) soils including (Db2.42 and Dd1.1) and also leached sands (Uc2.3) on mid and lower slopes; valley plains of (Dy3.41) with some areas of leached sands (Uc2.2 and Uc2.3), with flats and former swampy areas of dark cracking clays (Ug5.16, acid or neutral in reaction) and smaller areas of other soils including (Gn), (Ug), and (Dd3) soils, some of which have peaty surfaces; small areas of units Ob6 in the western part, and Pb3 in the south-eastern part of the unit. Occurs on sheet(s): 2"
"Tb5"
"Undulating areas of hard acidic yellow mottled soils (Dy3.41). some with pans in the A2 horizon and other (D) soils in association with leached sands (Uc2.3); small stream valleys of undescribed soils. Occurs on sheet(s): 2"
"Tb6"
"Hilly areas of hard acidic yellow mottled soils (Dy3.41, Dy3.61) with various kinds of leached sands (Uc2.3) and other undescribed soils in the stream valleys; small areas of unit A5 along the coast. Occurs on sheet(s): 2"
"Tb7"
"Hilly area of hard acidic yellow mottled soils (Dy3.41) and other undescribed soils; small stream valleys of undescribed soils. Occurs on sheet(s): 2"
"Tb8"
"Flanking hills of hard acidic yellow mottled soils (Dy3.41). Occurs on sheet(s): 2"
"Tb9"
"River terraces and valley plains: gently sloping river terraces of hard acidic yellow mottled soils (Dy3.41) in association with hard acidic brown soils (Db2.41), hard neutral yellow mottled soils (Dy3.42) with smaller areas of grey cracking clays (Ug5.2); hard alkaline yellow mottled soils (Dy3.43) in proximity to stream channels; small valley plains of dark cracking clays (Ug.5.16) where the stream is incised and (Ug6.1) in poorly drained areas. Occurs on sheet(s): 2"
"Tb10"
"Undulating foothills: undulating areas of hard acidic yellow mottled soils (Dy3.41) with smaller areas of (Dy3.42) and (Dy3.43), broken by islands of low rounded hills with rock outcrops and with (Dy3.41) and (Dd2.41) soils and nearer the coast with small plains and low hill slopes of leached sands (Uc2.33). Occurs on sheet(s): 2"
"Tb11"
"Hilly to steep hilly: gentle to steep slopes of hard acidic yellow mottled soils (Dy3.41) in association with shallow sand soils (Uc4.11) and (Gn) soils of unit Mh2 and rock outcrops; small valley plains of hard yellow mottled soils (Dy3.4). Occurs on sheet(s): 2"
"Tb12"
"Valley formations: flat to undulating terraces along the stream.s of hard acidic yellow mottled soils (Dy3.41) in association with (Dy3.42) and (Dr2.12); recent floodplains of dark cracking clays (Ug5.16) and (Ug6.1); flanked by hills and hill slopes--usually gentle lower slopes and steep upper slopes--of hard neutral brown soils (Db2.42 and Db1.42), hard neutral red soils (Dr2.12),. Occurs on sheet(s): 2"
"Tb13"
"Narrow valleys flanked by steep valley sides: terraces and lower hill slopes of hard acidic yellow mottled soils (Dy3.41) some of which have hard pans in the A2 horizon, in association with leached sands (Uc2.33 and Uc2.32) and (Uc2.35), bow which a clay layer may occur, and hard neutral brown soils (Db2.42); floodplains of various soils (unclassified); the whole flanked by steep valley sides of soils of the adjoining units. Occurs on sheet(s): 2"
"Tb14"
"Hilly to undulating areas of hard acidic yellow mottled soils (Dy3.41) in association with localized areas of many other soils including (Dy5.4) (Dr2.2), (Gn4.5), (Gn3.5), (Uc2.2), and (Uc2.3) some with clay D horizons; small stream valleys of undescribed soils. Occurs on sheet(s): 2"
"Tb15"
"Hilly areas of hard acidic and neutral glow mottled soils (Dy3.41 and Dy3.42) with small areas of other (D) soils including (Dy3.2); small areas of siliceous sands (Uc1.21); undescribed soils in the small creek valleys which are swampy in places. Occurs on sheet(s): 2"
"Tb16"

"Valley plain of hard acidic and neutral yellow mottled soils (Dy3.41 and Dy3.42) with other undescribed soils. Occurs on sheet(s): 2"
"Tb17"
"Undulating to low hilly areas of hard acidic and neutral yellow mottled soils (Dy3.41 and Dy3.42) and other undescribed soils but including small patches of soils of unit Mg1; some swampy areas. Occurs on sheet(s): 2"
"Tb18"
"Hilly with swampy valleys and basins: hill slopes of hard acidic yellow mottled soils (Dy3.41) and sandy acidic yellow mottled soils (Dy5.41) in association with leached sands (Uc2.3 and Uc2.36) with a clay D horizon, also with other (D) soils including (Dy3.1 and Dy3,61), (Dy4.41), and (Dr3.41), and shallow sand soils (Uc4.1); swampy valleys and basins of acidic peaty (O) soils margined by leached sands (Uc2.3) and smaller areas of red and yellow earths (Gn2.1 and Gn2.2). Occurs on sheet(s): 2"
"Tb19"
"Undulating to hilly with some flatter ridge tops and river valleys: undulating to hilly areas of hard acidic yellow mottled soils (Dy3.41) with some (U) soils and rock outcrops, in association with flat to undulating ridge-tops of dark cracking clays (Ug5.12): gorges and steep-sided stream valleys of cracking clays (Ug5.1), other (U) and also (Dy) soils and rock outcrops; some small floodplains of undescribed soils. Occurs on sheet(s): 2"
"Tb20"
"Undulating areas of hard acidic yellow mottled soils (Dy3.41) in association with other (D) soils such as (Dy5.4) and (Dy3.2); small stream valleys and alluvial flats of undescribed soils. Occurs on sheet(s): 2"
"Tb21"
"Undulating plain, low dunes and swamps: creek and river floodplains of hard yellow mottled soils (Dy3.41 and Dy3.42) in association with leached sands (Uc2.3) on low dune-swale areas; undescribed soils in swampy areas; small areas of unit A5 along the coast. Occurs on sheet(s): 2"
"Tb22"
"Hilly to steep hilly ranges with rock outcrops: chief soils are shallow stony hard acidic yellow mottled soils (Dy3.41), (Dy3.21), with (Dr2) and (Um4.1) soils. As mapped, areas of unit Ub39 are included. Data are limited. Occurs on sheet(s): 3"
"Tb23"
"Undulating to hilly (somewhat uneven topography), rock outcrops: chief soils are hard acidic yellow mottled soils (Dy3.41), often of shallow depth to weathered rock. Associated are: (Dy3.42 and Dy3.43) soils on lower slopes and in lower-lying sites generally; (Um4.1) soils on steeper slopes; and terraces of (Gn2.15) soils along major streams. Occurs on sheet(s): 3"
"Tb24"
"Hilly--undulating ridges with moderately steep side slopes, some tors: chief soils are hard acidic and neutral yellow mottled soils (Dy3.41 and Dy3.42). Associated are (Dr2.2) soils; and (Uc1.2) soils on steep colluvial slopes. Data are limited. Occurs on sheet(s): 3"
"Tb25"
"Dissected plateau tracts--undulating to hilly country, tors common: chief soils are hard acidic and neutral yellow and yellow mottled soils (Dy3.41), (Dy3.42), and (Dy2.21). Associated are: hard acidic and neutral red soils (Dr2.2) and (Dr2.4); some siliceous sands (Uc1.2) on colluvial deposits; and small areas of unit Mu7. Data are limited. Occurs on sheet(s): 3"
"Tb26"
"Undulating to steep hilly: chief soils are hard acidic and neutral yellow and yellow mottled soils (Dy3.41), (Dy3.42), and (Dy2.21) and hard acidic and neutral red soils (Dr2.2 and Dr2.4). Associated are: ranges of unit Ta6; narrow river flats of undescribed soils; and small areas of unit Qb14. Occurs on sheet(s): 3"
"Tb27"
"Ridge and valley terrain, generally of mild relief: low undulating often stony ridges of hard acidic yellow and yellow mottled soils (Dy2.41), (Dy3.41), and sometimes (Dy3.42) or (Dy2.42); also with shallow valleys of (Dy3.42) soils showing some saline patches. Associated are: (Dr2) and (Um4) soils and rock outcrops on some ridges; remnants of unit Wd5; scattered small but widespread occurrences of lateritic or bauxitic materials and silcrete with some (Gn2) soils; and small basaltic ridges probably with soils similar to unit Qr2. Data are limited. Occurs on sheet(s): 3"
"Tb28"
"Flat to undulating with low rises, knolls and ridges, swampy depressions, and valleys: chief soils are hard acidic yellow mottled soils (Dy3.41) with more or less regular occurrences of red earths (Gn2.14) on low rises, and various undescribed soils probably occurring in specific topographic situations. As mapped, islands of the soils of unit Gd3 and some areas of soils, especially the yellow earths, of unit Mb2 are included. Compare units Tb29 and Mu5. Occurs on sheet(s): 3"
"Tb29"

"Plains broken by rolling areas and by basaltic knolls and ridges: chief soils are: hard acidic yellow mottled soils (Dy3.41) on the plains which may be seasonally waterlogged; red earths (Gn2.14 and Gn2.15) on the rolling areas; (Um6.13 and Um6.12) and possibly other soils on basaltic knolls and ridges; and stream valleys of various soils, including (Ug5.16). Compare units Mu5 and Tb28. Occurs on sheet(s): 3"
"Tb30"
"Rugged ranges in a series of stepped undulating to hilly ridges with steep side slopes: chief soils are shallow (often only 18-24 in. thick) hard acidic yellow mottled soils (Dy3.41) on the undulating to hilly ridge tops (plateau tracts) with their perched seasonally swampy basins and/or valleys. Associated are: steep side slopes of (Dr2.41), (Dr2.21), (Dy3.41), and (Um) soils with rock outcrops (the (Dr2) soils are dominant on some slopes, while the (Um) soils including (Um2.12) are dominant on others); hilly areas of (Dr2.41) soils; (Gn2) soils in some ridge-top basins and on some slopes; and basaltic ridges and knolls of various soils including (Gn3.12). As mapped, this unit includes all dissection spurs and slopes adjacent to the main area but their soils are not known. Compare unit Ub31. Data are limited. Occurs on sheet(s): 3"
"Tb31"
"Steep slopes of shallow soils above entrenched streams with very narrow flood-plains: chief soils are probably shallow forms of hard acidic yellow mottled soils (Dy3.21) and (Dy3.41), and hard acidic red soils (Dr2.21), (Dr2.41), and (Dr3.41) with (Um4.1) soils and small areas of various soils such as (Um6.43) where special parent materials are exposed. Data are limited and soil dominance is likely to vary widely. Occurs on sheet(s): 3"
"Tb32"
"Gently undulating to flat country (topographical basins): chief soils are hard acidic and neutral yellow mottled soils (Dy3.41 and Dy3.42) with some local saline patches. Other soils may occur. Data are limited. Occurs on sheet(s): 3"
"Tb33"
"Dissected plateau: chief soils on undulating ridge crests are hard acidic yellow mottled soils (Dy3.41). Associated are: moderate to steep side slopes of various earths (Gn2), such as (Gn2.14), (Gn2.2), and (Gn2.9); some hilly areas of (Dr2.21), (Dy2.21), (Dy3.41), (Um4.1), and (Um4.2) soils with rock outcrops; some talus slopes of (Uc1.2) and (Uc2.2) soils; and some small flat areas of units Tb32 and Tb39. Occurs on sheet(s): 3"
"Tb34"
"Ridge and slope country: (i) narrow undulating to hilly ridge crests of hard acidic yellow mottled soils (Dy3.41) with yellow leached earths, such as (Gn2.74) and (Gn2.34), and other (D) soils such as (Dr2.61); (ii) steep to rugged side slopes of siliceous sands (Uc1.21) and leached sands (Uc2.2) with tors and areas of soils as for (i); and (iii) some hilly to steep hilly areas with (Dy3.21), (Dr2.21), (Um4.2), and (Dy3.41) soils. Data are limited. Occurs on sheet(s): 3"
"Tb35"
"Dissected plateau remnants--flat to undulating ridge tops with moderate to steep side slopes: chief soils are hard acidic yellow and yellow mottled soils (Dy3.41), (Dy2.21), and (Dy2.41) and hard acidic red soils (Dr2.21); many shallow profiles occur and profile thickness varies considerably over short distances. Associated are: (Gn3.54), (Gn3.14), and possibly other (Gn3) soils; (Db1.2) soils on some ridges; (Dy5.81) soils in areas transitional to unit Mb2; soils common to unit Mb2; and eroded lateritic remnants. Small areas of other soils are likely. Flat ferruginous shale or sandstone fragments are common on and/or in and/or below the soils of this unit. Occurs on sheet(s): 3"
"Tb36"
"Undulating: chief soils are hard acidic yellow mottled soils (Dy3.41) usually containing some ironstone gravels throughout the profile. Associated are small areas of units Pb12 and Pb13. Occurs on sheet(s): 3"
"Tb37"
"Dome-like hills and their slopes (a complex area of dolerite and shale): chief soils are hard acidic yellow mottled soils (Dy3.41), shale areas; and dark cracking clays (Ug5.1), dolerite areas. These soils are members of two somewhat interlocking slope sequences as follows: (i) on shale--upper slopes of (Dr2.21) passing to mid slopes of (Dy3.41) and lower slopes of (Dy3.42 and Dy3.43); (ii) on dolerite-crests of (Db3.12) and similar soils with steep slopes of (Um6) and/or (Uf6) soils and mid and lower slopes of dark cracking clays (Ug5.13, Ug5.14, Ug5.15, Ug5.16). Along the adjoining stream valleys are (Ug5.2), (Dd1.33), and (Dy3.43) soils. Buried soils are recorded from the area. Occurs on sheet(s): 3"
"Tb38"
"Flat to undulating: chief soils are hard acidic yellow and yellow mottled soils (Dy2.41) and (Dy3.41) sometimes containing ironstone gravel. Associated are hard acidic red soils (Dr2.21, Dr2.41), and small areas of other soils, including (Gn2) and (Gn3.54). Occurs on sheet(s): 3"
"Tb39"
"Undulating--often with short irregular slopes: chief soils are hard acidic yellow mottled soils (Dy3.41) often with large amounts of waterworn stone, and yellow earths such as (Gn2.74). Data are limited. Occurs on sheet(s): 3"
"Tb40"

"Undulating to hilly areas with some steep slopes and cliffs, rock outcrops, and narrow terraced valleys: chief soils are hard acidic yellow mottled soils (Dy3.41) with some shallow soils such as (Um4.1) and (Uc4.1) on the steeper slopes. Associated are: (Gn2.2) soils and (Dd1) soils, both of which occur on slopes; undescribed soils in the valleys; and some (Dy5) and (Uc1.2) soils along the coast. As mapped, small areas of units Gb10 and Cb28 are included. Occurs on sheet(s): 3"
"Tb41"
"Undulating to low hilly country, some rock outcrops on hillocks: chief soils are hard acidic yellow mottled soils (Dy3.41) and hard acidic red soils (Dr2.21). Associated are hilly areas of unit Ta7 soils, and the variable development of flood-plains and terraces along the streams with a variety of soils including (Dy3.42 and Dy3.43), (Dd1.33), (Um6.11), and other (Um) and (Uc) soils. Data are limited. Occurs on sheet(s): 3"
"Tb42"
"Undulating to hilly with a general ridge, slope, and valley sequence throughout; some outcropping sandstone or conglomerate on the ridges, occasionally some escarpments: chief soils are hard acidic yellow mottled soils (Dy3.41), possibly with (Dy3.42). Associated are: narrow ridges of shallow (Dy3.41) and (Dr3.41) soils, both often containing ironstone gravel; (Dr2.41) soils on broader ridges some broad sandy flats of (Dy5.81) soils containing ironstone gravels; dunes of (Uc1.2) soils on local sand deposits; and various undescribed soils along the streams where salinity is a common local feature. Occurs on sheet(s): 3"
"Tb43"
"Undulating to hilly terrain: chief soils are hard acidic yellow mottled soils (Dy3.41) on the flatter and consequently less well-drained portions throughout the area. Associated are: (Dy3.21) and/or (Dy3.11) and/or (Dr2.21) and/or (Gn3.54) on hill crests and upper slopes; (Dr4.21) and/or (Gn3.14) on mass movement and hill-slope terrace areas; and minor areas of other soils, such as (Dy5.21) and (Um6.12). As mapped, small areas of adjoining units are included, especially unit Mj2, along some streams. Occurs on sheet(s): 3"
"Tb44"
"Undulating to low hilly: chief soils are hard acidic and neutral yellow mottled soils (Dy3.41 and Dy3.42). Associated are hill slopes of (Dr2), (Dy2), (Dy3), and (Um4) soils, and river terraces of (Um6.11 and/or Um6.12) soils with other undescribed soils. Data are limited. Occurs on sheet(s): 3"
"Tb45"
"Low hilly to hilly with some steep ridges: chief soils are hard acidic and neutral yellow mottled soils (Dy3.41) and (Dy3.22) on slopes and ridges, with (Dy2.22), which often contains ironstone grit and has a surface scatter of ironstone slabs, in the flatter areas. Data are limited. Occurs on sheet(s): 3"
"Tb46"
"Undulating areas of hard acidic yellow mottled soils (Dy3.41) and probably other (Dy) soils. Associated are small rolling areas of red friable porous earths (Gn4.11) as for unit Mg22, and low-lying wet areas of undescribed soils. Data are limited. Occurs on sheet(s): 3"
"Tb47"
"Undulating to hilly: generally hilly areas of hard acidic yellow mottled soils (Dy3.41) and hard acidic red soils (Dr2.21) probably with other soils as for unit Tb43. Associated are very gentle slopes and/or terrace remnants of acid leached red earths (Gn2.14). Data are limited. Occurs on sheet(s): 3"
"Tb48"
"Hilly to steep hilly areas: chief soils are hard acidic yellow mottled soils (Dy3.41) with various shallow soils (Gn2.24) and/or (Um4.2) or (Um6.21) on hill crests. Other soils including (Uf6) soils may occur on some mid and lower slopes. Occurs on sheet(s): 3"
"Tb49"
"Ridge and valley complex--broad dissected river valleys: undulating to hilly lower slopes and upper terraces of hard acidic yellow mottled soils (Dy3.41) with some lower terraces of (Um6.11) soils; flanked by steep slopes of (Gn2.14), (Gn2.24), (Um4.2), and some (Db) soils, and with rock outcrops. As mapped, areas of unit Mw2 are included. Occurs on sheet(s): 3"
"Tb50"
"Undulating to hilly terrain: chief soils are hard acidic yellow mottled soils (Dy3.41) with some (Um4.1 or Um4.2) soils on the steeper slopes, (Dr2.2 1) soils on mid and upper slopes, and (Dy) soils containing ironstone gravel on lower slopes. Associated are small areas of unit Rh3; and small areas of unit Mw3 particularly towards the wetter parts, on steep scarp-like slopes. As mapped, areas of unit Mw5 may be included. Occurs on sheet(s): 3"
"Tb51"
"Undulating to hilly terrain of unit Tb50 with scattered remnants of unit Rh3. As mapped, areas of unit Mw5 may be included. Occurs on sheet(s): 3"
"Tb52"
"Flat area of hard acidic yellow mottled soils (Dy3.41) and other undescribed soils. Occurs on sheet(s): 3"
"Tb53"

"Hilly: gentle to moderate slopes of shallow hard acidic yellow mottled soils (Dy3.41) with intervening, often swampy flats of various leached sands (Uc2.3). Other soils are likely. Occurs on sheet(s): 3"
"Tb54"
"Hilly: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are (Gn2.44) and (Uc4.1) soils on steeper slopes. Small areas of unit Ke15 may be included. Occurs on sheet(s): 3"
"Tb55"
"Undulating to hilly: hard acidic yellow mottled soils (Dy3.41) and hard acidic red and red mottled soils (Dr2.21) and (Dr3.21 and Dr3.41), with generally flatter areas of sandy acidic yellow mottled soils (Dy5.61) often containing ironstone gravels. Soil dominance varies locally. As mapped, areas of units Wc7, Tb57, and minor occurrences of units Ml2 and Mg24 are included. Occurs on sheet(s): 3"
"Tb56"
"Hilly to steep hilly: generally similar to unit Tb55 but with rock outcrops and some shallow (Um) and (Uc) soils as well as soils of the adjoining units. Occurs on sheet(s): 3"
"Tb57"
"Hilly to steep hilly with rock outcrops: soil dominance seems to vary locally between the following (Dy), (Db), and (Dr) soils, namely, shallow forms of hard acidic yellow mottled soils (Dy3.21 and Dy3.41), hard acidic brown soils (Db2.41), and hard acidic red soils (Dr2.21 and Dr2.41). Associated are shallow (Um4) and (Uc4) soils and areas of unit Wc7. Valleys are steep-sided. Occurs on sheet(s): 3"
"Tb58"
"Gently to strongly undulating terrain of hard acidic yellow mottled soils (Dy3.41). Associates are not known. As mapped, areas of units Wc7 and Tb55 are included. Valleys are shallow and may be swampy. Occurs on sheet(s): 3"
"Tb59"
"Ridge and valley terrain: generally steep ridges of hard acidic yellow mottled soils (Dy3.21 and Dy3.41) with (Dr2.21) and (Um4.2) soils and rock outcrops. Associated are undulating valleys between the ridges of hard acidic yellow mottled soils (Dy3.41), similar to unit Tb58. Occurs on sheet(s): 3"
"Tb60"
"Hilly to steep hilly with some rugged terrain: moderate to steep slopes of hard acidic yellow mottled soils (Dy3.41) and hard acidic red mottled soils (Dr3.41) with (Dy3.21), (Dr2.21), (Uc4.1), and (Um4.2) soils on crests and ridge tops. Associated are small areas of a variety of other soils including (Gn2.44). As mapped, areas of unit Wc7 may occur, especially in the eastern portions of this unit. Valleys are steep-sided. Occurs on sheet(s): 3"
"Tb61"
"Undulating to hilly valley slopes flanking small creek and river flood-plains: chief soils seem to be hard acidic yellow mottled soils (Dy3.41 and Dy3.21), with (Dr2.21) and (Gn2.14 and Gn2.24). There are similarities to both units Tb58 and Pb15. No specific soils data are available. Occurs on sheet(s): 3"
"Tb62"
"Undulating to hilly valley slopes flanking creek and river flood-plains: chief soils on the gentle to moderately steep slopes are hard acidic yellow mottled soils (Dy3.41, Dy3.21, and Dy3.61). Associated are: on the slopes, various soils, such as (Dr3.41), (Uc4.1), (Um4.2), and (Gn2.1), with rock outcrops; and small terraced alluvial valleys of a wide variety of soils such as (Dy5.61), (Dy5.81), (Dy5.11), (Dd2.41), (Uc1.2), (Uc2.2 and Uc2.3). As mapped, minor areas of unit Ml2 are included. Occurs on sheet(s): 3,4"
"Tb63"
"Rolling to hilly, low coastal uplands: chief soils on the moderate to gentle slopes are hard acidic yellow mottled soils (Dy3.41 and Dy3.21) and hard acidic red soils (Dr2.21) with (Um4) soils. Associated are valley areas of unit NY1. Occurs on sheet(s): 3"
"Tb64"
"Rolling to hilly terrain with gentle to moderate slopes: chief soils are hard acidic yellow (Dy3.41) and red (Dr3.41) mottled soils. Associated are hard alkaline yellow (Dy3.43) and red (Dr3.43) mottled soils; sandy acidic yellow mottled soils (Dy5.41), (Dy5.31), and (Dy5.81) and leached sands (Uc2.2), all containing large amounts of nodular ironstone material, also with mottled clays, at depth, below the (Uc2) soils. As mapped, small areas of adjoining units are included. Occurs on sheet(s): 4"
"Tb65"
"Gently rolling areas of the subcoastal lowlands (less than 400 ft above sea level) with a maximum relief of 50 ft between crests and valleys. The soil pattern is complex and controlled by the lithology of the parent rock material. Chief soils seem to be hard acidic and neutral yellow and red soils (Dy3.41), (Dy3.42), (Dr3.41), and (Dr2.12) on sandstones. Associated are: cracking clays (Ug5.12), (Ug5.23), and (Ug5.37) on shales; (Dd1.43) soils on crests of rises and underlain by intermediate rock types with (Uf6.12) soils on their steeper slopes; (Ug5.12) soils on basic rocks; (Gn3.12) soils also on basic rocks; and small areas of terraced valleys as for unit MM9. Occurs on sheet(s): 4"
"Tb66"

"Gently rolling areas as for unit Tb65 traversed by moderately large areas of terraced valley plains as for unit MM9. Occurs on sheet(s): 4"
"Tb67"
"Hilly granitic country of moderate relief with broad convex slopes, some tors, some small flat-topped lateritic knolls and hills; narrow drainage-ways: chief soils on the hills and broad convex slopes are hard acidic yellow and yellow mottled soils (Dy3.41) and (Dy3.31) with (Dy2.41) and (Dy2.31). Associated are a wide range of soils including: (Dy3.11), (Dy5.41), (Dr2.41), and (Dr2.21); (Dy2.42) and (Db1.43) on the broad convex slopes; gravelly (Gn2.11) soils on some lateritic scarps and crests; (Uc2.12) soils on some crests; and (Ug5.16) along some of the narrow valleys. Minor soil occurrences include (Gn3.11) and (Gn2.24) on some slopes below lateritic scarps. Occurs on sheet(s): 4"
"Tb68"
"Undulating to low hilly--flat-topped ridges with broad concave slopes and possibly terraced valleys--a complex area: chief soils seem to be hard acidic yellow mottled soils (Dy3.41) on the dissection slopes with some (Dy3.42 and Dy3.43) soils. Associated are: (Gn3.21) and (Gn2.41) soils on lower slopes; (Gn2.11) soils on ridges and upper slopes; (Gn3.54) soils on some broad convex crests; (Gn2.84) on crests and slopes of lower hills; (Dy3.81) soils containing ironstone gravels on some flat-topped areas; and some (Dr) soils on slopes. Data are limited in this complex area. Occurs on sheet(s): 4"
"Tb69"
"Low rounded hilly terrain on shales and soft sandstones--gentle side slopes to shallow relatively broad valleys: chief soils are hard acidic yellow mottled soils (Dy3.41) and (Dy3.31) of shallow to moderate depth. Associated are shallow to moderately deep (Dr3.41) and (Dr3.31) soils on slopes; (Um2.12) soils on crests; and (Gn2.91, Gn2.94, and Gn2.95) soils with some (Dy2.31) soils in valley flats. Other soil occurrences include (Gn3.42), (Db1.13), and (Um6.21) on andesitic dykes; (Db1.33) on limestone lenses; and a (Dd2.31-Dy3.31) soil complex on siltstones. As mapped, ridges and knolls of red earths (Gn2.14) of unit Mw23 and valleys of unit Mm8 are included. Occurs on sheet(s): 4"
"Tb70"
"Low hilly to hilly terrain on shales and soft sandstones--rounded gentle to moderate slopes above shallow open valleys: chief soils are hard acidic yellow mottled soils (Dy3.41) and (Dy3.31) generally of shallow depth. Associated are shallow (Dr3.41), (Dr3.31), and (Dr2.31) soils on upper slopes; (Um2.12) and (Uc2.12) soils on hill crests and upper slopes; and (Gn2.91), (Gn2.94), and (Dy2.31) soils in flats. Other soil occurrences include (Db1.13) on andesitic dykes; (Dd2.31) and (Dy3.31) on siltstones; and (Gn3.54) and (Gn2.14) soils on ridges and knolls of unit Mw23. As mapped, small areas of units Ub69 and Cd7 may be included. Occurs on sheet(s): 4"
"Tb71"
"Low rounded hills of andesitic and trachytic tuffs; gentle to moderate slopes to narrow creek flats in open valleys, some bare rock outcrops: chief soils are hard acidic yellow mottled soils (Dy3.41), often shallow and gravelly, on hill crests and slopes. Associated are leached loams (Um2.12) often in complex with the (Dy3.41) soils on hill crests, and with (Dd1.81) soils on both crests and slopes. Other soils are (Gn3.41) soils on the more basic rock types and (Uf6.61) and (Ug5.1) soils on the poorly drained creek flats. Occurs on sheet(s): 4"
"Tb72"
"Dissected old coastal plain or low plateau, now of low hilly relief on siltstone, shales, and fine-grained sandstones: chief soils are hard acidic yellow mottled soils (Dy3.41) on crests, slopes, and valley plains. Associated are (Dr3.41) soils on slopes and (Gn2.74) and (Gn3.74) on the crests of included plateau remnants Other soil occurrences are: (Dr3.21) and (Dd1.41) on slopes; (Gn2.94) soils on creek flats; (Gn2.25) soils on stream levees; and (Gn3.11) soils on small inclusions of the adjoining unit Mp8. Occurs on sheet(s): 4"
"Tb73"
"Dissected old coastal plain or low plateau, of low hilly to hilly relief on siltstones, shales, and fine-grained sandstones: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are (Uc2.12) soils on hill crests and slopes and (Dy3.31) and (Dy2.31) soils on stream flats. Other soils include (Dy3.81) on granitic intrusions and (Dr3.41) and (Um2.12) soils on shales. Occurs on sheet(s): 4"
"Tb74"
"Dissected old coastal plain or low plateau, at about 100 ft above sea level and with an undulating relief: chief soils are hard acidic yellow mottled soils (Dy3.41) on all slopes, saddles, and in the broad shallow valleys. Associated are (Dy3.31) soils in the valleys and some saddles. Other soils are: (Gn2.94) and (Dy3.82) on recent stream flats; (Dg4.81) soils in swampy depressions; (Um2.12) soils on some crests; and (Gn2.74) soils on crests above 100 ft elevation. Occurs on sheet(s): 4"
"Tb75"
"Dissected old coastal plain or low plateau, at about 100 ft above sea level and with an undulating to rolling relief: chief soils are hard acidic yellow mottled soils (Dy3.41) on all slopes. Associated are a variety of (Gn) soils, such as (Gn2.31), (Gn2.64), (Gn2.71), and (Gn3.81) on ridge crests, and (Dy3.31) soils on lower slopes and along stream valleys. Other soils include (Gn2.91), (Gn3.91), and (Dg2.41) along stream valleys. Occurs on sheet(s): 4"

"Tb76"
"Low hilly to hilly terrain on shales and soft sandstones: chief soils are hard acidic yellow mottled soils (Dy3.41) on mid and lower slopes. Associated are (Dr3.41) and (Dr2.41) soils on upper slopes and crests and (Gn2.14) soils on flat-topped crests of the higher hills. Other soils include: (Dy2.41) on lower hill slopes and along stream valleys; (Gn2.74) on sandy rises in stream valleys and on fans; (Gn2.94) on valley floors; and (Db2.42 and Db2.43) on andesitic dykes. As mapped, small areas of unit Cd6 may be included. Occurs on sheet(s): 4"
"Tb77"
"Hilly landscape on shales with fine-grained sandstone bands; convex hills with moderate to steep side slopes and narrow valleys: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are (Um2.12), (Um4.1), (Dr2.41), and (Gn3.12) soils on hill crests and steep upper slopes. Other soils include (Dy3.32) on stream flats; (Gn2.14) and (Gn2.74) on narrow flat-topped hills; and (Dy5.81) and (Dy4.81) on some low hills and slopes. Occurs on sheet(s): 4"
"Tb78"
"Dissected granitic plateau at about 1850 ft elevation; of low hilly relief with narrow stream flats: chief soils are hard acidic yellow mottled soils (Dy3.41) and leached sands (Uc2.12) on slopes and crests respectively. Associated are (Uc4.2) soils on upper slopes. Other soils include (Dg2.41) along stream valleys. Occurs on sheet(s): 4"
"Tb79"
"Hilly land on shales and phyllites with narrow ridge crests and moderate to steep side slopes, narrow creek flats: chief soils are hard acidic yellow mottled soils (Dy3.41) on mid and lower slopes. Associated are (Um2.12) and (Um4.1) soils on ridge crests and upper slopes. Other soils include (Dr3.41) on ridges; (Gn3.42) and (Dr2.12) on andesitic dykes; and (Dy3.31) along creek flats. Occurs on sheet(s): 4"
"Tb80"
"Hilly terrain on shales with narrow crests and moderate to steep slopes, fairly open valleys with narrow alluvial flats: chief soils are hard acidic yellow mottled soils (Dy3.41) on crests and slopes. Associated are (Um2.12) soils on shales; (Gn3.42) soils on andesites; and (Dr2.21) soils on limestones. Other soils include: (Um4.1) and (Dd1.41) on shales; (Dy3.41) and (Dy2.42) on alluvial flats; (Gn3.41) and (Gn3.12) on volcanic rocks; (Gn3.43) on alluvium; and (Db1.41) on andesite. As mapped, small areas of unit Gd8 are included. Occurs on sheet(s): 4"
"Tb81"
"Generally low hilly terrain on sandstones; fairly long gentle to moderate side slopes to shallow open valleys with alluvial flats, and slope fan development: chief soils are hard acidic yellow mottled soils (Dy3.41) and related soils on crests and slopes. Associated are (Dr3.41) and related soils on crests and slopes. Other soils include: (Uc2.12) and (Gn2.14) on hill crests and platforms; (Dg4.41) and (Dy5.41) in wet saddles and basal slopes; (Uc2.31), (Dr2.11), (Uc2.34), and (Dy3.41) on fans; (Dd3.11) on terraces; and (Gn2.91 and Gn2.94) on stream flats. As mapped, small areas of unit Cd10 are included. Occurs on sheet(s): 4"
"Tb82"
"Generally low hilly terrain on shales--gentle to moderate side slopes to shallow open valleys with significant alluvial flats: chief soils are hard acidic yellow mottled soils (Dy3.41) and related soils on slopes and crests. Associated are (Um2.12) soils on crests; (Dy2.41) soils on lower slopes; and (Dy2.42) soils on flats. Other soils include (Uc4.11) and (Um4.1) on crests; (Dd1.33) on flats; and (Db1.12) and (Gn3.42) on andesitic dykes. Occurs on sheet(s): 4"
"Tb83"
"Gently rolling land on siltstones, shales, and fine-grained sandstones; broad low rises, shallow depressions, narrow coastal dunes and cliff faces in some localities: chief soils are hard acidic yellow mottled soils (Dy3.41) on crests and slopes. Associated are (Dy2.12) soils on slopes fronting the shoreline. Other soils include: (Dg4.81) and (Gn2.91) in depressions; (Dg2.41) in flats; (Uc1.22) on dunes; and (Gn2.14) on low platform remnants. As mapped, areas of unit A10 are included. Occurs on sheet(s): 4"
"Tb84"
"Low hilly to hilly headlands on sandstones and granites; generally moderate side slopes and some steeper bluffs to the coastline marked by a narrow strip of dunes, also with some higher hills (trachyte) in places: chief soils are hard acidic yellow mottled and red soils (Dy3.41) and (Dr2.41) with some rock outcrops. Associated are (Uc1.2) soils on the beach dunes and deep (Uc2.2) soils of unit Ca10 backed up against, and drifting onto the headland area. A big range of soils covering small areas may occur locally. Occurs on sheet(s): 4"
"Tb85"
"Hilly dissected plateau with crests to 1800 1900 ft above sea level on phyllites, slates, and shales; convex hill crests and moderate side slopes to narrow creek flats; soils are shallow and gravelly on crests and moderately deep and gravelly on slopes: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated soils are (Um2.12) on crests and (Dr3.41) on upper slopes. Minor soil occurrences include (Um4.1) on crests, (Dr2.41) on slopes, and (Dr2.21) and (Gn3.11) on greenstone and andesite. As mapped, small areas of units Mf13 and Tb78 are included. Occurs on sheet(s): 4"
"Tb86"

"Low hilly to hilly plateau on phyllites, slates, and shales and ranging in elevation from 1700 to 2400 ft above sea level; broad convex hill crests with moderate side slopes to narrow valleys: chief soils are hard acidic yellow mottled (Dy3.41) and yellow (Dy2.41) soils. Associated are (Dr3.41) and (Dr2.41) soils on hill crests and slopes and (Gn3.74) soils on mid and lower slopes. Minor soil occurrences include: (Um2.12) soils on metasediments; (Uc2.12) soils on granite hill crests; (Db1.41) soils on dyke rocks; (Gn3.11) soils on andesites; (Gn3.81 and Gn3.84) soils on lower slopes; and (Gn3.54) soils on fans. Occurs on sheet(s): 4"
"Tb87"
"Gently undulating coastal plain less than 25 ft above sea level; tidal stream channels, broad low sandy sheets and banks, sluggish drainage lines, mud flats, and coastal dunes: chief soils are hard acidic yellow mottled (Dy3.41) and yellow (Dy2.41) soils. Associated are (Dy5.81) and (Dy5.21) soils on low sandy rises and sand sheets and (Uc5.11) soils on sandy rises. Minor soil occurrences include (Uc1.22) on fore-dunes; saline (Uf6) soils on mud flats; and (Ug5.16) and (Gn3.0) soils in depressions. Small inclusions of units Mb12 and JK1 seem likely. Occurs on sheet(s): 4"
"Tb88"
"Steep hilly to mountainous country on metasediments: chief soils are hard acidic yellow mottled soils (Dy3.41) with hard acidic red soils (Dr3.41) and (Dr2.41), all often stony. Associated are shallow loams (Um1.42) and (Um2.12) on the steeper slopes; (Dr2.21), (Dy2.21), and (Dy2.23) soils with smaller areas of (Uc1.21 and Uc1.23) on included granites; and (Uf6.41) and (Gn3.11) soils on included basic rocks. As mapped, small areas of units Tb90, Tb92, and Tb96 are included. Occurs on sheet(s): 4"
"Tb89"
"Steep hilly to mountainous country on metasediments as for unit Tb88 but containing considerable areas of plateau remnants of unit Mw25. Occurs on sheet(s): 4"
"Tb90"
"Low rounded hills: chief soils are hard acidic yellow mottled soils (Dy3.41) with hard acidic red soils (Dr3.41) on metasediments. Associated are: (Dr4.12 and Dr4.13), (Dy4.12 and Dy4.13), and (Db3.12 and Db3.13) soils on lithic parent materials; (Dy2.12), (Dy2.21 and Dy2.22), (Dy2.41), (Dr2.21 and Dr2.22), and (Dr2.41) soils on granites; (Uf6.31 and Uf6.34), (Gn3.12 and Gn3.13), and (Db1.12) soils on the sporadic occurrences of basic rock types; (Gn3.13) soils on limestones; and areas of unit Tb92 in valleys. As mapped, small areas of units Tb88 and Mw25 are included. Occurs on sheet(s): 4"
"Tb91"
"Gently rolling granitic terrain with slopes not exceeding 6 deg (etch basins in granite): chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are (Dy3.11), (Dy3.13), (Dy2.21), and (Dr2.21) soils and small areas of (Uc2.12) and (Um1.42) soils on sandy hill slope accumulations. As mapped, small areas of units Tb92, Tb90, and Tb88 are included. Occurs on sheet(s): 4"
"Tb92"
"Terraced valley plains: chief soils are hard acidic yellow mottled soils (Dy3.41) which occur on the third terrace with (Dr2.12) and (Dr2.21) soils closer to the stream course. Associated are (Db3.12) soils on the second terrace, (Dd3.12) soils characterizing the first terrace, and (Uc1.22) soils on sandy fan deposits which may transgress the terraces. As mapped, small areas of unit Tb91 are included. Occurs on sheet(s): 4"
"Tb93"
"Hilly area on limestones and other sediments and of greatly variable elevation from 1000 to 100 ft above sea level within 1 mile: chief soils on the more steeply sloping portions seem to be hard acidic yellow mottled soils (Dy3.41), with (Dy3.22) and (Dr3.41) soils as well. Associated on the relatively restricted flat sites are (Gn2.14), (Gn3.11), and shallow (Uf6.34) soils with (Gn3.92) soils on their lower slopes. Occurs on sheet(s): 4"
"Tb94"
"Low hilly areas at high elevation on the tops of ranges: chief soils are hard acidic yellow (Dy3.41) and red (Dr3.41) mottled soils. Occurs on sheet(s): 4"
"Tb95"
"A hilly area varying between 300 and 600 ft above sea level: chief soils seem to be hard acidic yellow mottled soils (Dy3.41) on the metasediment hill slopes together with small hill-top occurrences of (Gn3.11), (Gn3.14), and (Gn3.74) soils. Associated are shallow soils (Uf6.34) and (Ug5.12) together with some (Db1.23) soils on the basaltic lower hill slopes; (Ug5.16) and (Ug5.34) clays cover the narrow stream flats, with (Dy2.43) soils near the junction with the hill slopes. Occurs on sheet(s): 4"
"Tb96"
"Strongly dissected hills on metasediments varying in height from 200 to 600 ft above sea level: chief soils are hard acidic yellow and red mottled soils (Dy3.41) and (Dr3.41) with some shallow (Um6.43) soils. Associated are (Uf6.34) soils on crests, (Gn3.13) soils on upper slopes, and (Dr2.12) soils on lower slopes of the more basic rock types; (Dr2.13) and (Dy2.13) soils occur on granites with (Uc1.21) soils on local sand accumulations. As mapped, small areas of unit Tb88 are included. Occurs on sheet(s): 4"
"Tb97"

"Low rounded hills on metasediments and granites with slopes of not more than 6 deg: chief soils are hard acidic yellow mottled soils (Dy3.41) on the slopes with shallow (Um6.43) soils on some crests. Associated are (Dy2.21), (Dy2.11), and (Dy2.41) soils on granitic slopes with (Uc1.21 and Uc1.22) soils on sandy accumulations in some lower slope positions. Small areas of (Gn3.13) and (Uf6.31) soils are found on basic rocks. As mapped, small areas of units Tb99, Tb88, and Tb92 are included. Occurs on sheet(s): 4"
"Tb98"
"Gently rolling coastal region (less than 200 ft above sea level): chief soils are hard acidic yellow mottled soils (Dy3.41) with hard acidic red mottled soils (Dr3.41). Associated are (Dy3.41), (Dg4.41), and (Gn3.92) soils in the broad rather swampy depressions with (Ug5.17) soils in more sharply defined depressions. Small areas of other soils such as (Dr5.41), (Dr4.13), (Dd1.43), (Dy3.43), (Uc1.21), and (Uc1.22) are recorded. Occurs on sheet(s): 4"
"Tb99"
"Low-lying poorly drained coastal plains subject to flooding, lower and middle reaches of river flood-plains and some swamps: chief soils are hard acidic yellow mottled soils (Dy3.41) with various leached sands (Uc2.3). Associated soils include (Gn2.9), (Dr3.41), (Dy2.31), and (Gn2.74). As mapped, small areas of units B21, Tb22, Tb97, and Mb12 are included. Occurs on sheet(s): 4"
"Tb100"
"Undulating to rolling sandstone country with long gentle colluvial slopes: chief soils are hard acidic yellow mottled soils (Dy3.41) with some (Dg2.21), (Dr2.21), and (Dr2.41) soils. Associated are (Gn2.11 and Gn2.12) soils on old fill deposits on gentle slopes. Minor soil occurrences include (Gn3.73) and (Dy3.43). Occurs on sheet(s): 4"
"Tb101"
"Low to moderately hilly lands on sedimentary rocks; closely spaced hills of low relief with broad crests and short moderate slopes straight to incised drainage lines: chief soils are hard acidic yellow mottled soils (Dy3.41), often very gravelly. Associated are (Dr2.41), (Dr2.42), and (Dr2.21) with (Dy2.41 and Dy2.42) on mid slopes and spurs; (Uc2.12) soils on some gravelly crests; and (Dy2.43) soils on lower slopes and in drainage-ways. Occurs on sheet(s): 4"
"Tb102"
"Strongly hilly lands on granites; moderate to steep slopes running straight to V-valleys; crests generally narrow and ridgy, but some rounded; some rock outcrop: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are (Uc2.12) soils on crests and upper slopes and (Uc2.21) and (Dy3.81) soils on colluvium. Minor soil occurrences include (Dr2.11) and (Dr3.11) on ridges and (Dr2.41) and (Dr2.81) on colluvium. Occurs on sheet(s): 4"
"Tb103"
"Low to moderately hilly lands on phyllites and schists; a close pattern of hills with short to moderate slopes: chief soils are gravelly hard acidic yellow mottled soils (Dy3.41) and (Dy2.41) with shallow gravelly loamy soils (Um2.12) and (Um4.1) on crests and upper slopes. Associated are gravelly (Dr3.41) soils. Minor soil occurrences include (Gn3.42). Occurs on sheet(s): 4"
"Tb104"
"Strongly rolling terrain on deeply weathered sediments generally grading down to gently sloping areas but with some low (2-10 ft) scarps: chief soils are hard acidic yellow mottled soils (Dy3 41). Associated are: (Um5.51), (Um2.12), (Um4.12), and (Uc2.12) soils on gravelly crests and knolls; (Gn2.11). (Dr2.41), and (Dr3.41) on some slopes and shoulders; and (Dy3.43) and (Dy2.43) soils in depressions and flats. Minor soil occurrences include (Db1.43) and (Gn2.12). Occurs on sheet(s): 4"
"Tb105"
"Gently rolling to low hilly granitic country: chief soils are hard acidic yellow mottled soils (Dy3.41) Associated are (Dr2.41) and (Dr2.61) soils on mid slopes and (Um2.12) soils on crests. Minor soil occurrences include (Db1.4). Occurs on sheet(s): 4"
"Tb106"
"Dissected plateau with low hilly relief, many shallow valleys with long gentle slopes; some mesas: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are (Dy2.41), (Dg2.41), (Dr2.41), (Dy2.21), (Dy3.21), and (Dy3.43) soils. Minor soil occurrences include (Uc2.12) and (Um2.12) on crests; (Um6.22) soils; and (Gn2.94) and (Gn2.21) soils. Generally the soil cover is about 3 ft thick and overlies mottled rock and laterite. Occurs on sheet(s): 4"
"Tb107"
"Low hilly valleys below old laterite surface: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are gravelly (Uc2.12) and (Um2.12) soils on rises; and various (Dy), (Db), and (Dr) soils in the lower parts of the valleys; some (Gn2.11) soils. Occurs on sheet(s): 4"
"Tb108"
"Low hilly to rolling topography with narrow to moderately wide valleys: hard acidic yellow mottled soils (Dy3.41) on the wider plains are associated with various cracking clays (Ug5) on hill slopes and red earth soils (Gn3.1) and (Gn2.1) on the areas of rolling relief. Other soil occurrences include (Dy3.42 and Dy3.43) on slopes

and ridges and (Ug5) clays in some valleys. Small areas of unit Mz5 are included also. Data are limited for this diverse area. Occurs on sheet(s): 4"
"Tb109"
"Undulating plains to gently rolling lands on freshwater sediments, sandstones, and volcanic rocks; mainly very gentle slopes: chief soils are hard acidic yellow mottled soils (Dy3.41) with (Dy2.41). Associated are: (Gn2.1 and Gn2.2) soils with ironstone gravels on the plain and on elevated remnants; (Dr2.41) soils on upper slopes; (Dy3.43) and (Dy2.43) soils on lower slopes; and variable areas of (Gn3.2) and (Gn3.42) soils throughout. Minor soil occurrences include (Um2) and (Um4.2) on crests; (Gn3.43) and (Ug5.15) on alluvial flats; and some (Ug5.12) on slopes. Occurs on sheet(s): 4"
"Tb110"
"Low hilly to rolling country with low (5-15 ft) mottled rock scarps to stripped lateritic mesas, or with their crests bevelled; long gentle slopes below scarps and crests; derived from lateritized sandstones with shaly layers and overlying a granitic complex: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are: (Dy3.42) soils on lower slopes; (Db1.43) soils in depressions; (Uc2.12) soils on crests; and (Gn2.1) and (Gn2.24) soils on slopes. Minor soil occurrences include (Dr2.41) and (Dy3.81). Occurs on sheet(s): 4"
"Tb111"
"Low hilly country as for unit Tb110 but with appreciable areas of unit Mm12 soils on smooth rounded slopes. Occurs on sheet(s): 4"
"Tb112"
"Low hilly country as for unit Tb110 but with appreciable areas of unit Mz9 where mesas are more evident. Occurs on sheet(s): 4"
"Tb113"
"Elevated strongly undulating or occasionally low hilly lands, often bounded by steep dissected scarps; rock outcrop is common on higher landscape sites: dominant are fairly shallow (18-30 in.) often stony loamy duplex soils (Dy3.41) and (Dy3.21), with associated similar (Dy2) soils. Also occurring are areas of loamy red duplex soils (Dr2.12), (Dr2.11), and mottled brown duplex soils (Db2.21). Throughout the unit are small areas of shallow stony loams (Um1.43) and (Um2.12). Occurs on sheet(s): 4"
"Tb114"
"Low hilly or strongly undulating lands: dominant are shallow loamy duplex soils (Dy3.41) that have stony A horizons, but mostly stone-free clay B horizons. Associated are (Dy3.42) and similar (Dy2) soils. On the stony steeper hills occur shallow loams (Um2.12), occasionally (Um1.42). Occurs on sheet(s): 4"
"Tb115"
"Low hilly or strongly undulating lands mostly occupying broad dissected valleys surrounded by or marginal to high hilly or mountainous areas; rock outcrop is common: dominant are shallow stony loamy duplex soils, chiefly (Dy3.41), but with associated (Dy3.31), (Dy3.21), (Dy3.42), (Db2.21), and (Dr2.21) soils. On some higher sites there are small areas of friable earths (Gn3.24) and (Gn3.14). Small alluvial stream flood-plains have deeper loamy duplex soils (Dy3.42). Occurs on sheet(s): 4"
"Tb116"
"Moderate to strongly undulating lands with some hilly areas: dominant are loamy duplex soils (Dy3.41) of moderate depth (2436 in.) that are often stony. Closely associated are other duplex soils (Dy3.42) and (Dy3.31) and similar (Dy2), (Db1), and (Db2) soils. The hilly areas often have friable earths (Gn3.24), (Gn3.21), and (Gn3.14) and areas of shallow stony loams (Um1.43) and (Um2.12). Associated small alluvial flood-plains have deeper loamy duplex soils (Dy3.42 and Dy3.43). Where adjacent to the coast the unit grades into salt pans and mangrove swamps. Occurs on sheet(s): 4"
"Tb117"
"Gently undulating plains: dominant are loamy duplex soils (Dy3.41) with moderately deep (10-12 in.) sandy or loamy A horizons. Weathered rock normally occurs at 36 40 in. Associated are (Dy3.42) and similar (Dy2) soils together with small areas of red loamy duplex soils (Dr2.41). Occurs on sheet(s): 4"
"Tb118"
"Gently undulating plains with some broad low rises: dominant are loamy duplex soils (Dy3.41) with deep to moderately deep (10 20 in.) sandy or loamy A horizons overlying strongly mottled grey, red, or yellow-brown very acid clays. A nodular laterite horizon may be present above the clay (Dy3.84). Similar (Dy5.41), (Dy5.84), and (Dy2.41) soils also occur. In some areas coarse sands are underlain by an indurated pan at moderate depths (Uc2.34). Occurs on sheet(s): 4"
"Tb119"
"Undulating to strongly undulating lands with many low sandstone mesas, lateritic scarps, and their dissected remnants: the dominant soils are probably those on higher sloping sites where very pale grey loamy duplex soils (Dy3.41) occur, associated with (Dy3.42) and similar (Dy2) soils. On the low dissected kaolinized sandstone mesas and pallid-zone scarps shallow stony sands (Uc2.12) are common associated with very pale sandy or loamy duplex soils (Dy3.41), (Dy2.41), (Dg4.41), and (Dg2.81). Some more extensive level plains or plateau surfaces have

loamy yellow earths (Gn2.21 and Gn2.25) with lesser areas of loamy red earths (Gn2.11 and Gn2.12). Throughout the unit adjacent to drainage lines are small plains of alkaline loamy duplex soils (Dy2.43) and (Dy3.43), and included in the unit as mapped are small inclusions of unit Cd14. Occurs on sheet(s): 4"
"Tb120"
"High hilly or mountainous lands with steep slopes; rock outcrop is very common: a complex range of shallow stony soils is present, the chief forms are (Dy3.41) and (Dy3.21), with (Dy3.42) more common on lower slopes and small alluvial plains fringing streams. On more basic rocks red loamy duplex soils (Dr2.41), (Dr2.21), and (Dr2.12) are prominent. On higher and more stony sites very shallow sands (Uc2.22) and (Uc5.11) and loams (Um2.12) and (Um4.1) are very common. In some low hilly areas shallow stony earths may occur, chiefly (Gn2.14) and (Gn3.14). Data are fairly limited. Occurs on sheet(s): 4"
"Tb121"
"Dissected land on metasediments, generally hilly but with remnants of other land surfaces as platforms, flats, and pans: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are shallow gravelly (Dr2.41) and (Um2.12) soils on slopes; (Gn2.14) soils on fans; and (Gn2.92) and (Gn3.04) soils on flats. Inclusions of small areas of many other soils are a feature. Areas of unit Tb122 are included in places. Occurs on sheet(s): 4"
"Tb122"
"Rolling to low hilly land on metasediments with gentle to moderate side slopes passing to undulating flats and fans: chief soils are shallow gravelly hard acidic yellow mottled soils (Dy3.41). Associated are (Gn3.02) and (Dy2.42) soils on the flats and fans and shallow gravelly (Dr3.41) soils on slopes. Small areas of many other soils occur also. Occurs on sheet(s): 4"
"Tb123"
"Rough low hilly terrain generally on metasediments; narrow crests of hills and ridges with gentle to moderate side slopes to narrow alluvial flats: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are shallow gravelly (Um2.21) soils on crests and slopes. Minor soil occurrences include (Dr3.41), (Um2.12), (Gn2.91), (Dy3.42), and (Gn2.14). Occurs on sheet(s): 4"
"Tb124"
"Generally rolling terrain but including some low granitic rises: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are important areas of (Gn2.24) soils, some with clay D horizons, on the sandy fans; and (Uc2.22) soils on terraces. Minor soil occurrences include (Dy5.81), (Dy3.81), and (Gn2.94). Occurs on sheet(s): 4"
"Tb125"
"Undulating to gently rolling terrain of trachyte rises and debris slopes with trachyte plugs rising abruptly to 500 ft above the general level; some bare rock outcrops; some minor creek flats are included: chief soils are hard acidic yellow mottled soils (Dy3.41) and (Dy3.31) on the low hills and the lower to middle parts of their debris aprons. Associated are (Dy2.41) and (Db2.13) soils on the banks and (Gn3.01 and Gn3.06) soils in the depressions of gilgai formations along the debris fringe; and (Um4.1) soils on the crests of rises and upper debris slopes. Minor soil occurrences include (Um4.2), (Gn2.34), (Gn2.74), and (Dd1.31). As mapped, small plains of unit Kf7 are included locally. Occurs on sheet(s): 4"
"Tb126"
"Low hilly terrain on phyllitic rocks with some schists: chief soils are hard acidic yellow mottled soils (Dy3.41) with some (Dr3.41); deep gravelly A horizons 20 30 in. thick are a feature. Associated are (Um2.12) soils, often gravelly, on crests and upper slopes, and (Dy2.42) and (Dr3.42) soils on mid and lower slopes. Minor soil occurrences include: (Dy2.43) on alluvial flats; (Dr2.22) on diorite and gabbro dykes; (Uc2.12) on cherts; and (Dy3.82) on basal slopes and fans. Occurs on sheet(s): 4"
"Tb127"
"Low to moderately hilly lands on metamorphic rocks; significant areas of colluvial slopes, fringing fans, and narrow valley plains; ridge crests are sharp with short moderate slopes; some rock outcrop: chief soils are hard acidic yellow and red mottled soils (Dy3.41) and (Dr3.41) on mid and lower slopes. Associated are (Um2.12), (Um4.2), and (Uc2.12) soils on ridges and upper slopes and (Dy3.43) soils on colluvial slopes, fans, and valley plains. Minor soil occurrences include (Dy2.43) and (Dr2.22). Occurs on sheet(s): 4"
"Tb128"
"Low hilly terrain on metamorphic rocks with some higher stony ridges and hills; some rock outcrop: chief soils on the crests and upper slopes are hard acidic yellow mottled soils (Dy3.41). Associated are (Dy3.43), (Dy2.43), and (Db1.43) soils on lower slopes; (Uc4.11) and (Uc2.12) soils on ridges; and (Dy5.41) and (Dy5.81) soils on broad rises and slopes. Minor soil occurrences include (Dr2.21), (Dr2.22), (Dr2.42), and (Dr3.42) on upper slopes. Occurs on sheet(s): 4"
"Tb129"
"Gently sloping and undulating outwash plain: the dominant soils are hard sandy acidic yellow mottled and yellow soils (Dy3.41) and (Dy2.41) with hard-pan formation below the solum. Associated are (Dy5.41) and (Dy5.81) soils

on sand areas and (Dy3.43) soils in depressions. Minor soil occurrences include (Dd1.43) in small seasonal swamps. As mapped, there are inclusions of units Mw29 and Cd21. Occurs on sheet(s): 4"
"Tb130"
"Generally low hilly areas on granitic rocks: the dominant soils seem to be gravelly hard acidic yellow mottled soils (Dy3.41). Associated are (Uc2.12) soils on steeper bouldery slopes; (Dy2.41) soils on fans; and (Dr2.11) on broad convex rises. Minor soil occurrences include (Uf6.41) in basin fills and (Dr4.61) on terraces. Occurs on sheet(s): 4"
"Tb131"
"Strongly rolling to convex low hilly lands on granite: little rock outcrop: chief soils are hard acidic yellow mottled soils (Dy3.41). Associated are: (Dy2.41) soils on some crests; (Dg2.41) soils on some crests; (Dg2.42) soils in depressions; (Dd1.21) and (Uf6.41) in wet depressions; and (Dy3.81) and (Dg2.81) soils on lower slopes. Minor soil occurrences include (Uc2.12) and (Dr2.11). Occurs on sheet(s): 4"
"Tb132"
"Strongly undulating plain with seasonally wet depressions and entrenched streams: chief soils on crests, upper slopes, and rises generally are hard acidic yellow mottled soils (Dy3.41) with (Dy2.41). Associated are (Dg2.41) soils on lower slopes grading to depressions and (Dg2.43) and (Dg2.83) soils in depressions. Minor soil occurrences include (Gn2.14), (Gn2.34), and (Dr2.2) on levees and terraces and (Dd2.43) soils on flats behind levees. Occurs on sheet(s): 4"
"Tb133"
"Low rolling hills and spurs of hard acidic yellow mottled soils (Dy3.41) with (Dy3.42) on some spurs and (Dy3.43) on lower slopes. Associated are (Um4) and (Um5) soils on crests and upper slopes. Minor soil occurrences include (Uc1.2) on foot-slopes; (Dr2.12) on rises; and (Ug5) and (Dy2.43) soils in alluvial sites. Occurs on sheet(s): 4"
"Tb134"
"Strongly undulating to hilly lands on greywacke, siltstones, and sandstones with rock outcrops, and interspersed with gently sloping to flat-floored valleys of variable size and extent: soil dominance varies markedly between the valleys and the hilly portions. Chief soils of the basal hill slopes and the valleys are hard acidic, and also neutral, yellow mottled soils (Dy3.41 and Dy3.42), sometimes with (Dy3.43) and usually in association with yellow and grey earths such as (Gn2.24) and (Gn2.95). Chief soils of the hill slopes are shallow stony and gravelly loams (Um4.1), (Um1.4) and sands (Uc4.1), (Uc2.12), in association with variable areas of stony and gravelly (D) soils such as (Dr2.21), (K-Dy2.21), and (Dr2.51) and yellow earths such as (Gn2.34) and (Gn2.74). Small areas of other soils, such as (Gn2.1), occur on included andesites and dolerite sills. Occurs on sheet(s): 8"
"Tb135"
"Gently sloping plains traversed by numerous creeks; occasional low dunes may occur near the coast: dominant soils are probably acidic yellow mottled duplex soils (Dy3.41), with similar neutral (Dy3.42) and probably alkaline (Dy3.43) soils occurring nearer the coastal margins. Commonly associated are loamy and sandy mottled grey earths (Gn2.81) and (Gn2.94), mottled yellow earths (Gn2.62, Gn2.64, and Gn2.61), and massive yellow mottled duplex soils (Dy3.81). Adjacent to stream channels are loamy brown earths (Gn2.42) and red earths (Gn2.12, Gn2.15). Small isolated areas of heavy grey clay soils (Ug5.2) and (Ug5.5) probably occur near the coastal margins associated with salt pans. Various deep (Uc) soils occur on the near coastal dunes and on some creek levees. Data are limited. Occurs on sheet(s): 7,8"
"Tb136"
"Moderately undulating lands with some low hilly to hilly areas; much rock outcrop occurs on higher slopes: dominant are shallow to moderately deep loamy duplex soils (Dy3.41), with lesser (Dy3.31) and (Dy3.42) and similar (Db2) and (Dy2) soils. Shallow gravelly sands (Uc4.21) and loams (Um4.2) occur on higher slopes; the sands may be locally dominant in areas of higher relief. The unit may also include some small lateritic mesas with loamy red earths (Gn2.11) on the crests and shallow gravelly loams (Um5.2) on the scarps. Data are limited. Occurs on sheet(s): 7"
"Tb137"
"Very gently undulating alluvial coastal plains rising to gentle outwash slopes and low foothills; the plains merge into salt pans and mangrove swamps to seaward: dominant are deep loamy duplex soils (Dy3.41), but other duplex soils (Dy3.21), (Dy2.41), and (Dy3.81) and mottled grey (Gn2.94) or yellow (Gn2.74) earths are associated. Loamy red or yellow earths (Gn2.14) and (Gn2.24) are common on the gentle outwash slopes, and friable earths (Gn3.14), (Gn3.74), and (Gn3.84) of unit Mj1O occur on the low foothills. A range of loamy earths, chiefly (Gn2.14), (Gn2.44), and (Gn2.24), occur on the levees of numerous small streams traversing the plains. Some low stranded beach ridges of unit AA15 may also be included in the unit. Occurs on sheet(s): 7"
"Tb138"
"Moderately to strongly undulating lands rising to low foothills at the margins of the unit: dominant are moderately deep to deep loamy duplex soils (Dy3.41) but other loamy duplex soils, chiefly (Dr3.21) and (Dr2.21) but with some (Dy3.31) and (Dy3.21), are common. Some loamy red or yellow earths (Gn2.14) and (Gn2.24) occur on

higher slopes and outwash fans. Deep friable earths (Gn3.74), (Gn3.84), and occasionally (Gn3.14) are common where the unit adjoins unit Mf17. Small areas of deep dark cracking clays (Ug5.13, Ug5.15) on basalt or alluvium derived from basalt also occur. Small lateritic mesa remnants of units Mr14 and Mw44 are also included. Occurs on sheet(s): 7"
"Tb139"
"Alluvial plains with some gently sloping marginal outwash slopes: dominant are deep loamy or silty mottled duplex soils (Dy3.41), with lesser (Dy2.41), (Dy3.42), and (Dy2.42). Loamy earths (Gn2.14), (Gn2.24), and (Gn2.44) are common on the narrow stream levees and the small areas of included outwash slopes and fans. Occurs on sheet(s): 7"
"Tb140"
"Undulating lands with some strongly undulating to low hilly areas: dominant are shallow to moderately deep loamy mottled duplex soils (Dy3.41). In very close association are other loamy duplex soils (Dr3.21), (Dr3.41), (Dr2.41), (Dy3.42), (Dy3.85), and (Dy2.41) and (Db) equivalents. Shallow gravelly loams (Um4.12), (Um4.23), and (Um2.12) and lesser sands (Uc4.12) are common on the low hilly areas. A range of loamy earths including (Gn2.14), (Gn2.24, Gn2.25), and (Gn2.75) occur on the gentle outwash slopes and fans. Alkaline loamy duplex soils (Dy3.43), (Dy2.23), and (Dr2.23) are common on the alluvium of the minor streams. Occurs on sheet(s): 7"
"Tb141"
"Low hilly to hilly lands with fairly short steep slopes; sedimentary rock outcrop is common on ridge crests and higher slopes with much detrital gravel on the surface and through the A horizons of the soils: dominant are shallow loamy duplex soils (Dy3.41). Major and minor associated soils are similar to those of unit Tb140 but with a greater proportion of shallow gravelly loams. Occurs on sheet(s): 7"
"Tb142"
"Level alluvial plains: dominant are moderately deep-surfaced loamy duplex soils (Dy3.41), with lesser (Dy3.11). The A-B horizon boundary is clear rather than abrupt. Also associated are slightly gilgaied brown friable earths (Gn3.51) and (Gn3.71, Gn3.74) and mottled bleached grey earths (Gn2.94) or yellow earths (Gn2.74). Occurs on sheet(s): 7"
"Tb143"
"Undulating lands with some isolated low hills; small alluvial plains occur adjacent to larger streams: dominant are moderately deep loamy duplex soils (Dy3.41), usually with a clear rather than abrupt change to the friable yellow clay B horizons. Associated are other similar duplex soils (Dy2.41), (Dy3.21), (Dr2.41), and (Dr2.21) and some loamy yellow earths (Gn2.64) and (Gn2.24). The low hills have shallow stony duplex soils (Dy3.41) and (Dr2.41) and shallow stony loams (Um2.12) and (Um2.21). The small alluvial plains have deep duplex soils (Dy3.41, Dy3.42, and Dy3.43) with some small levees of red earths (Gn2.14). Occurs on sheet(s): 7"
"Tb144"
"Alluvial near-coastal plains: dominant are loamy mottled yellow duplex soils (Dy3.41), usually with a clear rather than abrupt A-B horizon boundary. Nearer the coast similar neutral (Dy3.42) and (Dy3.82), and probably alkaline, duplex soils occur. Chief associated soils are the bleached mottled yellow or grey earths of unit Mb18, which occur on low rises throughout the plain. Adjacent to streams small levees with red earths (Gn2.14) are common. Near the coast the unit merges into the salt pans of unit Jb1. Occurs on sheet(s): 7"
"Tb145"
"Low hilly or hilly lands with some granite outcrop: dominant soils are shallow to moderately deep loamy mottled duplex soils (Dy3.41), with lesser (Dy2.41) and (Dy2.21) soils. On steeper sites Fitty stony loams (Um4.23) or sands (Uc4.21) occur, and occasionally shallow red earths (Gn2.14). Included in the unit are small strongly undulating areas of deep sands (Uc2.32, Uc2.33) or deep sandy bleached grey earths (Gn2.94). Data are fairly limited. Occurs on sheet(s): 7"
"Tc1"
"Hilly to steep hilly, small valley plains: hard acidic yellow mottled soils (Dy3.61) with shallow grey-brown sandy soils (Uc6.11) and rock outcrops in association with variable areas of (Dy3.41 and Dy3.42), (Dy3.22),[Dy2.21 - errata], (Dr2.12 and Dr2.22) on hills and hill slopes, and minor areas of (Dy3.61) containing ironstone gravel in the A horizons on some ridge tops; unclassified alluvial soils, peats (O), and acid swamp soils (O) in the wetter valleys. There are also pockets of many other soils such as red friable earths (Gn4.11) and (Gn3.12) through the hills. Occurs on sheet(s): 1"
"Tc2"
"Hilly with some small enclosed plains: hard acidic yellow mottled soils (Dy3.61) with shallow grey-brown sandy soils (Uc6.11), rock outcrops, and smaller areas of (Dy3.22), and (Dy5.61) on hills and hill slopes, also small areas of (Dy3.61) containing ironstone gravel on some ridge tops; leached sands (Uc2.2), sandy yellow mottled soils (Dy5.4 and Dy5.8), and hard yellow mottled soils (Dy3.4 and Dy3.8) in plains and valleys. There are also pockets of other soils (undescribed) through the hills. Occurs on sheet(s): 1"
"Tc3"

"Hilly, dissected tablelands: hard acidic yellow mottled soils (Dy3.61) and (Dy3.41) with shallow grey-brown sandy soils (Uc6.11) and rock outcrops and smaller areas of (Dr2.22) on hills and hill slopes; (Dy3.61) containing ironstone gravel in the A horizon on tableland remnants; with valley plains of (Dy3.4 and Dy3.8), (Dy5.4 and Dy5.8), and (Uc2.3). There are also pockets of other soils such as (Dr2.43) in special situations. Occurs on sheet(s): 1"
"Tc4"
"Undulating to low hilly areas of hard acidic yellow mottled soils (Dy3.61 and Dy3.41), some containing ironstone gravels, and other (D) soils including (Dy6.4); with some dunes of leached sands (Uc2.3); some swampy areas in low-lying situations. Occurs on sheet(s): 2"
"Tc5"
"Dissected plateau at low elevation of gently undulating to low hilly relief and characterized by extensive block laterite and lateritic (ironstone) gravels; some swamps: chief soils on slopes and undulating areas generally are hard acidic yellow mottled soils (Dy3.61) containing small to very large amounts of ironstone gravels. Associated are: (KS-Uc2.12), (KS-Uc2.2), and (Uc2.12) soils underlain by block laterite on the less dissected areas devoid of stream channels; acid grey earths (Gn2.94) sometimes containing ironstone gravels in shallow flat-bottomed valleys; (Uc2.32 and Uc2.33) soils on slopes below laterite-capped ridges and on flat areas at various levels (some areas have a clay substrate at depth); areas of unit MT8; small areas of (Dr2.61) soils containing ironstone gravels and often intimately associated with the (Dy3.61) soils; some (Gn2.22) soils containing ironstone gravels in colluvial sites; some (Dy) and (Uc2) soils in swamps; and minor areas of other soils. Occurs on sheet(s): 5"
"Tc6"
"Dissected lateritic plateau of hilly relief at moderate elevation: chief soils of the dissected hilly areas are hard acidic yellow mottled soils (Dy3.61), (Dy3.71), and (Dy3.81) with some hard acidic red mottled soils (Dr3.21) and brown earths (Gn2.45), all containing ironstone gravels; some (Um5.2) soils on major stream terraces. Associated are (Dy3.42), some (Dy3.43) and (Ug5) soils often with massive ironstone pavements, in the broad flat drainage-ways; and block laterite, gravelly and bouldery (Dy5.81) and (KS-Uc4.2) soils on the tops of rises and their colluvial slopes, together with some areas of leached sands (Uc2.3). Occurs on sheet(s): 5"
"Tc7"
"Knolls and hillocks--"islands"of (Dy) and (Gn) soils separated by swampy plains of (Uc) soils: chief soils of the knolls and hillocks are hard, and sandy, acidic yellow mottled soils (Dy3.61) and (Dy5.81) with some red earths (Gn2.15), all frequently containing ironstone gravels. Associated are leached sands (Uc2.2 and Uc2.3) of the swampy plains that vary in size from narrow drainage-ways to plains on which only a few hillocks occur. Occurs on sheet(s): 5"
"Td1"
"Dissected tableland: hard acidic yellow mottled soils containing ironstone gravels (Dy3.61) also (Dy5.61) and with very small areas of sandy acidic yellow mottled soils with laterite layer (Dy5.91) on the tableland remnants; hard and also sandy acidic yellow mottled soils (Dy3.41) and (Dy5.41) on the valley slopes; leached sands (Uc2.2 and Uc2.3), various organic soils (O), and alluvial soils (unclassified) in valley bottoms; leached sands (Uc2.2 and Uc2.3), sandy neutral and alkaline yellow mottled soils (Dy5.4) and (Dy5.8) also (Dy3.4), cracking grey clays (Ug5.2), and saline soils (unclassified) occur in small swamps associated with the headwaters of creeks. Occurs on sheet(s): 1"
"Td2"
"Dissected tableland: hard acidic yellow mottled soils containing ironstone gravels (Dy3.61) on the tableland remnants; hard acidic yellow mottled soils (Dy3.4) and hard neutral red soils (Dr2.22) also (Uc6.11) on the slopes; acid swamp soils (O) and leached sands (Uc2.2 and Uc2.3) with various alluvial soils (unclassified) in the small valley bottoms. Occurs on sheet(s): 1"
"Td3"
"Undulating to hilly: hard acidic yellow mottled soils containing ironstone gravels (Dy3.61), smaller areas (Dy5.61) and (Uc6.11) on hills and hill slopes; (Dy3.4), (Dy3.8), (Dy5.4), (Dy5.8) and also alluvial soils (unclassified) in the shallow valleys. Occurs on sheet(s): 1"
"Td4"
"Undulating land: hard acidic yellow mottled soils containing ironstone gravel (Dy3.61) and also (Dy5.61) with (Dy3.4), (Dy3.8), (Dy5.4), and (Dy5.8) on the relatively lower levels. Occurs on sheet(s): 1"
"Td5"
"Dissected tableland: hard acidic yellow mottled soils containing ironstone gravel (Dy3.61) in association with soft acidic and neutral yellow mottled soils containing ironstone gravel (Dy5.61 and Dy5.62); and smaller areas of (Dy5.8) and (Db2.2) on the tableland remnants; cracking grey clays (Ug5.2) and (Dy3.43) in shallow swampy situations on the tableland; various soils (unclassified) in the shallow valleys. Small areas of other soils (undescribed). Occurs on sheet(s): 1"
"Td6"

"Dissected tableland: hard acidic yellow mottled soils containing ironstone gravel (Dy3.6) in association with soft acidic yellow mottled soils containing ironstone gravel (Dy5.6) and small areas of (Dy5.91) on the tableland remnants; leached sands (Uc2.2 and Uc2.3) are common in relatively lower-lying situations. Small areas of other soils (undescribed). Occurs on sheet(s): 1"
"Tf1"
"Dissected granitic plateau at about 1000 ft above sea level, generally of hilly relief and with narrow stream valleys: chief soils are hard acidic yellow mottled soils (Dy3.81) and (Dy3.61) on crests and upper slopes. Associated are (Uc2.12) soils on crests and (Dy3.41) soils on mid to lower slopes and stream flats. Other soils include (Uc4.1) on crests and (Dg) and (Dd) along stream flats. Occurs on sheet(s): 4"
"Tf2"
"Generally low hilly land on granite with gentle to moderate slopes; open valleys with fairly wide alluvial flats: chief soils are hard acidic yellow mottled soils (Dy3.81) and (Dy3.71) on hill slopes and low ridge crests. Associated are (Uc2.12) and (Uc4.1) soils on hill crests and (Dy3.31) soils on lower slopes. Other soils include (Dy3.31), (Dy3.41), and (Dy3.42) on valley flats; (Gn2.91 and Gn2.94) on seasonally wet flats; and (Dy5.81) on some hill slopes. Occurs on sheet(s): 4"
"Tf3"
"Low hilly to hilly terrain that occupies a zone flanking unit JZ2. It comprises valleys that are frequently narrow and have short fairly steep pediments, along with breakaways, mesas, and occasional granite tors. Included also are undulating areas representing elements of unit JZ2: chief soils are hard acidic yellow mottled soils (Dy3.81) along with sandy acidic yellow mottled soils (Dy5.41) and (Dy5.81), all of which contain moderate to large amounts of ironstone gravels in their surface horizons. Ironstone gravels (KS-Uc4.2) occur on the ridge crests and on the fine gravel deposits of the gently undulating parts of the unit, along with leached sands (Uc2.21). Occurs on sheet(s): 5"
"Tf4"
"Low hilly to hilly portions of dissected lateritic plateau with gently undulating ridge crests and narrow incised valleys: chief soils are hard acidic yellow mottled soils (Dy3.81) and (Dy3.61) containing moderate to large amounts of ironstone gravel. Associated are (KS-Uc4.2) ironstone gravels and (Dy5.8) soils containing ironstone gravels on ridge crests; valley side slopes of the soils of unit Ub90; and (Uc2.21), sometimes with ironstone gravels and boulders in colluvial situations. As mapped, inclusions of adjoining units are likely. Occurs on sheet(s): 5"
"Tf5"
"Dissected lateritic plateau of a generally hilly relief: chief soils on the slopes are hard acidic, and also neutral, yellow mottled soils (Dy3.81 and Dy3.82), (Dy3.61 and Dy3.62) containing moderate to large amounts of ironstone gravels. Associated are block laterite, gravelly and bouldery (Dy5.81) and (KS-Uc4.2) soils on ridge tops; leached sands (Uc2.3), some on deposits containing water-worn stones; and small areas of soils of adjoining units. Occurs on sheet(s): 5"
"Tf6"
"Undulating to hilly portions of dissected lateritic plateau at moderate elevation: chief soils are hard acidic and neutral yellow mottled soils (Dy3.81 and Dy3.82), (Dy3.61 and Dy3.62) containing small to large amounts of ironstone gravels; possibly the (Dy3 .8) soils are more common in the eastern and the (Dy3.6) soils in the western portions. Associated are leached sands (Uc2.33) and sometimes (Dy5.42) soils in the flatter valleys; (Dy5.81) soils containing ironstone gravels adjacent to areas of unit Cd22, small areas of which are included also; small swampy areas of unit Cb43 soils; and valley side slopes of unit Ta9 soils where dissection is incised below the laterite. This unit merges with unit Cd22. Occurs on sheet(s): 5"
"Tf7"
"Flat and often swampy area: chief soils are hard acidic, and also neutral, yellow mottled soils (Dy3.81 and Dy3.82) in association with (Dy5.81) soils, all of which have some lateritic gravel at the junction of the A and B horizons. Other soils include leached sands (Uc2.21). Occurs on sheet(s): 5"
"Tf8"
"Very gently undulating alluvial plains: dominant are sandy duplex soils with massive sandy clay B horizons (Dy3.81); the A horizon depth varies from 8 to 20 in. Small areas of structured duplex soils (Dy3.41) occur in lower sites. Coarse sands (Uc2.34) overlying an ironstone pan at 24-30 in. are common on the low broad rises. Loamy red or brown earths (Gn2.14) and (Gn2.42) are common on the low stream levees. Occurs on sheet(s): 7"
"Tf9"
"Level plains: dominant are very deep mottled yellow-grey duplex soils (Dy3.81), with deep (15-30in.) A horizons and a clear boundary to the massive sandy clay loam B horizon. Associated are small areas of bleached yellow earths (Gn2.74) and (Gn2.34), and in lower sites loamy duplex soils (Dy3.41, Dy3.42). Small infilled sandy old stream channels have deep bleached sands (Uc2.21). Occurs on sheet(s): 7"
"Ti1"
"Hilly granitic country with moderate to gentle slopes to open valleys with narrow alluvial flats, but including some higher country with steep slopes: chief soils are hard acidic and neutral yellow mottled soils (Dy3.31 and

Dy3.32). Associated are (Uc2.12) soils on hill crests and (Dy2.21 and Dy2.22) soils on hill slopes. Other soils encountered are: (Uc4.1) on hill crests; (Dy3.81) on upper slopes; (Dr3.21) on slopes; (Dy3.41). (Dy3.42), and (Ug5.16) on creek flats; and (Gn3.92) on some stream levees. Occurs on sheet(s): 4"
"Ti2"
"Generally low hilly terrain on tonalite with significant alluvial flats--an erosion valley largely confined by its erosion scarp: chief soils are hard acidic yellow mottled soils (Dy3.31) on crests and slopes. Associated are (Dy2.11) soils on crests and slopes. Other soils include: (Dr2.11); (Gn3.14) soils on mica schists; (Gn3.91) on volcanic rocks; and (Gn2.91 and Gn2.94) on alluvial flats. Occurs on sheet(s): 4"
"Ti3"
"Rolling terrain of sandy and clayey alluvia over dissected sandstone--broad gently sloping flats and low convex rises with gentle slopes: chief soils are hard acidic yellow mottled soils (Dy3.3 1) and (Dy3.41) on slopes and better-drained flats. Associated are (Gn2.24), (Gn2.64), and (Gn2.74) soils on ridge crests and sand stringers with (Dg2.31) and (Dg4.81) soils on fairly wet flats. Minor soils include (Uc2.34) on sand stringers, (Dy5.81) and (Dy5.61) on flats, and small areas of a variety of other soils. Occurs on sheet(s): 4"
"Ti4"
"High hilly or hilly lands with some mountainous areas, steep slopes occur throughout; rock outcrop is usually common: dominant are sandy or loamy duplex soils (Dy3.31) and (Dy3.21) of shallow to moderate depth (2430 in.). The A horizons are normally stony but the clay B horizons are often stonefree. Associated are similar (Dy2) soils, some areas of red loamy duplex soils (Dr2.11), (Dr2.21), and (Dr2.41), and brown friable earths (Gn3.24 and Gn3.21). Throughout the unit are areas of shallow stony loams (Um1.43) and (Um2.12). Occurs on sheet(s): 4"
"Ti5"
"Strongly undulating or low hilly lands usually with much rock outcrop. A range of shallow stony sandy duplex soils occur, chiefly (Dy3.31) but with (Dy3.21), (Dy2.31), (Dy2.12), and (Dr2.12) all occurring locally. On higher more stony areas shallow gritty sands (Uc4.2) and (Uc5.11) are common. Data are fairly limited. Occurs on sheet(s): 4"
"Ti6"
"Very low-lying swampy lands subject to seasonal inundation: dominant are deep loamy duplex soils, chiefly (Dy3.31) with lesser (Dy3.41) and areas of gleyed duplex soils (Dg2.31) and (Dg2.41). Deep friable loams (Um6.34) of unit Gh1 occur on the slightly higher margins of the swamps and on low stream levees. Deep friable earths (Gn3.74), (Gn3.84), and (Gn3.34) occur where the unit lies adjacent to unit LN2. Occurs on sheet(s): 7"
"Ua1"
"Low rolling hills and small valleys with some steeper, broken hill chains: hard neutral yellow mottled soils (Dy3.22), shallow grey-brown sandy soils (Uc6.11), and outcropping rocks on the hills and with the two latter dominant in the more rugged situations; small areas of (Dy3.61), (Dd1.2)s (Dy2.22), (Gn3.12), and (Dr5.23) are encountered on the hills; (Dy3.43) and (Dy5.43) are common on lower hill slopes and in the small valleys but smaller areas of (Dy3.4 and Dy3.8) and (Dy5.4 and Dy5.8) occur too; variable alluvial soils (unclassified) occur on the present flood-plains of the streams. Occurs on sheet(s): 1"
"Ua2"
"Hilly to steep hilly: hard neutral yellow mottled soils (Dy3.22) and hard neutral red soils (Dr2.22) with shallow grey-brown sandy soils (Uc6.11) and outcropping rocks; variable alluvial soils (unclassified) in the valleys. Small areas of other soils such as (Uf6.11), (Um6.2), (Ug5.2) in special situations. Occurs on sheet(s): 1"
"Ua3"
"Plain: hard neutral yellow mottled soils (Dy3.22) with flints below the thin surface soils. Occurs on sheet(s): 1"
"Ua4"
"Low hilly to hilly terrain on andesite and related rocks with gentle to moderate often somewhat undulating side slopes and shallow open valleys: chief soils are hard neutral yellow mottled soils (Dy3.22) with hard neutral dark soils (Dd1.12) and (Dd1.22). Associates are (Db1.42), (Db1.32), and (Um6.21). Minor occurrences are (Gn3.12) and (Dr2.12) soils on ridge crests; (Db3.12) and (Gn3.42) soils on slopes; and (Gn2.91) and possibly (Ug5) soils on creek flats. As mapped, small areas of unit Gd5 may be included. Occurs on sheet(s): 4"
"Ua5"
"Low hilly granitic country with some rock outcrops near crests: chief soils are hard neutral mottled yellow soils (Dy3.22) with some (Dy3.42), (Dy2.22), and (Dy2.42) on crests and mid slopes. Associated are (Dy2.21) and (Dr2.11 and Dr2.12) soils on upper and mid slopes; and (Dy3.43) and (Dy2.43) soils on lower slopes. Occurs on sheet(s): 4"
"Ua6"
"Moderate to strongly undulating lands with some marginal low hilly areas: dominant are shallow (18-20 in.) gritty sandy or loamy duplex soils with 6 8 in. A horizons; stone is often present in the profile. The chief form is (Dy3.22). Closely associated are (Dy3.42) and (Dy2.42) soils and important areas of shallow stony (Dr2.21) soils. Higher ridges and low hills have much rock outcrop and shallow stony sands (Uc4.2) and loams (Um4.1). Lower

flatter slopes and valley floors in the unit have aLkaline loamy duplex soils (Dy3.43) and (Dy2.43). Occurs on sheet(s): 4"
"Ua7"
"Moderately to strongly undulating lands: moderately deep loamy duplex soils (Dy3.22) are probably dominant, but closely associated are a range of other duplex soils including (Dy3.42), (Dy3.43), (Dy2.42), (Dr2.32), (Dr2.42), (Dr3.42), and (Db1.43). Shallow sands (Uc4.21) and (Uc2.21) occur on some of the steeper rocky slopes. Included are occasional low basalt mesas with soils of unit Mo30. Occurs on sheet(s): 7"
"Ua8"
"Moderately to occasionally strongly undulating lands with some granite outcrop on higher ridge crests: dominant soils of the middle and upper slopes are sandy to loamy yellow duplex soils (Dy3.22) and (Dy2.22) of shallow to moderate depth and often with gravelly A horizons. On lower slopes and valley floors deeper alkaline soils (Dy3.43), (Db1.43), and (Db1.33) occur, often with a scalded surface. Higher ridge crests have shallow stony sands (Uc4.21, Uc4.22), (Uc3.21), and (Uc2.12). Gravelly red duplex soils (Dr2.22), (Dr2.12), and (Dr2.21) also occur on some upper slopes and flatter ridge crests. Occurs on sheet(s): 7"
"Ub1"
"Undulating: hard neutral yellow mottled soils (Dy3.42) with smaller areas of leached sands (Uc2.2 and Uc2.3); various alluvial soils (undescribed) in the stream valleys. Occurs on sheet(s): 1,2"
"Ub2"
"Undulating with remnants dissected tableland: hard neutral yellow mottled soils (Dy3.42) in association with a variety of soils including (Dy3.41), (Dy5.4), (Dy3.1), and (Dr4.1) on the undulating portions; (Dy3.61) and (Dy5.61) on the tableland remnants; various soils (undescribed) in swampy areas and along stream valleys. Occurs on sheet(s): 1"
"Ub3"
"Plain with dunes: hard neutral yellow mottled soils (Dy3.42) and related soils (undescribed) on plains with soft alkaline red soils (Dr4.13) on the limestone dunes. Other soils (undescribed) may occur also. Occurs on sheet(s): 1"
"Ub4"
"Rounded hills and hill slopes: hard neutral yellow mottled soils (Dy3.42 and Dy3.43) with (Dy3.82 and Dy3.83). Occurs on sheet(s): 1"
"Ub5"
"Hilly areas threaded with small valleys: shallow grey-brown sandy soils (Uc6.11) and small areas of (Dr2.22 and Dr2.23) also (Um6.21) and (Um5.41) on the hills and their upper slopes; hard neutral yellow mottled soils (Dy3.42 and Dy3.41) with (Dy3.82 and Dy3.81) on the hill slopes and in the valleys; some alluvial soils (undescribed) in the stream valleys. Occurs on sheet(s): 1"
"Ub6"
"Hilly areas threaded with small valleys: shallow grey-brown sandy soils (Uc6.11) and small areas of (Dy3.22) and (Dy3.61) on the hills and their upper slopes; hard neutral yellow mottled soils (Dy3.42 and Dy3.43) with (Dy3.82) and (Dy3.83) on the hill slopes and in the valleys; some alluvial soils (undescribed) in the stream valleys. Occurs on sheet(s): 1"
"Ub7"
"Hilly: hard neutral yellow mottled soils (Dy3.42, also Dy3.43) with (Dy3.8) and (Dy5.4) and small areas (Dr2.23) on the hills and their slopes; hard acidic yellow mottled soils containing ironstone gravels (Dy3.61) on ridge tops; (Dy3.43), (Dy5.43), and saline soils (unclassified) in the shallow valleys. Occurs on sheet(s): 1"
"Ub8"
"Undulating: hard neutral yellow mottled soils (Dy3.42 and Dy3.43) with (Dy3.8) and (Dy5.4) and small areas of (Dy3.61) on ridge tops; saline soils (unclassified) in the shallow valleys. Small areas of other soils (undescribed). Occurs on sheet(s): 1"
"Ub9"
"River terraces and valley plains; gently sloping river terraces of hard neutral yellow mottled soils (Dy3.42) in association with hard alkaline red soils (Dr2.13) and other (D) soils unclassified; small valley plains of dark cracking clays (Ug5.16) where the stream is incised and (Ug6.1) in poorly drained areas. Occurs on sheet(s): 2"
"Ub10"
"Gentle to steep slopes separated by benches and traversed by narrow valley plains: slopes and valley sides of hard neutral yellow mottled soils (Dy3.42) in association with (Dy3.43) and other soils, including (Gn) soils; flat to undulating benches of hard acidic yellow mottled soils (Dy3.41) in association with (Dy3.42 and Dy3.43) and (Dy5.61); narrow stream valleys of dark cracking clays (Ug5.16) and (Ug6.1); minor areas of dunes or sand sheets of leached sands (Uc4.31) and (Uc3.31). Occurs on sheet(s): 2"
"Ub11"

"Coastal plains: plains of hard neutral yellow mottled soils (Dy3.42) in association with (Dy3.43), (Dy3.12), (Ug5.16), and (Uc2.33); some saline flats and marshes with undescribed soils, fringed in places along the coast by dunes, as for unit A8. Occurs on sheet(s): 2"
"Ub12"
"Narrow valleys flanked by rounded hills: terrace remnants and lower hill slopes of hard neutral yellow mottled soils (Dy3.42) in association with (Dy3.43 and Dy3.41) and (Ug5.16 and Ug5.15), some minor areas of (Dy3.23), (Dy3.13), (Db1.22 and Db2.22), and (Dy5.42 and Dy5.43); some sand dunes and sand sheets of leached sands (Uc4.31 and Uc3.31) and (Uc2.33); some loessial sheets of hard neutral and alkaline red soils (Dr2.12 and Dr2.13); floodplains and alluvial fans of a variety of soils, including (Ug5.16), (Um6), and others unclassified; flanked by rounded hills of soils as for unit Qa1. Occurs on sheet(s): 2"
"Ub13"
"Narrow valleys flanked by hills: as for unit Ub12 but flanking hills bong to unit Wd4. Occurs on sheet(s): 2"
"Ub14"
"Narrow valleys flanked by rounded hills and low plateau remnants: as for unit Ub1 2 plus significant areas of unit Ab1 along the lower portions of the flanking hills. Occurs on sheet(s): 2"
"Ub15"
"Alluvial basins of subdued relief surrounded by hilly areas: terrace remnants and basin plains of hard neutral yellow mottled soils (Dy3.42) in association with (Dy3.43 and Dy3.41); small floodplains of dark cracking clays (Ug5.16 and Ug5.15); some sandy rises of sandy alkaline, and neutral, yellow mottled soils (Dy5.43 and Dy5.42) and leached sands (Uc2.3) with clay layers bow solum, also some areas of siliceous sand (Uc1.2); surrounded by gently to steeply sloping hilly areas of sand soils (Uc5.31), hard neutral red soils (Dr2.12), hard neutral brown soils (Db2.42). Occurs on sheet(s): 2"
"Ub16"
"Alluvial basins of subdued relief surrounded by hilly areas: basin areas as for Ub15 but (i) with lakes and (ii) surrounded by gently to steeply sloping hilly areas of sandy acidic yellow mottled soils (Dy5.81), and hard alkaline yellow mottled soils (Dy3.13 and Dv3.23) especially on lower. Occurs on sheet(s): 2"
"Ub17"
"Alluvial basins of subdued relief surrounded by hilly areas: basin areas as for Ub16 but (i) with lakes in which organic (o) soils, normally submerged, occur and (ii) surrounded by hilly areas of sandy acidic yellow mottled soils (Dy5.41) and other (D) soils, including (Dy3.23 and Dy3.13) and (Dr2.12); also with some areas of siliceous sand (Uc1.2). Occurs on sheet(s): 2"
"Ub18"
"Alluvial basins of subdued relief surrounded by hilly areas: basin areas as for Ub15 but with hilly areas of yellow leached earths (Gn3.94), hard acidic yellow mottled soils (Dy3.21 and Dy3.41); with some minor areas of siliceous sands (Uc1.2) ill various situations. Occurs on sheet(s): 2"
"Ub19"
"Alluvial basins of subdued relief surrounded by hilly areas: basin areas as for Ub15 but with hilly areas of hard neutral and alkaline red soils (Dr2.12 and Dr2.13), smaller areas of sandy acidic yellow mottled soils (Dy5.41); also with some areas of siliceous sands (Uc1.2). Occurs on sheet(s): 2"
"Ub20"
"Plains with swampy areas: plains of hard neutral yellow mottled soils (Dy3.42) with undescribed soils in the lower-lying swampy situations, some of which are saline. Occurs on sheet(s): 2"
"Ub21"
"Plains with dunes and alluvial flats: plains of hard neutral yellow mottled soils (Dy3.42) with alluvial flats of undescribed soils; dunes of leached sands (Uc2.2 and Uc2.3); beach dunes of siliceous sands (Uc1.1); some swampy areas; and small basaltic areas of undescribed soils. Occurs on sheet(s): 2"
"Ub22"
"Undulating with broad valley plains: lower hill slopes of hard neutral yellow mottled soils (Dy3.42) possibly with small areas of (Dy3.43 and Dy3.41); broad valley plains liable to flooding of (Dy3.4), (Gn), and (Um) soils. Occurs on sheet(s): 2"
"Ub23"
"Undulating to low hilly, somewhat broken terrain of hard neutral yellow mottled soils (Dy3.42) on hills and slopes with other undescribed soils in small valley plains; small areas of other soils, such as (Gn) soils, in localized situations. Occurs on sheet(s): 2"
"Ub24"
"Gently sloping, undulating, apron plains With some swamps, small stream valleys, and occasional low hills: undulating plains of hard neutral yellow mottled soils (Dy3.42) with hard alkaline yellow mottled soils (Dy3.43) in the relatively lower areas and also occasional small areas of (Dr2) soils on low rises; and with gilgai microassociations of gley cracking clays (Ug5.2) and hard alkaline yellow mottled soils (Dy3.33 and Dy3.43) in flat areas subject to flooding; some low hills of unit Qc1 are included also. Occurs on sheet(s): 2"

"Ub25"
"Plain: apron plain of hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43) with smaller areas of hard alkaline red soils (Dr2.33), some gilgais, traversed by small stream valleys of undescribed soils. Occurs on sheet(s): 2"
"Ub26"
"Undulating area of hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43), possibly with some areas of cracking clays (Ug5.1 and Ug5.2); layering of soil materials is evident ill places bow the sola of present-day soils and includes sandy ironstone and grey billy; occasional dunes of leached sands (Uc2.2) in the vicinity of coastal plains. Occurs on sheet(s): 2"
"Ub27"
"Low hilly areas with valley plains: hill crests and upper slopes of hard acidic yellow mottled soils (Dy3.41) in association with loamy soils (Um4.2 and Um5.41) and shallow grey-brown sandy soils (Uc6.11); middle and lower hill slopes of hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43); narrow valley plains of (Dy3.4) soils and broad valley plains of various soils including (Dy3.81) and (Dy4.21). Occurs on sheet(s): 2"
"Ub28"
"Undulating: long gentle to moderate slopes of hard neutral yellow mottled soils (Dy3.42) with ridge crests of sandy acidic yellow mottled soils (Dy5.41) in which ironstone grav is common; small areas of leached sands (Uc2.2 and Uc2.3) occur too; undescribed soils in the small stream valleys. Occurs on sheet(s): 2"
"Ub29"
"Dissected, undulating, high plain: gently sloping to flat areas of hard neutral and acidic yellow mottled soils (Dy3.42 and Dy3.41) in association with sandy neutral and acidic yellow mottled soils (Dy5.42 and Dy5.41), especially on the crests of low ridges and knolls; gilgais and occasional areas of (Dy3.43) occur in the flatter situations; ironstone gravs are common and gravely phases a feature; narrow stream valleys are deeply entrenched in places. Occurs on sheet(s): 2"
"Ub30"
"Hilly to undulating areas, generally at higher elevations than Ub29: hill slopes of hard neutral and acidic yellow mottled soils (Dy3.42 and Dy3.41) in association with sandy neutral and acidic yellow mottled soils (Dy5.42 and Dy5.41) and possibly hard red soils (Dr2.2); lower hill slopes and valley plains of (Dy3.43), (Uc2.3), and undescribed soils; ironstone gravs are common. Occurs on sheet(s): 2"
"Ub31"
"Low step-like range country--stepped rolling country with scarps, hills, and valleys: chief soils are hard neutral yellow and yellow mottled soils (Dy3.42), (Dy2.42), (Dy2.22), and (Dy3.22) with a variety of other (D) soils and some (Gn2) and (Um4) soils, generally associated as follows: irregularly spaced cuesta-like ranges with (i) moderate to steep scarps of rock outcrops, (Um4.1), (Dr3.42), (Dr2.22), and other (D) soils passing to (iia) long rolling back slopes of (Dy3.42), (Dy2.42), (Dy3.22) with (Dr2.22 and Dr2.42) and sometimes (Gn2.1 and Gn2.2) soils through the mid and upper slope positions, which in turn merge with (iib) undulating basins of (Dy3.42 and Dy3.43) soils sometimes with (Gn2.7) soils, and gullies of (Dy3.42) and/or (Gn2.7) and (Gn2.9) soils; this sequence may be broken by (iii) hills and mountains with slopes and/or scarps of (Um4.1), (Um4.2), (Dr2.21), (Dy3.41), and other (D) soils, also sometimes with belts of partially dissected upland basins of (Dy3.42) soils along the cre. Occurs on sheet(s): 3"
"Ub32"
"Undulating to low hilly: chief soils are hard neutral yellow mottled soils (Dy3.42) in the gently undulating terrain with hard acidic and neutral red soils (Dr2.21 and Dr2.22) on the more pronounced ridges and knolls; tors are often a feature of the landscape. Other soils include (Dy3.2) in hilly areas; (Gn2.1) in basins and terraces; and (Ug5.1) and other undescribed soils in shallow swampy stream valleys. Occurs on sheet(s): 3"
"Ub33"
"Undulating with seasonally very wet basins and valleys: chief soils are hard neutral yellow mottled soils (Dy3.42) with (Db1.22) and possibly other soils, some tors. Associated are: (Dy3.41), (Dr2.2), and (Um4.1) soils on hill slopes; (Um6.11) soils on some stream terraces; and small basaltic areas of undescribed soils. Data are limited. Occurs on sheet(s): 3"
"Ub34"
"Hilly to mountainous country with some small high plateau remnants and complex elevated basins: chief soils on the moderately steep to gently rolling hill slopes are hard neutral yellow mottled soils (Dy3.42). Associated are steeper hill and mountain slopes of (Dr2.2), (Um4.2), and (Dy3.2 and Dy3.4) soils; and broad valleys with slopes of (Dy3.42) soils, terraces of (Um6.11) soils, and present flood-plains of (Um1) soils. Other undescribed soils are likely in all situations. Data are limited. Occurs on sheet(s): 3"
"Ub35"
"Area of subdued relief--basins with low ridges and hills, some scarps: chief soils are hard neutral and/or acid yellow mottled soils (Dy3.42 and/or Dy3.41), sometimes with (Dd2.42) soils on flat to undulating areas.

Associated are (Um4), (Dr2.22), (Dr2.4), and (Dy3.41) soils and rock outcrops on low ridges, hills, and scarps fronting the unit in places. Some ironstone slabs and gravels occur. Occurs on sheet(s): 3"
"Ub36"
"Areas of subdued relief at moderate elevations (1800-3000 ft), broad valleys of low hilly (rolling) to hilly topography with undulating basins and some low residual ridges and hills, buried and layered soil materials occur: chief soils of the low hilly to hilly areas are hard neutral yellow mottled soils (Dy3.42) with yellow earths (Gn2.25 and Gn2.75) and sometimes with (Dd1.43) soils in the lowerlying and seasonally wet situations. Associated are: undulating basins of (Dy3.42 and Dy3.43) and/or (Gn2.15 and Gn2.25) soils; residual ridges and hills with slopes of (Dr2.22 and Dr2.42) and/or (Dy3.22 and Dy3.42) soils often in complexes with red and yellow earths (Gn2.15 and Gn2.25) especially in depositional sites, and with (Um4.2) soils and rock outcrops on hill tops; stream terraces of variable width of (Um1) soils on present flood-plains, (Um6.11) soils on the lower terrace, and (Gn2) so,ils on the next higher terrace remnants; and scarps of undescribed soils along some stream valleys. Other soi. Occurs on sheet(s): 3"
"Ub37"
"Areas of subdued relief: plains or very gently sloping basins of hard neutral yellow mottled soils (Dy3.42) separated by rolling areas, ridges, and hills of unit Ub31 soils, especially the (Dr2.22), (Dr3.42), and (Um4) soils, and traversed by stream valleys of variable width and development as for stream terraces of unit Mu4. Occurs on sheet(s): 3"
"Ub38"
"Areas of subdued relief: basins of hard neutral yellow mottled soils (Dy3.42) separated by low ridges and hills of the soils of adjacent units. Occurs on sheet(s): 3"
"Ub39"
"Undulating to hilly country: chief soils are hard neutral and acid yellow mottled soils (Dy3.42 and Dy3.41) in a general pattern as follows: (i) undulating to hilly slopes of various (Dy) and (Dr) soils, including (Dy3.41), (Dy3.42), (Dy3.2), (Dr2.2), (Dr2.4); (ii) (Dy3.42) and sometimes (Dr3.42) soils in basins which merge with unit Va21 and lower-lying sites generally; and (iii) less frequently (Gn2.15) and (Gn2.25) soils on gently undulating areas, usually situated between (i) and (ii). As mapped, small areas of units Tb22 and Va22 are included. Data are limited. Occurs on sheet(s): 3"
"Ub40"
"Undulating to rolling country broken by ridges and hills: chief soils are hard neutral yellow mottled soils (Dy3.42, Dy3.62) with red and yellow earths (Gn2.15 and Gn2.25); both the (Dy3.62) and (Gn2.25) soils contain ironstone gravels. Associated are: ridges and hills of (Dr2.22), (Dy3.2), and (Um4.1) soils (similar to unit Qb16); some dissected basins, particularly in the southern portion of the unit, of (Dy3.41, Dy3.42), and shallow stony (Um) soils (similar to unit Ub35); and stream terraces of variable width and development of (Um1) soils on present flood-plains, (Um6.11) on the youngest terrace, then the (Gn2.15) terrace and finally some remnants of (Dr2.4) and (Dy3.4) terraces. As mapped, small areas of unit Qb11 are included. Occurs on sheet(s): 3"
"Ub41"
"Basalt plateau of hard neutral yellow mottled soils (Dy3.42) with some ironstone gravel and basalt boulders. Associated are (Db3.12) and (Dr4.12) soils, often shallow and stony, on the scarps of the plateau; and (Ug5.1) soils in the gullies. Occurs on sheet(s): 3"
"Ub42"
"Undulating land: chief soils are hard neutral yellow mottled soils (Dy3.42) probably with some soils common to unit Qd4. Data are limited. Occurs on sheet(s): 3"
"Ub43"
"Ranges--hills, ridges, and steep scarp slopes with tors, some undulating ridge crests, some undulating valleys: chief soils seem to be hard neutral yellow mottled soils (Dy3.42) and leached sands (Uc2.12) on areas of milder relief, e.g. ridge crests (compare unit Cd1). Associated are pockets of other soils, including (Dr2), (Uc1.2), and (Gn2.1). Data are limited. Occurs on sheet(s): 3"
"Ub44"
"Rolling, with some tor-covered ridges and hillocks: chief soils are hard neutral yellow mottled soils (Dy3.42, Dy3.62) with red earths (Gn2.15, Gn2.12) and possibly other undescribed soils. Occurs on sheet(s): 3"
"Ub45"
"Gently sloping plain of hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43); other soils are likely. Data are limited. Occurs on sheet(s): 3"
"Ub46"
"Flat to undulating areas of hard neutral and acidic yellow mottled soils (Dy3.42 and Dy3.41), with some red and yellow earths (Gn2) as for unit Mw11, and with (Um6.11) soils along stream valleys. Occurs on sheet(s): 3"
"Ub47"
"River terraces and flood-plains: main high terrace of hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43) grading to (Gn3.9) soils, and possibly some (Uf6.4) soils in depressions. Associated are: levees of the

main terrace possibly of (Gn2.15 and Gn2.18) soils with sandy rises possibly of (Um4.31) soils--data are inconclusive; younger terraces of (Um6.11) and possibly other (Um) soils; and present flood-plains of (Um1) and (Uc1) soils. The unit has similarities to both units X9 and Gb6. Occurs on sheet(s): 3"
"Ub48"
"Hilly to steep country with rounded slopes and traversed by undulating valleys: chief soils are hard neutral, alkaline, and acidic yellow mottled soils (Dy3.42, Dy3.43, and Dy3.41) and a variety of similar (D) soils such as (Db1.42), (Db1.43), (Dr2.22), (Dr2.42), (Dr2.21), and (Dy2.42). Associated are: shallow loamy soils (Um4.1 and Um4.2) on the steeper slopes; (Ug5.1), (Um6.11), and other (Um) and (Uc) soils in the valleys; and some small localized areas of (Gn2) soils on deeply mantled colluvial slopes and on alluvial fans. As mapped, areas of unit LL2 are included. Occurs on sheet(s): 3"
"Ub49"
"Undulating to low hilly valleys and canyons in or adjacent to the escarpments of unit Mb2: slopes of hard neutral, acidic, and alkaline yellow mottled soils (Dy3.42, Dy3.41, and Dy3.43) with red and yellow earths (Gn2.1 and Gn2.2); and (Um6.11) soils with other (Um) and (Uc) soils on terraces along the streams. Associated are small areas of the soils common to units Oc10, Ke11, and Mb2. Occurs on sheet(s): 3"
"Ub50"
"Gently undulating to hilly country of hard neutral yellow mottled soils (Dy3.42) with hard neutral red soils (Dr2.42 and Dr2.22). Associated are red earths (Gn2.15) and possibly other (Gn2) soils; and small areas of other soils, including (Ug5.1) and (Gn3.1). As mapped, areas of unit Va20 are included along the larger streams. Data are limited. Occurs on sheet(s): 3"
"Ub51"
"Gently undulating to hilly with some steeper ranges, some flat areas, tor-covered ridges, and occasional basaltic ridges and knolls: chief soils are hard neutral yellow mottled soils (Dy3.42, Dy3.82, and Dy3.62) with some (Dr2.62 and Dr2.22) soils. Associated are: steep range areas probably similar to unit Ub43; areas similar to unit X10; (Dr4.12) soils on basaltic ridges; (Db1.43) soils on flat areas below basaltic ridges; (Dd1.4) soils along some valleys; and some small areas of red earths (Gn2.12) towards the western margins of the unit. Occurs on sheet(s): 3"
"Ub52"
"Gravelly ridge country--generally undulating to hilly terrain with gravelly ridges and hills of irregular frequency of occurrence: chief soils seem to be hard neutral yellow mottled soils (Dy3.42), usually very gravelly. Associated are other (D) soils including (Dr2.32) and (Dr3.42) soils, shallow loams (Um4.1), and (Gn2.12) soils--all of which may be gravelly. As mapped, areas of unit LK4 are included. Data are limited. Occurs on sheet(s): 3"
"Ub53"
"Undulating, with scattered basaltic knolls and ridges: chief soils on the undulating portions and in valleys are hard neutral yellow mottled soils (Dy3.42) with (Dy3.2) and (Db1.2) all commonly containing some ironstone gravel. Associated are: (i) cracking clays (Ug5)-- (a) (Ug5.13), (Ug5.14), and possibly (Ug5.3) on slopes especially below basaltic ridges and knolls, (b) (Ug5.15 and Ug5.16) in valleys, and (c) less commonly (Ug5.4) in swampy areas--the (Ug5) and the (Dy) soils also occur as soil complexes; (ii) red friable earths (Gn3.12) on some basaltic knolls and ridges; (iii) (Um6.2) soils on the crests of some basaltic ridges; (iv) (Db3.12) soils on the slopes of some basaltic ridges and knolls; (v) structured red clays (Uf6.31) and red earths (Gn2.11) on undulating areas sometimes with basaltic knolls; (vi) other earths such as (Gn2.74) on valley slopes and flat areas; and (vii) small areas of the various soils of unit Ub54. Laterite is present below the soils on some slopes. Note that the. Occurs on sheet(s): 3"
"Ub54"
"Undulating to low hilly terrain with variable hilly portions and some steep slopes, rock outcrops: chief soils are hard neutral and acidic yellow mottled soils (Dy3.42 and Dy3.41), generally on undulating areas and mid hill slopes. Associated are a wide variety of soils including commonly (i) (Um4.1) and (Um4.2)--upper slopes and hill tops; (ii) (Dr2.22), (Dr2.21), (Dy3.2), and shallow forms of (Dy3.41 hill slopes; (iii) (Dy3.41 and Dy3.42) both containing ironstone gravel--flatter, often poorly drained areas; (iv) (Dy3.43) on relatively low-lying sites in which some salinity may be evident; less commonly (v) red and yellow earths (Gn2.14 and Gn2.24); and (vi) (Db2.4) soils on hill slopes. Occurs on sheet(s): 3"
"Ub55"
"Low hilly: chief soils are hard neutral yellow mottled soils (Dy3.42) and friable brown soils (Db3.12). Generally the soils of unit Ub54 are interspersed with those of unit Rh4. Occurs on sheet(s): 3"
"Ub56"
"Low hilly to hilly terrain with some flat to undulating portions, rock outcrops: chief soils are hard neutral yellow mottled soils (Dy3.42). Associated are: (i) a great variety of other (Dy) soils including (Dy3.21) on upper slopes, (Dy3.41 and Dy3.42), both containing ironstone gravels, on relatively poorly drained areas, and (Dy3.43) on relatively low-lying sites and valleys; (ii) yellow earths (Gn2.55) on colluvial slopes; (iii) soils of unit Wa10; (iv) soils of unit JJ6 on hill tops; (v) minor areas of (Dr2) soils on hill slopes; (vi) minor areas (Dg1.41) in wet places; and (vii) minor occurrences of some soils of unit Rh5. Occurs on sheet(s): 3"

"Ub57"
"Hilly terrain similar to unit Ub56, but with areas of soils as for unit Rh4 on basaltic residuals and as for unit Kd4 along some valleys. Occurs on sheet(s): 3"
"Ub58"
"Hilly with some tors and some undulating plateau-like areas: chief soils are hard neutral and acid yellow mottled soils (Dy3.42 and Dy3.41) some of which contain ironstone gravels, especially in the more gently undulating portions. As mapped, areas of units Wa10 and Ub56 may be included. Occurs on sheet(s): 3"
"Ub59"
"Hilly: chief soils are hard neutral and acidic yellow and yellow mottled soils (Dy2.42 and Dy2.41) and (Dy3.42 and Dy3.41). Associated are: various shallow soils such as (Um4.1), (Um4.2), (Um6.23), (Dy2.5) on crests and upper slopes; (Dr2.2) soils on upper and mid slopes; and (Dy3.43) and (Dr2.4) soils on lower slopes and flat areas. Occurs on sheet(s): 3"
"Ub60"
"Gently undulating to low hilly: chief soils are hard neutral and acidic yellow mottled soils (Dy3.42 and Dy3.41) with hard acidic and neutral red soils (Dr2.21, Dr2.41, and Dr2.42). Associated are (Um4.1) and (Um4.2) soils on crests and upper slopes; and (Dy3.43) soils in flat areas and valleys. Occurs on sheet(s): 3"
"Ub61"
"Valley plains: chief soils are hard neutral yellow and yellow mottled soils (Dy2.42) and (Dy3.42) with (Dd1.42) and possibly (Db1.42) and (Dr2.42). Associated are (Um6.11) soils on terraces. Data are limited. Occurs on sheet(s): 3"
"Ub62"
"Undulating to low hilly terrain: chief soils on broad gently sloping to flat areas are hard-setting loamy soils with mottled yellow and yellow clayey subsoils (Dy3.42), (Dy2.43), (Dy3.43), (Dy2.23), and (Dy3.41). Associated are: (i) low often gravel-strewn ridges of hard-setting loamy soils with red or brown clayey subsoils such as (Dr2.33 and Dr2.32) and (Db1.43 and Db1.42); (ii) small hilly areas of rock outcrops with (Uc), especially (Uc2.12) soils, (Um) soils, and shallow (Dr) and (Dy) soils; and (iii) minor areas of soils of units Wa13 and CC20 are included. Alkaline soil reaction trends are more common in the western areas of this unit. Occurs on sheet(s): 3,4"
"Ub63"
"Strongly hilly to undulating: chief soils of the undulating to low hilly areas are hard-setting loamy soils with mottled yellow clayey subsoils (Dy3.42 and Dy3.43) and some (Dr2) soils. Associated are: hilly ridges of rock outcrops, (Uc) and (Um) soils with some shallow (Dy) and (Dr) soils; steep slopes of red earths (Gn2.14 and Gn2.15) with rock outcrops; and narrow valleys of undescribed soils some of which are affected by salinity. Occurs on sheet(s): 3"
"Ub64"
"Moderately undulating lands: dominant are sandy-surfaced mottled duplex soils (Dy3.42), (Dy3.32), and (Dy3.41) with some areas of (Dy5.42 and Dy5.41). On lower slopes alkaline loamy duplex soils (Dy2.43), (Dy2.33), (Dd1.43), and (Dd1.33) occur. Some associated stony ridges have shallow sands (Uc1.21) or loams (Um1.41). Occurs on sheet(s): 4"
"Ub65"
"Moderate to strongly undulating lands: dominant soils are sandy-surfaced with strongly mottled clay subsoils (Dy3.42) and (Dy3.32), with smaller areas of alkaline forms. Closely associated are deeper sandy-surfaced soils (Dy5.42 and Dy5.41) and (Dy5.82 and Dy5.81). Higher ridges or low hills have shallow stony sands (Uc1.21), (Uc4.2), and (Uc2.12) together with lesser (Um1.41 and Um1.43) soils. Valley floors have loamy duplex soils (Dy2.42), (Dy2.43), and (Dd1.33). Occurs on sheet(s): 4"
"Ub66"
"Moderate to strongly undulating lands with some low rounded hills and high linear strike ridges and associated valleys: . dominant soils of flatter areas are sandy duplex soils (Dy3.42), (Dy3.32), and (Dy3.43) but other forms commonly occur, chiefly (Dy2.33), (Dy2.32), (Dy2.43), (Dr2.12), (Dr2.32), and (Db1.33). The higher ridges and hills have shallow stony sands (Uc1.21), and flat valley floors with small stream flood-plains have mostly loamy duplex soils (Dy2.43), (Dd1.13), and (Dd1.33) and small areas of cracking clays (Ug5.13) and (Ug5.24). Occurs on sheet(s): 4"
"Ub67"
"Gentle to moderately undulating plains: dominant are sandyto loamy-surfaced duplex soils (Dy3.42), (Dy3.32), and (Dy3.22) with smaller areas of alkaline forms. Commonly associated are other loamy duplex soils (Dr2.3), (Dr2.33), (Db1.13), (Db1.23), and (Dd1.13), together with small areas of moderately gilgaied deep grey clays (Ug5.24). Small areas of sandy red earths (Gn2.12) occur in the unit and adjacent to streams are small sandy flood-plains of (Uc5.11) soils. Occurs on sheet(s): 4"
"Ub68"
"Gently undulating lands: dominant are sandyto loamy-surfaced duplex soils of moderate A horizon depth (6 12 in.): chief form is (Dy3.42) but alkaline and acid variants (Dy3.43 and Dy3.41) also occur. Associated are deeper

sandy-surfaced soils (Dy5.41) and areas of sandy or loamy red and yellow earths (Gn2.11) and (Gn2.21). Adjacent to some drainage lines are small flood-plains with loamy-surfaced (Dy2.43) and (Dy2.33) soils. Occurs on sheet(s): 4"
"Ub69"
"Low hilly to hilly granitic country with some undulating but also some steep hilly areas; generally moderate side slopes; some rock outcrops, open valleys, and narrow alluvial flats: chief soils are hard neutral yellow mottled soils (Dy3.42) and (Dy3.32). Associated are (Dy2.22) soils on slopes. Other soils include (Uc2.12) and (Uc4.1) on crests; (Db2.21) and (Gn3.12) on upper slopes; and (Dd1.12), (Dy3.42), and (Ug5) on creek flats. Occurs on sheet(s): 4"
"Ub70"
"Generally low hilly country on granitic rocks with long moderate to gentle slopes to drainage lines, some gentle lower slopes; narrow ridge crests with rock outcrops: chief soils are hard neutral yellow mottled soils (Dy3.42) with (Dy2.42) on all slopes. Associated are (Dy3.43) soils on lower slopes and (Uc2.12), (Uc4.1), and (Uc2.21) on upper slopes. Minor soils include (Dr2.12) and (Dr2.41). Occurs on sheet(s): 4"
"Ub71"
"Moderately hilly granitic country with short moderate to steep slopes covered with granitic boulders and tors; some scattered mesas: chief soils are hard neutral and acid yellow mottled soils (Dy3.42 and Dy3.41). Associated are (Dr2.42) soils on slopes; (Um4) soils on silcrete (billy) capped mesas; and (Uc2.12) and (Uc4.1) soils on crests. Minor areas of other (D) soils also occur. Occurs on sheet(s): 4"
"Ub72"
"Similar to unit Ub71 but there are no mesas and fewer tors. Occurs on sheet(s): 4"
"Ub73"
"Similar to unit Ub71 but only minor areas of (Dr) soils occur and the mesas are small and very scattered. Occurs on sheet(s): 4"
"Ub74"
"Moderately hilly country derived from hornfels and phyllites; some rock outcrops: chief soils are neutral hard yellow mottled soils (Dy3.42). Associated are (Um2.12) soils on crests. Minor soils include (Dr3.41) on slopes. Occurs on sheet(s): 4"
"Ub75"
"Moderately hilly sandstone country with narrow ridges and spurs; narrow valleys: chief soils are hard neutral yellow mottled soils (Dy3.42) and (Dy2.42) with some (Dy3.41), (Dr2.42), and (Dr2.41) soils on mid slopes and some crests . Associated soils are (Uc2 .12) and (Uc4 .1) on crests and upper slopes and (Dy3.43) soils on lower slopes. Minor inclusions of (Gn2.11) soils in areas adjacent to lateritic plateaux. Small areas of unit FM1 soils in some valleys. Occurs on sheet(s): 4"
"Ub76"
"Moderately hilly land on acid igneous rock with aplitic differentiation forming conspicuous parallel ridge-crest outcrops: chief soils are the hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43) of the mid and lower slopes. Associated are (Uc2.12) and (Uc4.1) soils on ridge crests. Minor soil occurrences are (Dy3.43) and (Dd1.43) in depressions and along creek flats. Occurs on sheet(s): 4"
"Ub77"
"Low hilly granitic country with narrow terraces and stream flats: dominant soils are hard neutral yellow mottled soils (Dy3.42) with some (Dy3.41). Associated are (Dr2.11) and (Dr2.21) soils on bouldery slopes of diorite and (Uc2.12) soils on crests. Minor soil occurrences include (Db1.23), (Db1.13), and (Gn3.23) on terrace flats with weak gilgai microrelief; and (Gn3.12) soils on the middle level bench of the valley formations. Occurs on sheet(s): 4"
"Ub78"
"Low hilly country on volcanic rocks; long gentle slopes; narrow valleys: chief soils are hard neutral yellow mottled soils (Dy3.42) with (Dy2.42 and Dy2.43) and (Dy3.41 and Dy3.43). Associated are a wide range of (D) soils such as: (Dr2.42) and (Dd1.2) on slopes; (Um4.1) and (Um2.12) on stony crests; (Gn3.22) and (Ug5.12) soils on long gentle slopes; and (Ug5.15 and Ug5.16) soils on creek flats. Occurs on sheet(s): 4"
"Ub79"
"Moderate or gently undulating lands: dominant are sandy to loamy duplex soils with moderately deep A horizons. The chief forms are (Dy3.42) and (Dy3.32) but similar (Dy2) soils are commonly associated; alkaline forms occur less frequently. Small areas of other duplex soils occur, chiefly (Dr2.42), (Dr2.12), (Db1.32), and (Db1.12). On some higher landscape sites small areas of sandy red earths (Gn2.12) may occur, and included in the unit as mapped are small areas of dark clays (Ug5.12 and Ug5.16). Occurs on sheet(s): 4"
"Ub80"
"Gently undulating plains: dominant are sandy or loamy duplex soils with moderately deep A horizons. The chief form is (Dy3.42) but (Dy3.12 and Dy3.13) also occur, associated with similar (Dy2) soils. Prominent higher ridges

have gravelly or sandy red earths (Gn2.12) and in lower sites there are often thin-surfaced dark loamy duplex soils (Dd1.13) and (Dd1.33) or gilgaied clays (Ug5.24) and (Ug5.16). Occurs on sheet(s): 4"
"Ub81"
"Gently undulating plains: dominant are sandy duplex soils with moderately deep (12-15 in.) A horizons. The chief forms are (Dy3.42) and (Dy3.32) but also commonly occurring are (Dy3.43), (Dy3.22), (Dy5.42), (Dy5.43), and (Dy5.32) together with similar (Dy2) soils. The alkaline forms are most common in lower landscape sites where there may also be small areas of (Dd1.33) and (Ug5.24) soils; the latter may have a moderate (1-2 ft) gilgai microrelief. Occurs on sheet(s): 4"
"Ub82"
"Strongly undulating lands with occasional high stony ridges or low mesas: dominant soils are sandy to loamy (Dy3.42) and (Dy3.32) with (Dy2.42), (Dy2.32), and (Dy2.43) closely associated. Similar (Dr2) soils may also occur. The high stony ridges have shallow loams (Um1.43) and (Um4.1) or sands (Uc4.2), and some shallow stony duplex soils (Dr2.32) and (Dy3.41). Occasional more extensive mesas have sandy or loamy red earths (Gn2.12). Occurs on sheet(s): 4"
"Ub83"
"Moderately undulating lands with occasional low stony hills: dominant are sandy to loamy duplex soils of shallow to moderate depths (18-40 in.). The chief forms are (Dy3.42) and (Dy3.32) but (Dy3.41) and (Dy3.43) occasionally occur. Associated are areas of deep sandy duplex soils (Dy5.42) and (Dy5.32) and loamy-surfaced (Dy2.42) and (Dy2.32) soils. The occasional high stony ridges and low hills have shallow sands (Uc1.21) and (Uc4.2) or loams (Um1.43). Occurs on sheet(s): 4"
"Ub84"
"Strongly undulating lands with some low hilly areas; rock outcrop may be common: dominant are loamy duplex soils (Dy3.42) of moderate to shallow depth and usually stony. Closely associated are (Dy3.43), (Dy3.41), and (Dy2.42) together with locally important areas of red duplex soils (Dr2.12). Higher hills have shallow stony loams (Um1.43), (Um1.42), and (Um2.12). Adjacent to some drainage lines are loamy friable earths (Gn3.25) and occasional swampy areas of dark clays (Ug5.16). Occurs on sheet(s): 4"
"Ub85"
"Hilly lands with steep slopes but rounded hill crests and some strongly undulating areas merging into narrow valley floors: rock outcrop is common: dominant are fairly shallow (18-24 in.) sandy to loamy duplex soils with stony A horizons but mostly stone-free clay B horizons. The chief form is (Dy3.42) but (Dy3.41) and (Dy3.21) also commonly occur. Associated are similar (Dy2) soils and some areas of (Dr2.12 and Dr2.11). Steeper hills have shallow stony loams (Um1.43) and (Um2.12) or sands (Uc2.21). On small alluvial stream flood-plains loamy (Dy3.43) soils are common. Occurs on sheet(s): 4"
"Ub86"
"Undulating lands with some isolated low hilly areas: dominant are loamy or occasionally sandy duplex soils of moderate to shallow depth; on higher landscape sites the soils are usually stony. The chief form is (Dy3.42) with (Dy3.41) and less often (Dy3.43), (Dy3.33), and (Dy3.32). Similar (Dy2) soils are associated and on the low hills are shallow stony loams (Um1.42) and (Um2.12). Occurs on sheet(s): 4"
"Ub87"
"Level or very gently undulating alluvial plains rising slowly to undulating low foothills: dominant are fine sandy or loamy duplex soils, chiefly (Dy3.42) but (Dy3.43), (Dy3.41), (Dy3.32), (Dy3.33), and similar (Dy2) soils also occur. In lower swampy areas a prominent (6-8 in.) trench gilgai microrelief is often present. Also present in the unit are slightly higher old stream levees with coarse-textured gradational soils (Gn2.44) and (Gn3.24) and occasionally brown sandy duplex soils (Db1.22). On the undulating foothills shallower stony duplex soils (Dy3.41 and Dy3.42) are common, (Gn3.24) occurring less often. Adjacent to the coast the unit grades into salt pans with (Uf6.6) and eroded (Dy3.43) soils, and mangrove swamps. The unit is very similar to Va47 but neutral soils are dominant. Occurs on sheet(s): 4"
"Ub88"
"Alluvial plains often terraced rising to strongly undulating foothills: dominant soils of the broader plains are loamy-surfaced (Dy3.42) and (Dy3.32) but (Dy3.21), (Db1.21), (Db1.22), (Dy3.33), and (Dy3.43) also occur. Higher terraces have brown friable earths (Gn3.24) and the most recent terraces have uniform loams (Um6.31) and (Um5.4). The moderate to strongly undulating foothills have sandy duplex soils (Dy3.41), (Dy3.42), and (Db1.21). Occurs on sheet(s): 4"
"Ub89"
"Moderate to strongly undulating lands with occasional low hilly areas: dominant are shallow loamy duplex soils (Dy3.42) and (Dy3.32) but with (Dy3.43), (Dy3.33), and similar (Dy2) soils also common. A prominent gravelly stone line is often present at the base of the A horizons. Higher ridges and low hilly areas have very shallow stony similar duplex soils and also some occurrences of (Dr2.12), (Db1.12), (Db1.22), (Um1.43), and (Um2.12). Occurs on sheet(s): 4"
"Ub90"

"Generally rolling to hilly country with tors; lateritic mesas and buttes on some interfluve areas: chief soils are hard neutral and acidic yellow mottled soils (Dy3.42 and Dy3.41) sometimes containing ironstone gravels. Associated are variable areas of hard acidic and neutral red soils (Dr2.31), (Dr2.21), (Dr2.32), and (Dr2.22) on slopes; (Dy3.82 and Dy3.81) soils containing moderate to large amounts of ironstone gravels on ridges, crests of hills, and upper slopes; and many small areas of other soils. As mapped, areas of adjoining units may be included. Occurs on sheet(s): 5"
"Ub91"
"Undulating to hilly with some steep slopes; tors common; some lateritic mesas and buttes on drainage divides: chief soils are hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43). Associated are (Dy3.82) soils containing ironstone gravels; and small areas of (Dr) soils, such as (Dr2.22), may occur. The landscape of this unit is similar to that of units Qb29 and Qb30 but (Dy) soils, not (Dr) soils, seem characteristic. Occurs on sheet(s): 5"
"Ub92"
"Valley plains: chief soils are hard neutral yellow mottled soils (Dy3.42). Associated soils are not described. Salinity, including resalinized areas, is a feature. Occurs on sheet(s): 5"
"Ub93"
"Valley side slopes of gentle to steep relief where dissection has cut below the laterite level: the soils vary locally, although the hard neutral yellow mottled soils such as (Dy3.42) and (Dy5.62) seem the more common, together with variable proportions of related (Dr) soils such as (Dr2.32) and (Dr5.62). As mapped, soils of the adjoining units are included. Occurs on sheet(s): 5"
"Ub94"
"Gently undulating plains along stream valleys with some steeper valley side slopes; mesas and buttes of units Ca24 and Cb42; and some saline flats: chief soils of the flatter areas in which some microrelief occurs are hard neutral yellow mottled soils (Dy3.42) and hard neutral red soils (Dr2.42). Associated are a variety of (Dr) and (Dy) soils such as (Dr3.43), (Dy3.43), and (Dy3.82) in which ironstone gravels occur; undescribed soils associated with the slopes of mesas and buttes; and undescribed soils of saline flats. Occurs on sheet(s): 5"
"Ub95"
"Valley plains with some sandhills, dunes, lateritic gravel areas, and swamps: chief soils are hard neutral and sandy neutral yellow mottled soils (Dy3.42) and (Dy5.42). Associated are leached sands (Uc2.21) and siliceous sands (Uc1.21) of the sandhills and dunes; some (KS-Uc) gravels on residual knolls and ridges; areas of the soils of units Ub96 and Va64; and undescribed swamp soils. As mapped, areas of adjoining units may be included. There are similarities with unit Ca22. Occurs on sheet(s): 5"
"Ub96"
"Valley plains in which some salinity is usually present: chief soils are hard neutral, and also alkaline, yellow mottled soils (Dy3.42 and Dy3.43). Associated are small areas of many other soils including minor areas of sands as for unit Ub95. As mapped, areas of adjoining units may be included. Occurs on sheet(s): 5"
"Ub97"
"Very gently undulating plain: chief soils are neutral, and also alkaline, yellow mottled soils (Dy3.42 and Dy3.43) overlying siliceous pans at depth. Occurs on sheet(s): 5"
"Ub98"
"1 Hilly with granitic and gneissic rock outcrops: chief soils are hard neutral yellow mottled soils (Dy3.4). Small areas of other soils are likely. As mapped, small areas of unit Ms8 may be included. Occurs on sheet(s): 5"
"Ub99"
"Low hilly to hilly terrain on sandstones with rock outcrops: chief soils are hard neutral yellow mottled soils (Dy3.42) and (Dy3.22). Associated are small saline valleys with areas of (Uc2.22) and (Uc5.22) soils; and ironstone boulders and slabs adjacent to areas of unit AC9. Occurs on sheet(s): 5"
"Ub100"
"Broken hilly terrain on sandstones and claystones with mesas and buttes of unit Uc2; some saline flatssome rock outcrops: chief soils seem to be hard neutral yellow mottled soils (Dy3.42). Associated are small areas of the soils of units Pb29 and Xd3. Occurs on sheet(s): 5"
"Ub101"
"Hilly terrain: chief soils seem to be hard neutral yellow mottled and red mottled soils (Dy3.42) and (Dr3.42). Other soils include areas of (Uc5.22) on fills. Occurs on sheet(s): 5"
"Ub102"
"Very gently undulating plains with many relic stream channels and levees: dominant are mottled duplex soils (Dy3.42) with moderately deep (10-14 in.) sandy A horizons. Associated are other sandy duplex soils (Dy3.32, Dy3.31) and (Dy3.41), with lesser similar loamy duplex soils in slightly depressed areas. Loamy mottled brown earths (Gn2.45) and (Gn2.52, Gn2.53) are common on the stream levees. Included also are small open grassy plains with deep cracking clay soils (Ug5.24) and (Ug5.14) and lesser loamy duplex soils (Dy2.33) and (Dy2.43). Occurs on sheet(s): 7"
"Ub103"

"Undulating to moderately undulating lands with high strike ridges and occasional low hilly areas; rock outcrop may occur on higher slopes and ridge crests: dominant are shallow to moderately deep loamy duplex soils (Dy3.42), with lesser (Dy3.43, Dy3.41). Shallow gravelly sands (Uc2.12) are common throughout the unit, occurring on broad ridge crests with other deeper bleached sands (Uc2.23, Uc2.22). Loamy red earths (Gn2.14) are common on the levees of the minor streams, and various deep loamy duplex soils, chiefly (Dy3.43), occur on the narrow flood-plains. Included in the unit are numerous small basalt plateau remnants with soils similar to those of unit Mo30. Occurs on sheet(s): 7"
"Ub104"
"Low hilly to hilly lands with much rock outcrop: dominant and associated soils are as for unit Ub1O3. However, with the stronger topography the soils are shallower and the chief associates are very gravelly sands (Uc2.12), with lesser (Uc4.2). Also included are hilly lands with the shallow gravelly leached loamy soils of unit Fu20. Data are limited. Occurs on sheet(s): 7"
"Ub105"
"Very gently undulating alluvial plains with some low lateritic rises: deep loamy duplex soils (Dy3.42) are dominant, but other duplex soils (Dy2.42), (Dy3.32), and (Dy3.43, Dy3.41) are widespread and in some areas may be locally dominant. Loamy red earths (Gn2.14) and grey earths (Gn2.94) are common on the crests and upper slopes of the low rises, while loamy red duplex soils (Dr2.81) and (Dr3.81) occur on the lower slopes. Loamy brown earths (Gn2.42, Gn2.45) are common on the younger stream terraces and areas of deep cracking clays (Ug5.15, Ug5.17) occur adjacent to some streams. Occurs on sheet(s): 7"
"Ub106"
"Undulating lands rising to low foothills: dominant soils are loamy or occasionally sandy duplex soils (Dy3.42). with associated yellow earths (Gn2.61) and (Gn2.21, Gn2.24). On lower slopes and small alluvial plains alkaline duplex soils (Dy3.43) and (Dy2.43) are common, while small stream levees have loamy red earths (Gn2.14). Higher ridges and the low foothills have shallow stony soils of unit Fu25. Data are fairly limited. Occurs on sheet(s): 7"
"Ub107"
"Level alluvial plains, often cut by small distributary stream channels and subject to occasional inundation: dominant are loamy or silty mottled yellow-grey duplex soils; a range of reaction trends is present but neutral forms (Dy3.42) and (Dy3.32) are probably most common. Closely associated are similar acid duplex soils (Dy3.41) and (Dd2.11) and, less commonly, alkaline duplex soils (Dy3.43), (Dy3.33), and (Dy3.13). Associated in some lower sites are slightly gilgaied friable mottled yellow earths (Gn3.71, Gn3.73), and occasionally deep cracking clays (Ug5.5) and (Ug5.28). On some slightly higher plains and on old stream levees occur loamy yellow earths (Gn2.71, Gn2.74), (Gn2.64), and (Gn2.25). At the northern margin of the unit there is a gradual transition to the marine plain clays of unit II12. Occurs on sheet(s): 7"
"Ub108"
"Level or very gently undulating alluvial plains with many old sand-filled stream channels and low levees: dominant are loamy or sandy bleached duplex soils; neutral forms (Dy3.42), with lesser (Dy2.42), are probably most common but alkaline soils (Dy3.43) occur nearer the coast where small areas of slightly gilgaied massive grey clays (Ug5.5) may be associated. Also occurring are small areas of deep sandy-surfaced gleyed duplex soils (Dg2.8 1, Dg2.82). The old stream channels and levees have deep bleached sands (Uc2.22, Uc2.21, and Uc2.23), other sands (Uc4.22, Uc4.21), or sandy red earths (Gn2.14). In the northern extent of the unit small areas of grey-brown friable earths (Gn3.92) occur adjacent to larger streams. Occurs on sheet(s): 7"
"Ub109"
"Moderately to strongly undulating lands with occasional low hilly areas; ridge crests are mostly rounded with occasional granite outcrop: dominant are sandy or loamy shallow to moderately deep Fitty or gravelly mottled duplex soils, usually with a clear rather than abrupt A-B horizon boundary. The chief form is probably (Dy3.42), but (Dy3.41), (Dy3.21), (Dy3.22), and (Dy2.21) also occur, together with occasional red duplex soils (Dr2.21) and (Dr2.61). The low hills usually have shallow stony sands (Uc4.21) and (Uc4.12) or bleached sands (Uc2.12). Occurs on sheet(s): 7"
"Ub110"
"Very gently undulating alluvial plains and some higher undulating outwash fans: dominant on the plains are loamy bleached duplex soils (Dy3.42), with occasional (Dy3.43). Associated on small, slightly higher rises are deep-surfaced sandy massive duplex soils (Dy3.81) or deep sandy bleached earths (Gn2.94) and (Gn2.74). The higher undulating outwash fans have similar (Dy3.81) soils and deep sandy red earths (Gn2.14). Occurs on sheet(s): 7"
"Uc1"
"Steep hilly to hilly dissected lateritic plateau with steep valley side slopes: chief soils are hard, and also sandy, neutral, and also acidic, yellow and yellow mottled soils (Dy3.62), (Dy5.62), (Dy2.82), (Dy3.21), with conspicuous but relatively smaller areas of red earths (Gn2.15 and Gn2.14). Associated are areas of block laterite, gravelly and bouldery (Dy5.81) and (KS-Uc4.2) soils on tops of rises and their colluvial slopes; some areas of leached sands

(Uc2.34); some (Dr2.21) soils on slopes; some (Um5.2) soils on terraces of major streams; and areas of unit Wd8. Occurs on sheet(s): 5"
"Uc2"
"Dissected lateritic plateau: chief soils seem to be hard neutral yellow mottled soils (Dy3.62) containing ironstone gravels and boulders. Associated are some (Dy5.8) soils; and various (Dr) and (Dy) soils on the dissection slopes. Occurs on sheet(s): 5"
"Uf1"
"Undulating terrain with ridges, spurs, and lateritic mesas and buttes: chief soils on the broad undulating ridges and spurs are hard, and also sandy, neutral, and also acidic, yellow mottled soils (Dy3.82 and Dy3.81), (Dy5.82 and Dy5.81), all containing ironstone gravels. Associated are a variety of soils on the shorter pediment slopes, including (Dr2.32), (Dr3.41), (Dy2.33), and others of similar form; and dissection products of the lateritic mesas and buttes. As mapped, small areas of unit Ms7 may occupy some drainage divides, unit Va63 traverse some drainage-ways, and unit Qb29 occur in localities of deeper dissection. Occurs on sheet(s): 5"
"Uf2"
"Gently undulating: chief soils are hard neutral yellow mottled soils (Dy3.82) containing ironstone gravels. Associated are small areas of (Dy5.42) soils in low-lying situations; and small areas of soils of unit Ub93 on slopes. Occurs on sheet(s): 5"
"Uf3"
"Dissected plateau at low elevation having an undulating to rolling ridge and slope relief with some steep bluffs adjacent to drainage-ways; some swamps: chief soils are hard neutral yellow mottled soils (Dy3.82) containing ironstone gravels in their surface horizons on the flat to gently undulating ridge crests. Associated are leached sands (Uc2.2) sometimes underlain by boulder laterite and (Dy5.8) soils on the ridge crests; (Dy3.42), (Dy2.42), (Dr2.32), (Dr3.42), and possibly other similar (Dy) and (Dr) soils on the valley side slopes; and small areas of (Uc4.11) soils adjacent to tors on valley side slopes. As mapped, small areas of unit Od8 occurring in areas of major dissection are included. Occurs on sheet(s): 5"
"Ui1"
"Level or very gently undulating alluvial plains: dominant are loamy or occasionally sandy duplex soils, chiefly (Dy3.32), but (Dy3.42), (Dy3.43), and (Dy3.21) also occur, together with similar (Dy2) soils. On some undulating low ridges there are gravelly (nodular) duplex soils with an indurated nodular laterite horizon (Dy3.84). On some more recent flood-plains and levees coarser-textured brown earths (Gn2.41 and Gn2.44) are common. Occurs on sheet(s): 4"
"Ui2"
"Gently undulating country, developed on shales and sandstone, with a few widely spaced steep-sided residuals: chief soils are neutral hard yellow mottled soils (Dy3.32) with associated areas of (Dy5.32) and (Uc5.21) soils. Shallow stony sandy soils (Uc1.43) flank the sandstone-capped scarps on which there is much rock outcrop. Streams are bordered by sandy detritus (Uc1.22). Occurs on sheet(s): 9"
"Ui3"
"Alluvial plains with many relic stream channels and meander cut-offs; marginally the unit includes some gently sloping narrow outwash slopes and fans: dominant are deep loamy or silty duplex soils (Dy3.32), with associated (Dy3.42), (Dy3.31), (Dy3.41), and (Dy3.22) soils. A range of loamy earths, chiefly (Gn2.41) but also including (Gn2.21, Gn2.24), (Gn2.14), and (Gn2.74), and occasionally deep sands (Uc4.21, Uc4.22) are associated with the present and prior stream channels and levees. Soils of unit Mw41 occur on the narrow outwash slopes of adjacent mountains. Occurs on sheet(s): 7"
"Ui4"
"Gently undulating lands with long gentle slopes, rounded ridge crests, and broad flat drainage lines: dominant are deep loamy duplex soils (Dy3.32), but areas of (Dy2.22) and (Dr2.22) soils also occur. Deep alkaline duplex soils (Dy3.43), (Db2.43), and (Db2.33) are common adjacent to drainage lines where there are also small areas of deep cracking clay soils of unit Kf11. Minor associated soils include bleached sands (Uc2.12) and (Uc2.22) and other shallow sands (Uc4.12) and (Uc4.21). Occurs on sheet(s): 7"
"Va1"
"Valley plains and some lower hill slopes: hard alkaline yellow mottled soils (Dy3.43) associated with small areas of cracking grey clays (Ug5.2) and localized areas of hard alkaline red soils (Dr2.43). Occurs on sheet(s): 1"
"Va2"
"Plains with occasional stony rises: gilgai plains of hard alkaline and neutral yellow mottled soils (Dy3.43 and Dy3.42) in association with small areas of cracking grey clays (Ug5.2) which may be dominant locally; stony rises with shallow friable loamy soils (Um6.12, Um6.13, Um6.21, Um6.24, and Um6.41); dark cracking clays (Ug5.16) on terraces and some floodplains along stream valleys; minor areas of (Dy3.41), (Dy3.11), (Dy5.42), and (Ug5.1) occur on the plains as well. Ironstone gravs are a common feature of surface horizons of (D) soils. Some volcanic cones occur in the Va2 area in Sheet 2 but their associated soils are not described. Occurs on sheet(s): 1,2"
"Va3"

"Plain: hard alkaline yellow mottled soils (Dy3.43) in association with hard alkaline red mottled soils (Dr3.43); some soils have silaceous hardpans. Occurs on sheet(s): 1"
"Va4"
"Undulating outwash plains; hard alkaline yellow mottled soils (Dy3.43) and (Dy5.43) with smaller areas of (Dr2.33) shallow forms (Um6), (Uc6.11) and (Gc1.12). Occurs on sheet(s): 1"
"Va5"
"Plain with some swamps and small stream valleys: plains of hard alkaline yellow mottled soils (Dy3.43) with very small areas of hard alkaline red soils (Dr2.33 and Dr2.23) in the better drained sites and hard alkaline brown soils (Db1.43) in sites of intermediate drainage status; and with gilgai microassociations of grey cracking clays (Ug5.2) and hard alkaline yellow mottled soils (Dy3.33 and Dy3.43) in flat areas subject to flooding. Occurs on sheet(s): 2"
"Va6"
"Undulating plain of hard alkaline yellow mottled soils (Dy3.43), some of which contain ironstone grav. Occurs on sheet(s): 2"
"Va7"
"Basin-like area of subdued relief with a lake and also swampy flats along some stream valleys: plain and undulating areas of hard alkaline yellow mottled soils (Dy3.43) in association with small areas of gilgais in which dark cracking clays (Ug5.16) occur; various undescribed soils ill the swampy flats. Occurs on sheet(s): 2"
"Va8"
"Gently sloping, undulating, apron plains with some swampy areas: undulating plains of hard alkaline yellow mottled soils (Dy3.43) with small low-lying areas in which grey cracking clays (Ug6.2) occur in gilgai microassociation. Occurs on sheet(s): 2"
"Va9"
"Gently undulating plain with swamps, lakes, some stony rises, volcanic cones, and an occasional low hilly area: undulating plain of hard alkaline and neutral yellow mottled soils (Dy3.43 and Dy3.42) with smaller areas of (Dy5.4) and (Dy3.22); stony rises with shallow friable loamy soils (Um6) and often with dark cracking clays (Ug5.13) at their base; soils in other topographic positions not described; this area has features in common with unit Va2, and to a lesser extent with unit HH1. Occurs on sheet(s): 2"
"Va10"
"River valleys and their adjacent hill slopes: (1) valley plains of hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43) on the colluvial slopes and upper terraces of major streams and also floodplains of some tributary streams, in association with sandy acidic yellow mottled soils (Dy 5.41) on low rises and other soils, including (Gn2.8) on the flatter portions of the middle terraces along major stream valleys, loamy soils (probably (Um5.4 and/or Um1)) on the lower terraces and floodplains of the major streams, and with swampy areas close to some of the major stream channels: (2) surrounding hill slopes of hard acidic yellow mottled soils (Dy3.4) and hard acidic red soils (Dr2.21 and Dr2.41). Occurs on sheet(s): 2,3"
"Va11"
"Gilgai plain of hard alkaline yellow mottled soils (Dy3.43) with grey cracking clays (Ug5.2) in microassociation; occasional broad, low rises of hard neutral red soils (Dr2.22). Occurs on sheet(s): 2"
"Va12"
"Plains with prior streams: plains of hard alkaline yellow mottled soils (Dy3.43) and lesser areas of (Dy3.42), with gilgais and areas subject to flooding; some plains of friable earths (Gn3) and possibly sandy yellow mottled soils (Dy5); some low banks and rises of hard alkaline and neutral red soils (Dr2.23 and Dr2.22) throughout the plain; levees of red friable earths (Gn3.13 (2) with (Dr2.23 and Dr2.22), and depressions of various unclassified soils in the areas of prior stream activity. Occurs on sheet(s): 2"
"Va13"
"Plain with marshes and lakes: plains of hard alkaline yellow mottled soils (Dy3.43) and grey cracking clays (Ug5.2) with gilgais, especially adjacent to basaltic areas; saline areas; and minor areas of soils of unit A6. Occurs on sheet(s): 2"
"Va14"
"Plains of hard alkaline and neutral yellow mottled soils (Dy3.43 and Dy3.42). Associated are various earths (Gn2.2 and Gn2.9) with other undescribed soils. Data are limited. Occurs on sheet(s): 3"
"Va15"
"River flood-plains and terraces, buried soils materials present at shallow depths (2 ft) in some places: chief soils of the gently sloping plains are hard alkaline and neutral yellow mottled soils (Dy3.43 and Dy3.42). Commonly associated are: (Dy3.22) and/or (Dr2.22) and (Dr3.21) and/or (Gn2.1 and Gn2.2) soils on terrace remnants; (Um6.11) soils on the "low"terrace and some levees; low-lying swampy areas of various soils, including (Dd3.13); and generally smaller areas of (Uc1.22), (Ug5.1), and other soils not described. Soil variations exist between the flood-plains and terraces of the different streams, but are not clearly defined at present. Occurs on sheet(s): 3"
"Va16"

"Gently undulating to low rounded hilly terrain with some ridges and flat areas: chief soils are hard alkaline and neutral yellow mottled soils (Dy3.43, Dy3.33, and Dy3.42) sometimes containing ironstone gravels in the areas of milder relief and on mid to lower slopes generally. Associated are hard neutral and alkaline red soils (Dr2.32, Dr2.42), (Dr3.33) and shallow loams (Um4.1) similar to unit Qc3, on the areas of stronger relief. There are similarities to unit Ta5 of Sheet 2. Data are limited. Occurs on sheet(s): 3"
"Va17"
"Flat to gently undulating country with some swamps and broken by an occasional low gravelly or stony ridge or hillock: chief soils are hard alkaline yellow mottled soils (Dy3.43) and (Dr2.33), both containing ironstone gravel and sometimes forming soil complexes. Associated are: ridges and hillocks of (Dr2.32, Dr2.42) and (Um4.1) soils similar to unit Qc3; small flat areas of (Dr2.23); and various undescribed soils in local situations, e.g. subjacent to swamps and on stream terraces. Data are limited. Occurs on sheet(s): 3"
"Va18"
"Gently undulating, some gravelly surfaces: chief soils seem to be hard alkaline yellow mottled soils (Dy3.43) beneath which mottled and pallid clayey materials occur. As mapped, soils of unit Ob8 may be included. Occurs on sheet(s): 3"
"Va19"
"Undulating to hilly, tors: chief soils seem to be hard alkaline yellow mottled soils (Dy3.43) with other (D) soils such as (Db2.43). As mapped, areas similar to unit Ub43 are included. Data are limited. Occurs on sheet(s): 3"
"Va20"
"Valley plain and terraces of hard alkaline yellow mottled soils (Dy3.43), red earths (Gn2.15), and possibly other (Gn2) soils. Associated are younger terraces of (Um6.11) soils and flood-plains of (Um) and (Uc) soils. Compare units Ub47, Gb6, and X9. Data are limited. Occurs on sheet(s): 3"
"Va21"
"Plain with lagoons, swamps, and some small saline areas: chief soils are hard alkaline yellow mottled soils (Dy3.43). Associated are various soils including (Gn2.75), (Gn2.95), and (Dy5.12). As mapped, this unit includes portions of the basin plains of unit Ub39 and their (Dy3.42) soils. Data are limited. Occurs on sheet(s): 3"
"Va22"
"Valley plain: chief soils are hard alkaline yellow and yellow mottled soils (Dy2.43) and (Dy3.43). Associated are various soils, notably (Gn2.95), also (Ug5.16) and (Gn2.1), with some (Um) soils close to the stream. Occurs on sheet(s): 3"
"Va23"
"Basin plains at moderate elevations (> 2000 ft) with lakes, swamps, lunettes, small stream valleys, and low residual hills and ridges; some buried layered soil materials: basin plains of hard alkaline and neutral yellow mottled soils (Dy3.43 and Dy3.42) with other undescribed soils. Associated are (i) lunettes and/or levee-like ridges of red earths (Gn2.15) and possibly some sand sheets of (Uc) soils; (ii) narrow depressions of (Dd1.43) soils; (iii) ?old terrace remnants of (Dr2.41) soils above which some gravel fills may occur; and (iv) broken by some undulating to low hilly areas of (Dy3.42) soils with (Gn2.25 and Gn2.75) soils. Occurs on sheet(s): 3"
"Va24"
"Gently undulating plains of hard alkaline and neutral yellow mottled soils (Dy3.43 and Dy3.42) and (Dy2.43 and Dy2.42); some acid variants may occur. Associated are: (i) (Db1.43) soils; (ii) sandy soils (Dy5.41 and Dy5.42) and (Dy5.81 and Dy5.82) near drainage lines; and (iii) small areas of (Dr2) and (Dr3) soils. Some high stony ridges, scarps, or mesa-like remnants of units Fz2 and Fz3 may occur, as may inclusions of unit CC20. Occurs on sheet(s): 3,4"
"Va25"
"Plains: chief soils are hard alkaline yellow mottled soils (Dy3.43 and Dy3.33) and (Dd1.33 and Dd1.43) soils, often in complex with cracking grey clays (Ug5.2). Minor areas of soils of unit My3 are included. Occurs on sheet(s): 3,4"
"Va26"
"Gently undulating plains: chief soils are hard alkaline and neutral yellow mottled soils (Dy3.43 and Dy3.42) in association with soils of unit HG1 along the drainage lines. Occurs on sheet(s): 3"
"Va27"
"Undulating country with low rounded hills, saddles, and gentle slopes: a complex soil pattern of hardsetting loamy soils with mottled yellow clayey subsoils (Dy3.43 and Dy3.33), and brown clayey subsoils (Db1.33 and Db1.43) in association with cracking clay soils (Ug5.1 and Ug5.2) which may be dominant locally, especially in proximity to basaltic parent materials. Occurs on sheet(s): 3"
"Va28"
"Undulating ridges and some gently sloping plains: dominant soils have a deep sandy surface overlying mottled clay (Dy3.43), (Dy3.33), (Dy3.42), and (Dy3.82). Associated are areas with a loose sandy surface (Dy5.41 and Dy5.42) and (Dy5.81 and Dy5.82). Smaller areas of sandy red earths (Gn2.12 and Gn2.11) also occur together with

areas of loamy yellow-grey duplex soils (Dy3.43) and (Dy2.43), and red duplex soils (Dr2.21 and Dr2.22), (Dr2.31 and Dr2.32), and (Dr2.41 and Dr2.42). Occurs on sheet(s): 4"
"Va29"
"Undulating or rarely strongly undulating lands with an occasional isolated low hill: dominant soils have fine loamy A horizons (8-12 in.) overlying mottled clay. Chief forms are (Dy3.43) and (Dy3.33) with smaller areas of neutral types. Associated are small areas of other mottled duplex soils (Dr3.32), (Db2.43), and (Dy5.42). In valley floors loamy (Dy2.43) soils are common and the isolated stony hills have gravelly (Um1.43) and (Uc1.23) soils. Occurs on sheet(s): 4"
"Va30"
"Undulating or moderately undulating lands with occasional low hilly areas: a complex range of soils is present but on moderate slopes loamy-surfaced duplex soils are dominant, chiefly (Dy3.43 and Dy3.42), with smaller areas of (Dr2.12), (Dr2.43), and (Dy2.43). Small areas of deeper-surfaced (Dy5.42 and Dy5.43) soils also occur. On more gentle slopes there may be areas of cracking clays (Ug5.22) and (Ug5.32) with associated duplex soils (Dd1.33) and (Db1.33) and small areas of friable earths (Gn3.93) and (Gn3.23). Aggraded valley floors have loamy duplex soils (Dy2.43) and (Dd1.43). The occasional low hills have shallow stony sands (Uc1.21 and Uc1.23) or loams (Um1.43). Occurs on sheet(s): 4"
"Va31"
"Gentle or moderately undulating lands with some more strongly dissected marginal slopes: dominant soils are loamy-surfaced (6-8 in.) (Dy3.43) and (Dy3.33). Also occurring, more particularly on the marginal slopes, are duplex soils with deeper sandy A horizons (1-20 in.) which are often gravelly. Common forms are (Dy3.43 and Dy3.42). Other duplex soils also occur, particularly along drainage lines; these are chiefly (Db1.13), (Dy2.43), (Dy2.33), (Dd1.13), (Dd1.33), and (Dy4.32). Included in the unit are small areas of moderately to strongly gilgaied cracking clays (Ug5.24) and occasional small areas of sandy red earths (Gn2.11). Occurs on sheet(s): 4"
"Va32"
"Low concave convex hills with some mesas of lateritized rock: chief soils are hard alkaline yellow mottled soils (Dy3.43). Associated are hard neutral gley soils (Dg2.82) on crests of low rises; hard alkaline dark soils (Dd1.43) on concave slopes; and hard acidic yellow and red mottled soils (Dy3.41) and (Dr3.41) on cuesta crests. Small areas of other soils may occur. Occurs on sheet(s): 4"
"Va33"
"Similar to unit Va32 but there are a large number of mesas with shallow (Um) soils. There are some areas of leached sands (Uc2.22) as well. Occurs on sheet(s): 4"
"Va34"
"Moderately hilly lands largely on mudstones and sandstones--generally short medium slopes straight to drainage-ways but some low hilly areas with gentle slopes: chief soils are hard alkaline yellow mottled soils (Dy3.43) with (Dy3.42), often gravelly and stony. Associated are gravelly (Um4.1) and (Um2.12) soils on crests and upper slopes; (Dr2.42) and (Dr3.42) soils on moderate slopes; and (Dy3.41) and (Dr3.41) soils on small areas of granite. Minor soil occurrences include (Ug5.15) on flats and (Ug5.12) on slopes. Occurs on sheet(s): 4"
"Va35"
"Undulating lands on sediments and metasediments, some phyllites: chief soils are hard alkaline yellow mottled soils (Dy3.43). Associated are (Dr3.33), (Dr3.32), (Dr2.41), (Dr2.42), (Dy2.41), and (Dy3.41) soils, often gravelly and stony; and (Ug5.12), (Ug5.15), and (Uf6.22) soils on included basalts. Occurs on sheet(s): 4"
"Va36"
"Low hilly valley areas derived from a wide range of volcanic rocks--long gentle slopes and undulating areas: chief soils are hard alkaline yellow mottled soils (Dy3.43) with (Dy3.42) and (Dr2.42) soils. Associated are (Ug5.15), (Ug5.12), and (Uf6.21) soils on basic rocks. Minor soil occurrences include (Dd1.42), (Dd1.22), and some (Um2.12) and (Um4.2). Occurs on sheet(s): 4"
"Va37"
"Valley plains, colluvial formations, and areas of low hills with rounded crests; derived from acidic rocks and freshwater sediments: chief soils are hard alkaline yellow mottled soils (Dy3.43) in alluvial, colluvial, and sedentary sites. Associated are: (Dd1.43) and (Dd1.23) soils in colluvial and alluvial sites; (Dy2.41), (Dy3.41), and (Dy3.42) soils on the hills; (Um2.12) and (Um4.1) on hill crests; (Ug5.13) and (Gn3.43) in sedentary sites; and (Ug5.15 and Ug5.16) in alluvial areas. Minor soil occurrences include (Gn3.93), (Gn3.13), and (Gn3.23); and (Dr2.22), (Dy2.62), and (Uc5.11) on levees. Occurs on sheet(s): 4"
"Va38"
"Gently undulating valley plains and terraces on alluvium derived from sandstones: chief soils are hard alkaline yellow mottled soils (Dy3.43) . Associated are (Ug5 .15 and Ug5 .16) soils on flats and depressions. Minor soil occurrences include (Ug5.25) on basal slopes and fans; (Gn2.11) on terrace remnants; and (Gn3.11) on included low hills. Occurs on sheet(s): 4"
"Va39"

"Low hilly country derived from sandstones which are often ferruginized; long gentle slopes grading to gently undulating plains with some low rises; some rock outcrops: chief soils are hard alkaline yellow mottled soils (Dy3.43). Associated are (Dy3.41) and (Dg2.41) in upper slope positions and (Dy3.42) and (Dy3.22) on mid slopes. Minor soil occurrences include (Uc2.12) and (Uc4.1) on crests; (Db2.22) in depressions; and (Gn2.11) on included flat-topped plateau remnants. Occurs on sheet(s): 4"
"Va40"
"Rounded low hilly granitic country; some tors in places: chief soils are hard alkaline yellow mottled soils (Dy3.43). Associated are: (Uc2.12) soils on crests; (Dy2.42), (Dy3.42), and (Dy2.41) soils on upper slopes; (Uc2.21) soils on colluvial deposits; and (Um2.12) soils on some crests. Minor soil occurrences include (Dd2.43) and (Db1.42) soils on lower slopes and depressions. Occurs on sheet(s): 4"
"Va41"
"Narrow valley plains with minor terrace levels, marginal slopes, and spurs cut in strongly weathered and lateritized sedimentary rocks: dominant soils are the hard alkaline yellow mottled soils (Dy3.43) and (Dy2.43) of the valley plains and lower slopes. Associated are (Dy3.41 and Dy3.42) soils of marginal slopes; (Db1.13) and (Dd1.43) on terraces; and shallow (Gn2.11), (Dr2.21), and (Dr2.41) often containing ironstone gravels on the lower slopes and spurs. Occurs on sheet(s): 4"
"Va42"
"Generally low hilly country on sandstones and shales with gentle to moderate slopes and some narrower ridges and spurs: chief soils are hard alkaline yellow mottled soils (Dy3.43) with some (Dy2.43) over all mid and lower slopes. Associated are (Dy2.42) and (Dy3.42) soils on upper slopes and broader crests and (Uc2.12) soils on crests and steep sites. Other soil occurrences include (Dr2.41), (Dr2.42), (Dy3.41), and (Db1.42). There are small inclusions of unit FM1. Occurs on sheet(s): 4"
"Va43"
"Generally low hilly country with distinct valley plains: dominant soils of the low hilly areas are hard alkaline yellow mottled soils (Dy3.43). These areas are similar to unit Va42. Dominant soils of the valley plains are alkaline dark friable earths (Gn3.43). These areas are similar to unit Mm14. Occurs on sheet(s): 4"
"Va44"
"Undulating to gently rolling lands on tertiary sandstones and gravels: chief soils are hard alkaline yellow mottled soils (Dy3.43). Associated are (Dy2.43) soils; (Gn3.43) and (Ug5.14) soils under brigalow; and some (Gn3.1) soils. Data are limited. Occurs on sheet(s): 4"
"Va45"
"Strongly undulating slopes rising to rounded low hilly areas; rock outcrop is common on higher landscape sites: dominant are shallow stony loamy duplex soils (Dy3.43) and (Dy3.33). Associated are shallow stony loams (Um1.43), (Um1.42), (Um1.41), and (Um2.12), and small areas of shallow stony red loamy duplex soils (Dr2.22), (Dr2.12), and (Dr2.43). Similar (Dy2) soils may also occur. Occurs on sheet(s): 4"
"Va46"
"Level or gently undulating alluvial flood-plains of limited extent, rising to undulating low foothills: dominant are loamy-surfaced duplex soils (Dy3.43) with lesser (Dy3.42) and similar (Dy2) soils. On slightly higher old stream levees sandy-surfaced soils (Gn3.25), (Dr2.22), (Db1.12), and (Db1.22) occur. In small local swampy depressions are cracking clays (Ug5.16) and (Ug5.24). Occurs on sheet(s): 4"
"Va47"
"Level or very gently undulating alluvial plains rising slowly to undulating low foothills: dominant soils have fine sandy or loamy A horizons overlying strongly mottled clay (Dy3.43). Closely associated are (Dy3.42 and Dy3.41) and (Dy3.33 and Dy3.32). Similar (Dy2) soils may also occur. The surface of lower swampy areas has a prominent (6-8 in.) irregular trench gilgai microrelief. Slightly higher old stream levees traversing the plains have coarser-textured gradational soils (Gn3.24), (Gn2.44), and (Gn2.71) or occasional brown duplex soils (Db1.22). On the undulating marginal foothills shallow often stony loamy duplex soils occur, chiefly (Dy3.42 and Dy3.41). Where the unit is adjacent to the coast the (Dy3) soils merge into salt pans (eroded (Dy3.43) soils), mangrove swamps, or less commonly marine plains (unit NN2). This unit is very similar to unit Ub87. Occurs on sheet(s): 4"
"Va48"
"Level alluvial plains with some terraces developed near major streams: dominant are moderately deep-surfaced loamy duplex soils (Dy3.43) and (Dy3.33) but (Dy3.42), (Dy3.32), and similar (Dy2) soils also often occur. In lower swampy sites there are dark cracking clays (Ug5.16). The more recent terraces have a variety of gradational sandy or loamy soils, including (Gn3.93 and Gn3.91), (Gn3.54 and Gn3.51), and (Db1.21 and Db1.22). Near the coast the unit may merge into mangrove swamps and salt pans. Occurs on sheet(s): 4"
"Va49"
"Moderate to strongly undulating lands with occasional low hilly areas, often dissected by shallow drainage lines; granite tor outcrop may be common: dominant are fairly coarse sandy duplex soils with strongly mottled sandy clay subsoils at moderate depths (10-15 in.). Most common form is (Dy3.43) but (Dy3.42) and (Dy3.41) also occur. Associated are some areas of similar (Dy2) and (Dy5) soils and also occurrences of gritty gradational soils

(Gn2.12) and (Gn2.45). On higher ridges and low hills gritty stony sands are common, chiefly (Uc5.11), (Uc2.12), (Uc4.11), (Uc4.2), and (Uc1.22). Also occurring in the unit as mapped are small areas of red loamy duplex soils (Dr2.12) and occasionally similar gradational soils (Gn3.12). Occurs on sheet(s): 4,7"
"Va50"
"Undulating or gently undulating lands: dominant are sandy or loamy often gritty duplex soils (Dy3.43) with lesser (Dy3.33) and (Dy3.42). Some similar (Dy2) soils also occur. Closely associated, particularly on higher landscape sites, are loamy red duplex soils (Dr2.12), rarely (Dr2.13). Small areas of granite outcrop within the unit have shallow coarse sands (Uc4.2 and Uc4.1), less commonly (Uc2.12). Occurs on sheet(s): 4,7"
"Va51"
"Gently or broadly undulating plains: dominant are sandy to loamy duplex soils, chiefly (Dy3.43) but (Dy3.42), (Dy3.32), (Dy5.42), and similar (Dy2) soils also occur. On some higher ridge crests sandy or loamy red earths occur (Gn2.12) and there may also be some small level plains of loamy or sandy yellow earths (Gn2.22 and Gn2.21). In some lower sites gilgaied grey clays (units CC30 and CC33) may occur associated with (Dy2.33) and (Dy2.43) soils. Fringing major streams are narrow levees with sandy or loamy duplex soils (Dr2.22), (Dy3.33), and (Dr3.32). Occurs on sheet(s): 4"
"Va52"
"Undulating or gently undulating lands with occasional small low sandstone cuestas or mesas near the margins of the unit: dominant are mostly sandy duplex soils with deep A horizons (10-20 in.); the lower A2 and upper B horizons often have many ironstone nodules. The chief form is (Dy3.43) but (Dy3.42), (Dy5.31), (Dy5.41), (Dy5.21), and similar (Dy2) soils also occur, together with small areas of earthy sands (Uc5.22). These latter and the (Dy5) soils occur most commonly near marginal sandstone ranges. Where present the low sandstone mesas and cuestas have sandy soils (Uc4.1), (Uc2.12), and (Uc1.21). In some lower landscape sites small areas of grey clays occur (unit CC30), or loamy duplex soils (Dy2.43). Occurs on sheet(s): 4"
"Va53"
"Undulating lands with occasional high ridges or low hills: dominant are mostly shallow (18-24 in.) often stony fine loamy-surfaced duplex soils (6 8 in. A horizons) with highly alkaline mottled clay subsoils (Dy3.43). Similar (Dy2) soils are also present with (Dr2.43) and (Dr3.43) occurring on higher slopes. Some ridges and the low hills have rock outcrop and shallow stony loams (Um4.1), (Um1.43), and (Um2.12). In lower sites there may be areas of gilgaied clays (Ug5.24) and (Ug5.34) associated with loamy duplex soils (Dy2.43), (Dy2.33), and similar (Db1) soils. Occurs on sheet(s): 4"
"Va54"
"Strongly undulating or low hilly lands occupying a broad dissected valley within the high sandstone ranges of unit JJ12: dominant are loamyor sandy-surfaced duplex soils with mottled yellow clay subsoils (Dy3.43). Other soils occurring include (Db1.43), (Db2.43), (Dy2.43), (Dy5.41), and (Dr2.43). Some eroded siliceous sandstone hills with shallow (Uc) soils occur in the unit, particularly marginally; these are inclusions of unit JJ12. Data are limited. Occurs on sheet(s): 4"
"Va55"
"Undulating or moderately undulating lands with broad valleys: dominant are sandy to loamy mottled duplex soils of shallow to moderate depth (18-30 in.). The chief form is (Dy3.43) but a range of other loamy duplex soils also occurs, chiefly (Dy3.33), (Dy3.32), (Dr3.21), (Dr2.12), (Dr2.42), (Dr2.31), (Dy2.43), (Db1.13), (Db1.43), and (Db1.33). In some lower sites there may be small areas of slightly gilgaied brown clays (Ug5.32 and Ug5.34). Throughout the unit there are small areas where the soil surface is covered with a mantle of billy gravel to 4 in. diameter. Occurs on sheet(s): 4"
"Va56"
"Undulating lands with some alluvial plains: dominant are very pale grey loamy or sandy duplex soils (Dy3.43) with similar neutral and acid forms occurring on higher landscape sites. Included in the unit as mapped are small areas of loamy or sandy yellow earths (Gn2.22) and small inclusions of unit Tb119. Data are limited. Occurs on sheet(s): 4"
"Va57"
"Very gently undulating alluvial outwash fan plains: dominant are sandy or gritty duplex soils with moderately deep A horizons (12-15 in.). The chief form is (Dy3.43). Associated are small areas of loamy duplex soils (Dy2.33) and (Dy2.43) which may have shallower A horizons (units Si10 and Sl16). Less commonly, deep sandy red duplex soils (Dr2.42) occur, particularly near and on old stream levees. Occurs on sheet(s): 4,7"
"Va58"
"Undulating to strongly undulating lands with occasional high linear stony ridges: dominant are fine sandy or loamy duplex soils (Dy3.43), with lesser (Dy3.42 and Dy3.41). Some similar (Dy2) and (Dy5) soils are associated. The high stony ridges have shallow gravelly sands (Uc2.12) and (Uc1.21) or loams (Um4.1) and (Um1.43) with much sandstone outcrop; these are inclusions of unit Bz8. Also occurring in the unit are small sloping plains of loamy yellow earths (Gn2.22). The Pentland occurrence has small inclusions of unit Qa9 instead of unit Bz8. Occurs on sheet(s): 4"

"Va59"
"Gently sloping and undulating plains: chief soils are hard alkaline yellow mottled soils (Dy3.43) with (Dy2.43). Minor soil occurrences are (Gn2.14) on broad convex riSes with (Dr2.41) on their slopes; and fringing areas of (Dy3.42). Occurs on sheet(s): 4"
"Va60"
"Strongly rolling to broad convex low hilly lands on metamorphic rocks but with inclusions of some high narrow-crested hills: chief soils are hard alkaline yellow mottled (Dy3.43) and yellow (Dy2.43) soils. Associated are (Dr2.12), (Ug5.12), and (Dd1.12) soils on crests and upper slopes of broad low rises; and (Uc2.12), (Dr2.42), (Dy2.42), and (Dr2.12) soils on the higher hills. Minor soil occurrences include (Um2.12) on crests and (Ug5.16) on creek flats. Occurs on sheet(s): 4"
"Va61"
"Gently sloping and undulating plains with low banks, narrow and shallow depressions, low fans, levees, and low crab-hole and linear gilgai microrelief: the dominant soils occupying the more extensive and slightly raised areas are hard alkaline yellow mottled soils (Dy3.43). Associated are (Ug5.16) clays in the depressions and (Dy2.43) soils on banks and levees. Minor soil occurrences include (Dd1.43) and (Db1.43) on fans with (Ug5.16) on linear gilgais. Occurs on sheet(s): 4"
"Va62"
"Very gently undulating outwash plain with broad low banks, shallow depressions, and some sandy levees: chief soils on the broad banks are hard alkaline yellow mottled soils (Dy3.43) with surface soil 8-15 in. in thickness. Associated are (Dy3.43) soils with surface horizons less than 8 in. thick in the shallow depressions; (Dy2.43) soils on low banks; and (Dy5.41 and Dy5.42) soils in sandy areas. Minor soil occurrences include deep sandy soils of the levees and other areas of sandy deposition. Occurs on sheet(s): 4"
"Va63"
"Valley plains and terraces: chief soils are hard alkaline yellow mottled soils (Dy3.43). Associated are small areas of a range of soils including (Dy3.42), and (Dr5.8) and (Dy5.8), both containing laterite or large amounts of ironstone gravels; and some (Dr2.4) and (Uc2.34) soils. As mapped, areas of adjoining units are included. Occurs on sheet(s): 5"
"Va64"
"Plains--shallow flat-bottomed valley plains in which some salinity is usually evident: chief soils are hard alkaline and neutral yellow mottled soils (Dy3.43 and Dy3.42). Associated are small areas of many soils including occasional terraces of (Dr2.4) soils. As mapped, areas of adjoining units are included. Occurs on sheet(s): 5"
"Va65"
"Plains characterized by lakes with lunettes (often multiple lunettes) and other aeolian deposits covering ironstone gravel ridges: chief soils in a very variable soil situation are probably hard alkaline and neutral yellow mottled soils (Dy3.43 and Dy3.42). Associated are hard alkaline and neutral red soils such as (Dr2.43) and (Dr2.72) on older lunettes; (Dy2.33) soils in swales between lunettes; (Uc1.21) sands on younger lunettes; (Dr2.23 and Dr2.33) soils, often only 9-12 in. thick, on aeolian deposits covering ironstone gravel ridges; and probably other soils. Occurs on sheet(s): 5"
"Va66"
"Gently undulating to rolling terrain with some ridges and uneven slopes; and with the variable presence of lateritic mesas and buttes and granitic tors and bosses: chief soils are hard alkaline yellow mottled soils (Dy3.43) and hard alkaline red soils (Dr2.33), (Dr3.33), and (Dr2.43), either of which may be dominant locally. Associated are a variety of soils, notably (Dy) soils such as (Dy3.82 and Dy3.83) and (Dr) soils such as (Dr3.32). Acid lateritic strata are common below 4-5 ft. As mapped, lateritic mesas and buttes of unit Ms8 soils are a constant feature, as are small granitic bosses and tors of unit JJ16 and minor valleys of units Sl28, Oc31, and Vb2. Western occurrences of this unit have some features transitional to unit Uf1, especially the larger areas of (Dy3.82) soils. Occurs on sheet(s): 5"
"Va67"
"Undulating to hilly ridge and slope topography with flat to gently sloping crests to the ridges; rock outcrops are common on slopes: chief soils are hard alkaline yellow mottled and red mottled soils (Dy3.43) and (Dr3.43) on the valley side slopes. Associated are a wide range of soils including shallow forms of (Dy5.42) and (Dr5.42) underlain by kaolinized granites at 18-24-in. depth, on upper hill slopes; (Dy5.82) soils containing ironstone gravel on ridge crests; some (Dr2.42) soils on slopes; and some (Ug5) soils on river terraces as for unit Od9. Data are limited. Occurs on sheet(s): 5"
"Va68"
"Stream valleys--broken terrain with some steep and often rocky valley side slopes, mesas and buttes of units Xd1 or Cz1, stream terraces and levees, some swamps: chief soils of the valley side slopes seem to be hard alkaline and neutral yellow mottled soils (Dy3.43) and (Dy3.82) which may contain ironstone gravel. Associated are various (Dr) and (Dy) soils such as (Dr3.43) on the valley side slopes; soils of units Xd1 and Cz1 on mesas and buttes; and

undescribed soils of the terraces, levees, and swamps. Unknown variations may occur along the length of the streams as data are limited. Occurs on sheet(s): 5"
"Va69"
"Broad flat valleys: chief soils are hard alkaline yellow mottled soils (Dy3.43). Associated are small areas of other soils including (Dr2.33) and the soils of adjoining units. Occurs on sheet(s): 5"
"Va70"
"Valley plains and terraces: chief soils are hard alkaline yellow mottled soils (Dy3.43). Associated are small areas of other soils including (Gc1.22) and (Gc1.12) and the soils of adjoining units. Occurs on sheet(s): 5"
"Va71"
"Valley plains and terraces: chief soils are hard alkaline yellow mottled soils (Dy3.43). Associated are saline flats; areas of (Gn2.1) soils; and soils of the adjoining units. Occurs on sheet(s): 5"
"Va72"
"Nearly flat plains: chief soils are alkaline hard yellow mottled soils (Dy3.43) in gilgai depressions, in complex with grey cracking clays (Ug5.2) on gilgai rises. Associated are saline (Uf) and (Um) soils. Occurs on sheet(s): 8,9"
"Va73"
"Open flat to gently sloping plains traversed by streams flanked by levees and active flood-plain areas: both (Dy3) and (Gn2) soils characterize these plains but it is not clear which soil is dominant. The common soils are hard alkaline, hard neutral, and hard acidic yellow mottled and yellow soils (Dy3.43), (Dy3.33), (Dy3.42), (Dy3.41), (Dy3.11), and (Dy2.43) in which A horizon thickness varies from < 6 in. to > 12 in. in depth; acidic and neutral yellow earths (Gn2.24 and Gn2.25) often containing ironstone gravel, and with their sola often overlying either cemented ferruginous layers or dense alkaline clays; and yellow and grey leached earths (Gn2.74) and (Gn2.94 and Gn2.95), often containing ironstone gravels. Any of the foregoing soils may be dominant on an individual plain; indeed, the plain associated with each stream invariably has features peculiar to itself. Other soil occurrences include (Uc1.21), (Uc1.43), (Um5.4), and (Um) and (Uf) soils on levees and flats close to streams; and (Dg2.41). Occurs on sheet(s): 8"
"Va74"
"Undulating lands with occasional massive sandstone outcrop: dominant are moderately deep loamy duplex soils, chiefly (Dy3.43) but with other duplex soils (Dy3.33) and (Dr3.33) commonly associated. Adjacent to sandstone outcrops are shallow gravelly sands (Uc4.11) and (Uc4.2). Occurs on sheet(s): 7"
"Va75"
"Gently undulating plains: dominant are loamy or occasionally sandy mottled duplex soils (Dy3.43) and (Dy3.33) with moderately deep (6-15 in.) A horizons. Small stream flood-plains have loamy duplex soils (Dy2.33) and (Db1.33) with shallower (4-6 in.) A horizons. Slightly higher rises occurring in parts of the unit have sandy or loamy yellow earths (Gn2.61, Gn2.64), and (Gn2.21, Gn2.22) or occasionally massive duplex soils (Dy3.81). Marginal to unit CB11 are small areas of grey cracking clays (Ug5.22), and adjacent to the sandstone mesas of unit JK23 are areas of outwash sand (Uc4.22). Occurs on sheet(s): 7"
"Va76"
"Alluvial plains with some low stream levees and relic infilled stream channels: dominant are loamy or occasionally sandy duplex soils (Dy3.43). Other duplex soils, chiefly (Dy2.43), (Dy3.33), (Dy2.33), (Dd1.33), and (Db1.33), are closely associated. The range of soils occurring on the low stream levees and channel infills is similar to that described in unit Va78. Also included are some weakly gilgaied areas of unit Sil0. Occurs on sheet(s): 7"
"Va77"
"Gently undulating alluvial plains with numerous stream levees and channels. The pattern of soils is similar to that of unit Va76 but the sandy duplex soils occupy a greater part of the unit. Occurs on sheet(s): 7"
"Va78"
"Gently undulating to undulating outwash slopes and fans with occasional isolated low hills: dominant on the outwash areas are sandyor gritty-surfaced duplex soils (Dy3.43) with moderately deep (6 12 in.) A horizons. Associated duplex soils include (Dy3.33), (Dy3.23), (Dy2.23), (Dy2.43), (Db1.11), (Db1.12), and (Dr3.43). Various loamy earths (Gn2.14), (Gn2.44), and (Gn2.24) occur on the low stream levees and younger fans. Loamy red duplex soils (Dr2.12) are common on the granite hills, with shallow stony loams (Um4.1) and (Um4.2) or sands (Uc4.1), (Uc4.2), and (Uc2.12) occurring on other hills. Occurs on sheet(s): 7"
"Va79"
"Undulating to moderately undulating lands with occasional higher strike ridges and low hilly areas: the soils vary according to the lithology of the sedimentary rocks, but dominant are shallow sandy to loamy duplex soils with A horizons ranging from 4 to 8 in. deep. The chief form is (Dy3.43) but very closely associated are many other duplex soils including (Dy3.41), (Dy3.33), (Dy2.23), (Dy2.43), (Dr2.22), (Dr2.4), (Dr3.4), (Dr3.3), (Db1.23), and (Db1.43). Shallow sands (Uc2.12) and lesser loams (Um2.12) are common on the higher ridges. All soils have moderate to high amounts of surface gravel with variable amounts through the profile. Included are small areas of gilgaied deep cracking clays, with (Ug5.16) in the depressions and (Ug5.2) on the puffs. Occurs on sheet(s): 7"

"Va80"
"Undulating lands with long gentle slopes to fairly broad drainage lines; included in some areas are small lateritic mesas: dominant soils are shallow to moderately deep sandy or Fitty mottled duplex soils (Dy3.43). A wide range of other duplex soils (Dy3.32), (Dr2.33), (Dr2.43), (Dy2.23), (Dr3.43), and (Db1.23) occur on the sloping country, while uniform loams (Um4.2) and loamy duplex soils (Dy3.43) and (Dy3.33) occupy the drainage lines. Shallow nodular red or yellow earths (Gn2.15) and (Gn2.25) occur on the low lateritic mesas. Data are fairly limited. Occurs on sheet(s): 7"
"Va81"
"Strongly undulating to low hilly lands with many high narrow strike ridges: dominant are shallow gravelly sandy or loamy duplex soils (Dy3.43). Associated duplex soils include (Dy3.33), (Dy3.41), and (Dy2) and (Dr2) equivalents. Shallow gravelly sands (Uc2.12) and (Uc1.21) are common on higher slopes and ridge crests and are associated with much rock outcrop. Data are limited. Occurs on sheet(s): 7"
"Va82"
"High hilly to mountainous lands with very steep slopes and much rock outcrop: dominant are shallow gravelly loamy duplex soils (Dy3.43). Very closely associated are shallow sands (Uc4.2) and (Uc1.4), lesser (Uc2.12), and loams (Um4.2) and (Um1.42) which occur on higher slopes and adjacent to rock outcrop. Other loamy duplex soils (Dy3.41), (Dy2.43), (Dy2.33), (Db1.33), (Dr2.33), and (Dr2.21) occur on lower slopes and in minor drainage lines. Loamy red earths (Gn2.11, Gn2.14) occur on the levees and small alluvial terraces of the major streams. Occurs on sheet(s): 7"
"Va83"
"Moderately to strongly undulating lands with occasional low hills. The unit has a complex range of soils that is closely related to the variable sedimentary rock parent material and to topography: dominant are shallow gravelly loamy duplex soils (Dy3.43), but closely associated are other similar duplex soils (Dy3.32), (Dy3.22), (Dy2.22), (Dy2.23), (Dy2.32), (Db1.42), (Db2.32), (Db2.33), (Dr2.12), (Dr2.22), (Dr2.23), (Dr2.32), and (Dr3.33). Shallow gravelly loams (Um4.2), (Um5.2), (Um2.12), and (Um4.12) and similar sands may occur on all landscape sites, but are more common on higher slopes and ridge crests and may be locally dominant in areas of stronger relief. Occurs on sheet(s): 7"
"Va84"
"Shallow dissected valley between low lateritic plateaux; numerous low lateritic scarps and mesa remnants occur: dominant are moderately deep loamy duplex soils, chiefly (Dy3.43) but with a range of similar soils including (Dy2.43), (Dy2.42), (Db1.43), (Db2.43), (Db2.33), (Dr2.22), and (Dr3) equivalents. Loamy red or yellow earths (Gn2.14) and (Gn2.24) occur on the lateritic mesas, while shallow gravelly loams (Um4.12) and (Um4.21) occur on the low scarps. The alluvium of the valley floor has deep cracking clays (Ug5.15, Ug5.17) in the lower back swamp areas and loamy earths (Gn2.14, Gn2.15) and (Gn2.44) on levees and recent alluvial terraces. Data are fairly limited. Occurs on sheet(s): 7"
"Va85"
"Level alluvial plains rising to short gently sloping pediments and foot-slopes; some isolated low hilly areas are included: dominant are deep loamy or occasionally sandy duplex soils (Dy3.43), with lesser (Dy3.42), (Dy3.41), (Dy2.43), (Db2.43), and (Dr3.43). Loamy earths, particularly (Gn2.14) but also (Gn2.44) and (Gn2.24), occur on the levees and recent alluvium of the major streams. Included in some areas are very small occurrences of gilgaied yellow friable earths (Gn3.53). Shallow stony loams (Um2.12), (Um4.23), and (Um4.1) or loamy duplex soils (Dy3.41) are common on the low hills. Occurs on sheet(s): 7"
"Va86"
"Gently undulating outwash slopes and fans: dominant are deep loamy duplex soils (Dy3.43), with closely associated deep bleached sands (Uc2.22, Uc2.21). The sands are confined to the relic stream channel infills and fans. Minor associated soils include other loamy duplex soils (Dy2.43) and (Dy3.41) and occasionally (Dr2.21). Data are limited. Occurs on sheet(s): 7"
"Va87"
"Level or very gently undulating alluvial plains and smaller well-defined drainage depressions originating in the northern areas of unit Mr11: dominant are loamy or fine sandy bleached mottled duplex soils; (Dy3.43) is most common but other similar duplex soils (Dy3.42), (Dy3.33), (Dy3.83), (Dy3.73), (Dy2.43), and (Dy2.42) also are common. Also occurring are loamy bleached grey earths (Gn2.95, Gn2.94) and, in occasional swampy depressions, slightly gilgaied deep grey clays (Ug5.5) and (Ug5.24). Towards the coastal margins of the unit there are small areas of the bleached mottled friable grey earths (Gn3.04) of unit MF10. Throughout the unit on the wider alluvial plains there are old stream levees, infilled channels, and small sandy rises. These have sandy earths (Gn2.14), (Gn2.24), (Gn2.64), and (Gn2.74) and occasionally deep sands (Uc4.22). Occurs on sheet(s): 7"
"Va88"
"Very gently undulating alluvial plains and smaller well-defined drainage depressions originating in unit Mw5O; the wider plains often have many small drainage lines and occasionally low sandy rises: dominant are sandy or loamy bleached mottled duplex soils, chiefly (Dy3.43) but with some areas of (Dy3.42) and (Dy2.42), occasionally

(Dy3.81) and (Dy5.43). The sandy duplex soils often have deep (10-20 in.) A horizons. Associated are some bleached grey earths (Gn2.95, Gn2.94). On the more extensive alluvial plains there are often low rises with deep bleached sands (Uc2.21) and (Uc2.34) and occasionally small islands of the sandy red earths (Gn2.14) of unit Mw50. Occurs on sheet(s): 7"
"Vb1"
"Plain with lunettes and subdued dunes: plains of hard alkaline yellow mottled soils (Dy3.83) and sandy alkaline yellow mottled soils (Dy5.43); low dunes of leached sand (Uc2.2); small areas of (Dr2.23, shallow forms), (Dy2.23), and (Um6.24) especially on and near lunettes. Occurs on sheet(s): 1"
"Vb2"
"Upper reaches of broad gently sloping valleys: chief soils are hard alkaline yellow mottled soils (Dy3.83) and (Dy3.43) and leached yellow earths, possibly (Gn2.55), both containing siliceous hardpans in the subsoil as well as variable amounts of ironstone gravels. Associated are small areas of other soils including shallow yellow earths (Gn2.2) often only 24 in. thick and overlying truncated (Dy) or (Gn2) soils. As mapped, small areas of units Oc31 and Sl28 may be included. Occurs on sheet(s): 5"
"Vc1"
"Area of subdued relief: gently sloping lower hill slopes of hard alkaline yellow mottled soils (Dy3.23) in association with (Dy3.13), and smaller areas of (Dy3.4), (Dd2.11), (Uc4.32), and (Uc1.4); terrace remnants of hard neutral brown soils (Db1.22 and Db2.22) with small areas of (Uc5.11); floodplains and fans of dark cracking clays (Ug5.16), brown friable earths (Gn3.22), and friable loamy soils (Um6). Occurs on sheet(s): 2"
"Vc2"
"Hilly: moderate hill slopes of hard alkaline yellow mottled soils (Dy3.23) in association with (Dy3.13) and smaller areas of (Dy5.41) and (Uc5.31), rock outcrops; some small areas of rounded hills of hard neutral and alkaline red soils (Dr2.12 and Dr2.13); small valleys of hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43) on terrace remnants and dark cracking clays (Ug5.16 and Ug5.15) in floodplains. Occurs on sheet(s): 2"
"Vc3"
"Gently undulating sandy plains underlain by mottled highly alkaline saline clays; near the margin of Lake Buchanan the landscape consists of low broad parallel dunes. The chief soils are (Dy3.23) and (Dy3.43) with lesser (Dy3.63), (Dy5.63), and (Dy5.43). The partly included dry margins of Lake Buchanan have saline clays (Uf6.61) with some salt incrustations occurring locally. In some areas of this unit it is likely that the duplex profiles are due to wind-blown sand covering clay pans. Occurs on sheet(s): 4"
"Vd1"
"Low hilly area with steep slopes and narrow, incised, stream valleys: rounded, upper and mid hill slopes of dark cracking clays (Ug5.13 and Ug5.12) in association with hard alkaline and neutral yellow mottled soils (Dy3.33 (2) and Dy3.23 (2); concave, lower hill slopes of (Dy3.33 (2), (Dy3.23 (2), and (Dy3.13); evidence of soil creep and soil layering on slopes; small areas of (Ug5.1) soils in the narrow stream valleys; other undescribed soils are like. Occurs on sheet(s): 2"
"Vd2"
"Level or very gently undulating plains and broad shallow valleys associated with drainage lines: dominant soils have deep sandy A horizons and are chiefly (Dy3.33) and (Dy3.43), but (Dy3.23), (Dy3.32), and similar (Dy5) soils also occur. Smaller areas of loamy-surfaced (Dy2.33) soils are associated with some drainage lines. Included in the unit as mapped are small areas of sandy yellow earths (Gn2.22), (Gn2.62), and occasionally swampy depressions with clay soils (Ug5.24). Occurs on sheet(s): 4"
"Vd3"
"Gently undulating slightly elevated plains with a slight (6-12 in.) gilgai microrelief: dominant soils have loamy A horizons 412 in. deep. The chief form is (Dy3.33), rarely (Dy3.43). These duplex soils occur on level sites, most puffs, and all depressions; in the latter, A horizons are at the deep end of the range. Occasionally on some better-defined puffs grey clays (Ug5.24) occur. Data are fairly limited. Occurs on sheet(s): 4"
"Vd4"
"Level or very gently undulating alluvial plains: dominant are duplex soils with fine sandy or loamy A horizons 6-10 in. deep. The chief forms are (Dy3.33) and (Dy3.43). Closely associated are slightly lower plains with a gilgai complex. The clay puffs are elevated (4 6 in.) and have grey or dark grey clays (Ug5.28) and (Ug5.16). Intervening areas have loamy duplex soils (Dy3.33), (Dy3.43), (Dy2.43), (Dy2.33), and (Dd1.33); A horizon depth ranges from 4 to 6 in. Also included in the association are smaller slightly gilgaied clay plains with clay-dominant soils (Ug5.16) and (Ug5.28), and some areas of thin-surfaced loamy duplex soils (unit Sl16). Occurs on sheet(s): 4,7"
"Vd5"
"Moderate to strongly undulating lands with occasional high strike ridges with sandstone outcrop: dominant are loamy duplex soils with mottled yellow-brown subsoils. The chief form is (Dy3.33) but (Dy3.23) and (Dy3.43) also occur. Important areas of red loamy duplex soils (Dr2.12), (Dr2.32), (Dr2.42), and (Dr3.33) are present in the unit. Associated small alluvial plains have grey loamy duplex soils (Dy2.43) and occasional highly calcareous

ridges have shallow loams (Um1.3). Where sandstone outcrop is prominent shallow sand soils of units JJ13 and Cd15 are found. Occurs on sheet(s): 4"
"Vd6"
"Flat, fairly extensive valley floors: chief soils are hard alkaline yellow mottled soils (Dy3.33). Associated are (Dy3.43) soils along with areas of gilgai and cracking clays (Ug5.37), as well as some (Dr3.33) and (Dr3.43) soils. Occurs on sheet(s): 5"
"Vd7"
"Gently sloping valley floors: chief soils are hard alkaline yellow mottled soils (Dy3.33) and (Dy3.43), some with cemented cappings to the clay subsoil. Other soils include (Dr2.33). Occurs on sheet(s): 5"
"Vd8"
"Level alluvial plains often cut by numerous old infilled channels and drainage depressions: dominant are moderately deep to deep-surfaced (7-24 in.) loamy to silty duplex soils (Dy3.33) and (Db2.33), with (Dy3.32), (Dy2.33), and (Db1.33) also often associated. Also occurring in marginal sites are small areas of loamy yellow earths (Gn2.62) and some structured earths (Gn3.05). Associated in lower sites are deep massive mottled cracking clays (Ug5.5, Ug5.4, and Ug5.6), with occasionally self-mulching cracking clays (Ug5.28). Slightly elevated infilled stream channels have earthy sands (Uc5.21) and (Uc5.11), bleached sands (Uc2.21), and some bleached sandy grey earths (Gn2.94). Marginal to the sand-filled channels are deep sandy-surfaced duplex soils (Dy3.42), (Dy3.82), and (Dy3.43). Occurs on sheet(s): 7"
"Vd9"
"Gently undulating alluvial plains and short gently sloping fans and pediments rising to low foothills: dominant are sandy or loamy duplex soils, chiefly (Dy3.33) but with (Dy3.23), (Dy3.43), (Dy2.23), (Dy2.43), (Db1.33), and (Db1.43) soils closely associated and in some areas locally dominant. Loamy red or yellow earths (Gn2.15), (Gn2.22), and (Gn2.25) occur on the more recent alluvial fans and on stream levees. Occurs on sheet(s): 7"
"WM1"
"Low hilly lands, often occurring as high plateaux with marginal high hills and steep scarps; in some areas, particularly at the margins of the unit, there is much granite outcrop: dominant soils are probably shallow to moderately deep yellow-brown friable earths (Gn3.54), but other friable earths are also common, chiefly (Gn3.51), (Gn3.71), (Gn3.74), (Gn3.21), and (Gn3.14). Less common are some shallow yellow (Gn2.21) or grey (Gn2.81) earths. Other associated soils are shallow gravelly loams (Um4.22, Um4.23) or sands (Uc4.21), and shallow gravelly duplex soils (Dy3.21), (Dy2.21), and (Db1.21). Data are fairly limited. Occurs on sheet(s): 7"
"Wa1"
"Dissected tableland: moderate to very steep slopes of sandy acidic yellow mottled soils (Dy5.41) in association with hard acidic yellow mottled soils (Dy3.41) with relatively small areas of (Dy3.61) and (Dy5.91) on the tableland remnants; a great variety of soils of very small individual area, including leached sands (Uc2.3), various organic soils (O), and alluvial soils (unclassified) in the stream valleys. Occurs on sheet(s): 1"
"Wa2"
"Hilly: small steep hilly to mountainous areas as for unit JJ3, surrounded by rounded foothills of sandy acidic yellow mottled soils (Dy5.41), in some of which the lower A2 horizon forms a hardpan; leached sands (Uc2.3) and (Uc4.3), bow which a clay layer occurs are common in the wetter situations; small areas of swamp and other soils not described. Occurs on sheet(s): 2"
"Wa3"
"Rounded foothills with broad valleys: rounded foothills of sandy acidic yellow mottled soils (Dy5.41), in some of which the lower A2 horizon forms a hardpan, smaller areas of leached sands (Uc2.3) and (Uc4.3), with a clay layer bow the solum, occur in the wetter situations; broad valleys of various soils, including (Dy5.4), which often have a "melon-holey"microrelief; minor areas of other soils (unclassified) in special situations, e.g. on lunettes; inclusions of steep hilly to mountainous areas as for unit JJ3. Occurs on sheet(s): 2"
"Wa4"
"Hilly, dissected by steep-sided stream valleys with narrow floodplains: hill slopes of sandy acidic yellow mottled soils (Dy5.41) in association with (Dy5.31, Dy5.71), (Dy3.41), (Dr4.21) on tertiary marine sediments, (Uc2.2), (Uc2.36), (Uc4.3), and other soils not described. Occurs on sheet(s): 2"
"Wa5"
"Undulating plain with an occasional area of low hills: undulating plain of sandy acidic yellow mottled soils (Dy5.41) traversed by river floodplains of hard acidic yellow mottled soils (Dy3.21) which are very wet where not drained; other undescribed soils occur too. Occurs on sheet(s): 2"
"Wa6"
"Hilly with broad flat-topped ridges and small valley plains with some swampy areas: hills and hill slopes of sandy acidic yellow mottled soils (Dy5.41), often with nodules of coffee rock and in association with leached sands (Uc2.21 and Uc2.33); flat-topped ridges of hard acidic yellow mottled soils (Dy3.41), usually with ironstone gravs; small valley plains of undescribed soils. Occurs on sheet(s): 2"
"Wa7"

"Undulating to hilly plateau and its escarpment: (1) undulating to hilly plateau of sandy acidic yellow mottled soils (Dy5.41 and Dy5.21) and hard acidic yellow mottled soils (Dy3.41) in association with rock outcrops and areas of siliceous sands (Uc1.21), leached sands (Uc2.2), hard red soils (Dr2.2) on shales, and (Gn) soils in poorly drained sites; (2) the escarpment of (Uc4.11) soils, rock outcrops and boulders on the steeper slopes and (Dy5.41) soils on the more moderate slopes. Occurs on sheet(s): 2"
"Wa8"
"Dissected plateau: ridge tops of sandy acidic yellow mottled soils (Dy5.41) containing ironstone grav; mid and lower slopes of shallow red friable earths (Gn3.13), probably other (Gn), (Um6), and possibly (Ug6) soils, not described; narrow stream valleys with small floodplains of undescribed soils. Occurs on sheet(s): 2"
"Wa9"
"Hilly with some flat-topped ridges and small swampy valleys, granitic tors: chief soils are sandy acidic yellow mottled soils (Dy5.41) and/or (Dy5.81). Associated soils are riot known. This unit probably has similarities to units Wa14 and Wa10. Occurs on sheet(s): 3"
"Wa10"
"Undulating to hilly, granitic tors: chief soils seem to be sandy acidic yellow mottled soils (Dy5.41 and/or (Dy5.81); leached sands (Uc2.31) and/or (Uc2.34); and yellow earths such as (Gn2.24) Associated are soils common to unit Ub56; occasionally red earths (Gn2.14); and red earths con taining large amounts of ironstone or bauxitic gravel (Gn2.11). As mapped, areas of units Cb30 and Ub56 are included. There are similarities to units Wa9 and Wa14. Occurs on sheet(s): 3"
"Wa11"
"Low hilly to hilly with tors: chief soils are sandy acidic yellow mottled soils (Dy5.41) and/or (Dy5.81). Associated are leached sands (Uc2.34 and Uc2.31) with various (Dy), (Db), and some (Gn2) soils. This unit is close to units Wa9 and Wa10. As mapped, small areas of unit Rh3 are included. Occurs on sheet(s): 3"
"Wa12"
"Broken topography--undulating to hilly with sandstone ledges and rock outcrops towards the ranges (east), and long sandy ridges running out towards the plains (west): chief soils are sandy acidic and neutral yellow mottled soils (Dy5.41 and Dy5.42) often containing ironstone gravels. Associated are yellow earths (Gn2.21 and Gn2.22) and possibly other undescribed soils. This unit has similarities to both units X11 and Ms1. Occurs on sheet(s): 3"
" Wa13"
"Flat to gently sloping plains with occasional undulating sandy ridges: chief soils are sandy soils with mottled yellow clayey subsoils (Dy5.41 and Dy5.81) and (Dy5.42 and Dy5.82). Associated are (Dy2.42 and Dy2.43) and (Dy3.43 and Dy3.42) soils; and minor areas of acid hard-setting (Dr2) and (Dr3) soils. Some low hills of unit Fz3 are included. Occurs on sheet(s): 3,4"
"Wa14"
"Hilly tableland from 1500 to 4000 ft elevation with numerous ridges separating broad open valleys traversed by shallow streams with some swampy flats and marshes in their headwaters: chief soils of the broad open valleys--the gently undulating to flat areas with some subsurface waterlogging-are the sandy acidic yellow mottled soils (Dy5.41). Associated are: granitic tors with sloping areas of leached sand soils (Uc2.2) and some detrital areas of (Dy2.41) soils; swampy flats with such soils as (Dg4.41); and hilly ridges of granitic tors with some shallow (Uc) soils and (Uc2.2) soils in colluvial sites. Hardpans may occur in some areas of the (Dy) soils. Some of the more rugged portions are similar to unit Cb30. Occurs on sheet(s): 3"
"Wa15"
"Moderate to strongly undulating lands with occasional low mesa-like hills: dominant soils have deep sandy A horizons (12-24 in.) overlying strongly mottled sandy clays (Dy5.41) and (Dy5.21) with smaller areas of (Dy5.42 and Dy5.43). Commonly associated are hard sandy duplex soils (Dy3.42), (Dy3.43), (Dy3.41), and (Dy2.42); and deep sand soils (Uc1.21), (Uc5.11), (Uc4.2), and (Uc2.12). Some small stream flood-plains have dark loamy duplex soils (Dd1.13) and (Dd1.33). Occurs on sheet(s): 4"
"Wa16"
"Undulating or moderately undulating lands: dominant soils have deep sandy A horizons (12-24 in.) overlying mottled clay or sandy clay (Dy5.41), (Dy5.81), and (Dy5.21). Closely associated are hard sandy duplex soils (Dy3.42 and Dy3.41). Also occurring are some areas of deep bleached sands (Uc2.22); other sandy soils (Uc5.11) and (Uc5.22); and areas of mostly nodular sandy yellow earths (Gn2.21) or red earths (Gn2.11). Occurs on sheet(s): 4"
"Wa17"
"Rolling to low hilly terrain on sandstones with gentle to moderate slopes; shallow open valleys with poorly defined drainage-ways; some sandstone inselbergs rise above the general level: chief soils are sandy acidic yellow mottled soils (Dy5.41) in association with (Dy5.21) and (Dr5.41) on the slopes, while (Dy3.41) and (Dy2.41) soils are found in saddles and on mid and lower slopes with (Dg4.81) and (Dg2.81) in the swampy depressions. Small areas of many other soils occur and especially the (Gn) soils of adjacent units. Occurs on sheet(s): 4"
"Wa18"

"Hilly terrain on tuffs, rhyolite, and trachyte, rising above valley floors and coastal plains to 400-600 ft above sea level; crests are narrow and side slopes moderate to steep; some rock outcrops and cliff faces: chief soils are sandy acidic yellow mottled soils (Dy5.41) and (Dy4.41) with (Dy5.21), (Dy4.21), and (Dy3.41). Associated are (Gn4.54) and (Uc2.22) soils. Minor soil occurrences include a range of (Gn3) soils such as (Gn3.74). As mapped, there are inclusions of unit MF6. Occurs on sheet(s): 4"
"Wa19"
"Gently undulating plains, locally with stronger relief: dominant soils have deep loose sandy A horizons and strongly mottled clay subsoils. The chief form is (Dy5.41) but neutral and alkaline forms also occur. In lower sites hard-setting sandy duplex soils occur, chiefly (Dy3.42 and Dy3.43). Small areas of sandy yellow earths (Gn2.21) are included in the unit. Data are limited. Occurs on sheet(s): 4"
"Wa20"
"Rolling to low rounded hilly generally sandy terrain with some flat narrow ridge crests; concave valleys with ill-defined channels: chief soils are sandy acidic yellow mottled soils (Dy5.41) on slopes and low hill crests. Associated are (Dy3.41) soils on slopes and (Gn2.91 and Gn2.96) soils in valley flats. Minor soil occurrences include (Dr3.41) and gravelly (Gn2.14). Small areas of unit NV1 are included. Occurs on sheet(s): 4"
"Wb1"
"Dissected tableland: sandy acidic yellow mottled soils with a laterite layer (Dy5.91), and small areas of (Dy3.61), (Dy5.61) on the tableland remnants; leached sands (Uc2.2 and Uc2.3) in the ill-defined drainage-ways. Occurs on sheet(s): 1"
"Wb2"
"Undulating dissected tableland: as for Wb1 but with (Uc6.11) and (Um6.24), exposed sheet limestone and lagoons at the lower levels. Occurs on sheet(s): 1"
"Wc1"
"Hilly: gentle to moderate slopes of sandy acidic and neutral yellow mottled soils (Dy5.61 and Dy5.62) in association with hard acidic yellow mottled soils (Dy3.81), leached sands (Uc2.3) and (Uc4.3), bow which clay layers occur, and rock outcrops; steep slopes of sand soils (Uc4.11) and rock outcrops. Occurs on sheet(s): 2"
"Wc2"
"1 Rugged mountain terrain at moderate to high elevation: moderate to steep slopes of sandy acidic yellow mottled soils (Dy5.61), often with a thin organic pan above the clay subsoils, leached sands (Uc2.3), shallow sand soils (Uc4.11) and rock outcrops possibly in association with yellow leached friable earths such as (Gn3.74, Gn3.84, and Gn3.14); some leached sands (Uc2.3) with other undescribed soils on lower slopes above stream valleys and some acid peaty (O) soils in the small valley plains. Occurs on sheet(s): 2"
"Wc3"
"Mountainous: moderate to steep slopes of sandy acidic yellow mottled soils (Dy6.61), in which a thin organic pan may occur above the clay subsoil, and in association with other acidic (Dy6) soils, shallow sand soils (Uc4.11), and rock outcrops with minor areas of many other soils, including (Gn2.94), (Gn3.94), and (Gn4.11); lower slopes above river valleys of leached sands (Uc2.3 including Uc2.35) and other undescribed soils; small valley plains of various soils, including acid peaty (O) soils in the flatter swampy situations. Occurs on sheet(s): 2"
"Wc4"
"Deeply dissected plateau: gentle to steep hill slopes of sandy acidic yellow mottled soils (Dy5.61 and Dy5.21) in association with other (D) soils, such as (Dy3.61) and (Dy3.42 and Dy3.82), also some leached sands (Uc2.3 and Uc4.32); very steep slopes to the creek valleys of (Uc) and (Um) soils with some areas of (Dy3.41); ironstone gravs are common throughout the area. Occurs on sheet(s): 2"
"Wc5"
"Plain with many low-lying wet areas: plain of sandy acidic yellow mottled soils (Dy5.61) and hard acidic yellow mottled soils (Dy3.61), both of which have thin organic pans between the A and clayey B horizons (similar to the pans found in (Uc2.3) soils); there are probably many other undescribed soils, especially in the wet areas. Occurs on sheet(s): 2"
"Wc6"
"Undulating to hilly with small creek and river flood-plains: gentle to moderately steep slopes of sandy acidic yellow mottled soils (Dy5.61) with some sand soils, such as (Uc4.1) and (Uc1.2), also possibly some hard acidic yellow mottled soils (Dy3.41). These areas flank terraced alluvial flats of (Dy5.11), (Dy5.81 and Dy5.41), and (Uc2.2) soils. Occurs on sheet(s): 3"
"Wc7"
"Broken hilly often with prominent and massive sandstone ledges: chief soils are sandy acidic yellow mottled soils (Dy5.61 and Dy5.81), the former often containing ironstone gravel in the surface horizons. Associated are leached sand soils (Uc2.3) and possibly other undescribed soils. Occurs on sheet(s): 3"
"Wc8"

"Flat to strongly undulating: chief soils are sandy acidic yellow mottled soils (Dy5.61, Dy5.41, and Dy5.81). Associated are various sand soils such as (Uc4.2) and (Uc2.2) on low rises, and soils of unit Tb55. Valleys are shallow and often poorly drained. Occurs on sheet(s): 3"
"Wc9"
"Strongly undulating lands with narrow high ridges and broad valleys: on most slopes deep sandy-surfaced duplex soils (Dy5.61) are dominant with lesser (Dy5.41 and Dy5.42). On the upper slopes and crests of some higher ridges moderately deep sands (Uc1.21), (Uc4.2), and (Uc2.21) occur; and on valley floors sandy or loamy duplex soils (Dy3.42) and (Dy2.42) are usually present. Also occurring in the unit are small high stony ridges or low linear hills of unit Bz8 and small areas of sandy red or yellow earths (Gn2.11) and (Gn2.22). Data are limited. Occurs on sheet(s): 4"
"Wd1"
"Series of peneplains and terraces traversed by narrow valley plains, with lagoons, lunettes, dunes, and sandsheets: undulating peneplain remnants at the highest levels of sandy acidic yellow mottled soils (Dy5.6 1); gravely river terraces at intermediate levels of sandy acidic yellow mottled soils (Dy5.81) in association with (Dy5.41) and (Db3.41); river terraces at lower levels of hard acidic yellow mottled soils (Dy3.41) in association with (Db2.41), (Dy3.42), sometimes with puffs of Ug5.2 and depressions of (Dy5.12) and (Dy3.43) close to stream channels; all these traversed by narrow valley plains of dark cracking clays (Ug5.16) where streams are incised, and (Ug6.1) where plain is poorly drained; dunes, sandsheets, and lunettes of leached sands (Uc4.31) and rated (Uc3.3) and (Uc2.3) soils. Occurs on sheet(s): 2"
"Wd2"
"Undulating plains: undulating plains of sandy acidic yellow mottled soils (Dy5.81), some of which have a thin organic pan above the clay subsoil,in association with leached sands (Uc2.33), bow which a clay layer is present; broad flats of crusty sandy soils with yellow clayey subsoils (Dy1.63) in association with low rises of sandy alkaline yellow mottled soils (Dy5.23 and Dy5.83); minor areas of swamps, lagoons, lunettes, and dunes. Occurs on sheet(s): 2"
"Wd3"
"Hilly: gentle to moderate slopes of sandy acidic yellow mottled soils (Dy5.81), some of which have a thin organic pan above the clay subsoil, with (Dy5.21, Dy5.41, and Dy5.61), (Gn3.94), (Gn3.12), (Db1.52) and (Dd1.41 or Dd1.81) soils, and also in association with hard acidic yellow mottled soils (Dy3.41) on the lower hill slopes and shallow sand soils (Uc4.11), with rock outcrops on the upper hill slopes. Occurs on sheet(s): 2"
"Wd4"
"Steep hilly: moderate to steep slopes of sandy acidic yellow mottled soils (Dy5.81), some of which have a thin organic pan above the clay subsoil, with (Dy5.21), (Dy5.41), and (Dy5.61) soils, and in association with other soils including (Gn2.94), (Gn3.94), (Dd1.81), (Dy4.61), (Uc2.3), and (Uc4.11), and rock outcrops. Occurs on sheet(s): 2"
"Wd5"
"Undissected and dissected river terraces: chief soils are: on the higher and most extensive terrace, sandy acidic yellow mottled soils (Dy5.81 and Dy5.41) and/or leached sands (Uc2.2) sometimes with clay (D) horizons; on the middle terrace, hard neutral yellow mottled soils (Dy3.42) probably in association with (Gn2.7) and/or (Gn2.9) soils; and on the lower terrace, (Um) soils. The terraces are separated by short, sharp erosion scarps in which sandy ironstone may be exposed. Some silcrete boulders occur. As mapped, "islands"of units Tb27 and Tb23 may be included. Data are limited. Occurs on sheet(s): 3"
"Wd6"
"Plain: chief soils are sandy acidic yellow mottled soils (Dy5.81), some of which contain ironstone gravel, and in some deeper varieties (18 in. of A horizon) (Uc2.22) soils are now forming. Associated are acid yellow earths (Gn2.24). Other soils include (Dy3.81) containing ironstone gravel; (Dy3.71); low dunes of (Uc2.33) soils; and some swamps with variable soils. Occurs on sheet(s): 5"
"Wd7"
"Flat to gently undulating plain or plateau at low elevation with a few flats, depressions, swamps, lakes, and dunes: chief soils on the plains are sandy acidic yellow mottled soils (Dy5.81) containing ironstone gravel and (Dy5.84) containing laterite, with leached sands (Uc2.2 and Uc2.3) developed in the A horizons of some areas of the (Dy5) soils, and some (KS-Uc2.12) gravels on indurated layers. Associated are minor areas of soils as follows: well-drained flats of (Dy5.42) soils; poorly drained flats of (Dy5.43) soils; poorly drained depressions of (Dg4.42 and Dg4.43) soils; poorly drained clay flats of (Ug5.25) soils; dunes associated with lakes and swamps of (Uc2.2) and (Uc2.33) soils; some (Dy3.8) soils on ridges; areas of boulder laterite; and minor areas of undescribed soils. As mapped, small areas of unit Xc1 are included. Occurs on sheet(s): 5"
"Wd8"
"Gently undulating drainage divides developed on quartzite: chief soils are sandy acidic yellow mottled soils (Dy5.81) and (Dy5.41) with leached sands (Uc2.3) often associated with deep deposits of water-worn quartz sand

and grit (Uc1.2). Sometimes ironstone gravelly (Dy5.81) and (KS-Uc4.2) soils are associated. Occurs on sheet(s): 5"
"Wd9"
"Broad valleys and undulating interfluvial areas with some discontinuous breakaways and occasional mesas; lateritic materials mantle the area: chief soils are sandy acidic yellow mottled soils, (Dy5.81) containing much ironstone gravel in the A horizons, and (Dy5.84), both forming a complex pattern with each other and with lateritic sandy gravels (KS-Uc2.12). Associated are leached sands (Uc2.21) underlain by lateritic gravels and mottled clays that occur at a progressively greater depth down slope. Occurs on sheet(s): 5"
"Wd10"
"Broad valleys and undulating interfluvial areas; some evenly sloping pediments with exposures of sandstone and shale: chief soils are sandy acidic yellow mottled soils, (Dy5.81) containing much ironstone gravel in the A horizons, and (Dy5.84), both forming a complex pattern with each other and with lateritic sandy gravels (KS-Uc2.12). Associated are leached sands (Uc2.21) underlain by lateritic gravels, and mottled clays that occur about 3 ft in depth and are shallower than in unit Wd9. Other soils include (Dy3.7 1), (Dy3 .81), (Dy5.41) as well as (Uc2.21 and Uc2.22) on the pediments; and (Dr3.32), (Dy3.32), and (Dy3.22) in areas where country rock has been exposed. Occurs on sheet(s): 5"
"Wd11"
"Gently undulating plains developed on sandstones, limestones, and shales; small mature stream valleys; some laterite: chief soils are probably sandy acidic yellow mottled soils (Dy5.81) and red earths (Gn2.12), both containing variable amounts of ironstone gravel. Associated are some deep sandy soils probably including (Uc4.12). Small areas of other soils occur including some with peaty surfaces in the moister flats. Occurs on sheet(s): 8"
"Wd12"
"Undulating terrain on granites, some scattered rocky hills; poorly defined seasonally flooded drainage-ways; some massive laterite: chief soils seem to be sandy acidic yellow mottled soils (Dy5.81) containing variable amounts of ironstone gravel, together with gritty and gravelly sands (Uc4.12) and possibly other (Uc) soils. Small areas of (Gn2.7) and (Gn2.9) soils occur on the alluvial stream flats and shallow (Uc) soils on the rocky hills. As mapped, small areas of adjoining units, notably unit LK22, may be included. Occurs on sheet(s): 8"
"Wd13"
"Undulating to rolling and hilly terrain on granites; many rock outcrops and tors on crests and upper slopes: chief soils are sandy acidic yellow mottled soils (Dy5.81) with (Dy4.81) and (Dr4.81) on the undulating to rolling areas. Associated are (KS-Dy5.81) and (Dy5.81) containing ironstone gravels on gently undulating o flat portions, and gritty and gravelly sands (Uc4.12) and possibly (Uc5.2) on crests and upper slopes. The (Uc) soils are dominant in some localities. As mapped, small areas of adjoining units may be included. Occurs on sheet(s): 8"
"Wf1"
"Erosion scarps cut in sandstone; scarp base at about 350 ft above sea level and crests at 550 600 ft above sea level; slopes are very steep and ridge tops narrow: chief soils are sandy acidic yellow mottled soils (Dy5.21), often shallow and gravelly and in association with (Uc4.1) and shallow (Dr5.21) soils. Other soils include shallow gravelly (Gn2.14) on some ridge platforms. As mapped, small areas of soils of unit Rh12, and some trachyte plugs, as found in unit Mf12, are included. Occurs on sheet(s): 4"
"Wf2"
"Low hilly to hilly terrain on sandstone; narrow sharply convex ridge crests with rock outcrops with gentle to moderate side slopes and narrow creek flats: chief soils are sandy acidic yellow mottled soils (Dy5.21). Associated soils are (Uc4.2) on crests; (Dr5.21) on upper slopes; and (Gn2.14) on basal slopes, fans, and platforms. Small areas of many other soils occur. As mapped, small areas of adjoining units, notably "valleys"of unit MF4, are included. Occurs on sheet(s): 4"
"X1"
"Gently undulating plain with swamps: sandy neutral yellow mottled soils (Dy5.42 and Dy5.82) also including (Dy5.41, Dy5.43, and Dy5.83) with smaller areas of leached sands (Uc2.2 and Uc2.3), shallow dark cracking clays (Ug5.11), peaty soils (O), friable loamy soils (Um6.13), shallow dark plastic clay soils (Uf6.11). Other soils may be present in minor areas. Occurs on sheet(s): 1"
"X2"
"Plains and valley plains with some swamps: sandy neutral yellow mottled soils (Dy5.42) with smaller areas of (Dy5.41 and Dy5.43) in association with leached sands (Uc2.2 and Uc2.3) which may be co-dominant locally. Other soils such as (Dy3.6) containing ironstone gravel are present in minor areas, but may be prominent locally. Occurs on sheet(s): 1"
"X3"
"Plains: sandy neutral yellow mottled soils (Dy5.42 and Dy5.82) with smaller areas of (Dy5.6) and (Uc2.2). Other soils (undescribed) may be present also. Occurs on sheet(s): 1"
"X4"

"Plains with areas of dunes and ranges of sandhills: sandy neutral and alkaline yellow mottled soils (Dy5.42 and Dy5.43) on the plains in association with leached sands (Uc2.2) on the dunes and sandhills; soils of minor area include cracking grey clays (Ug5.2), (Dd1.23), (Um6.23), and shallow forms of (Dr2.13) and (Dr2.33) on the plains. Area has clay substrata. Occurs on sheet(s): 1"
"X5"
"Undulating--dissected dunes and plains--swamps and lakes: sandy neutral yellow mottled soils (Dy5.42) with hard alkaline yellow mottled soils (Dy3.4) and in association with leached sands (Uc2.2 and Uc2.3) which may be co-dominant locally; soils of minor area include cracking grey clays (Ug5.2) and hard alkaline dark soils (Dd1.23). Occurs on sheet(s): 1"
"X6"
"Hilly with small valleys: sandy neutral yellow mottled soils (Dy5.42) and related soils on the lower levels, in association with hard neutral red soils (Dr2.42) and related soils on the higher elevations. Area has acid clay substrata. Incomplete data. Occurs on sheet(s): 1"
"X7"
"Gently undulating plain: low knolls of sandy neutral yellow mottled soils (Dy5.42) with small basins of (Dd3.13) in the drier southern portion of the area; hard neutral yellow soils (Dy2.52) with (Gn3.74) and (Dy4.51) in the relatively lower situations, especially the wetter northern portion of the area. Other soils (undescribed) are present. Unit is complex and not satisfactorily known. Occurs on sheet(s): 1"
"X8"
"Undulating plain with tracts of dunes: plains of sandy neutral yellow mottled soils (Dy5.42) and hard yellow mottled soils (Dy3.4) in association with leached sands (Uc2.3); dunes and swales of leached sands (Uc2.3) with some dunes of sandy yellow mottled soils (Dy5.8); banks of river grav deposits showing the (Uc2.3) profile; dunes of leached sands (Uc2.2) towards the coast; some swampy areas and small valley plains of undescribed soils. Occurs on sheet(s): 2"
"X9"
"Plains--former river terraces and levees: chief soils are sandy neutral yellow mottled soils (Dy5.42) with leached sands (Uc2.3) on the broader plains. Associated are (Dy3.41, Dy3.42, and Dy3.43) soils, some containing ironstone gravels, in relatively low-lying areas and depressions, and (Dr2.2), (Gn2.15), and (Gn2.18) soils on levees. Areas of other soils, possibly including (Um4.31), occur throughout what is a complex unit. As mapped, areas of units Gb6 and Sp1 are included. Occurs on sheet(s): 3"
"X10"
"Rolling with some steeper hills, tors common: chief soils are sandy neutral yellow mottled soils (Dy5.42 and Dy5.82), sometimes a hardpan occurs in the subsoil. Associated are (Dy3.4) and (Dr2.4) soils. Data are limited. Occurs on sheet(s): 3"
"X11"
"Gently to strongly undulating land: chief soils on the gentle to moderate slopes are sandy neutral and alkaline yellow mottled soils (Dy5.42 and Dy5.43) and hard alkaline yellow mottled soils (Dy3.43). Associated are: broad flat ridge tops ("broom plains") of sandy neutral yellow mottled soils (Dy5.62) sometimes with ironstone gravel in the deeper subsoils; narrower ridges and/or hillocks, often capped with ironstone gravel and slabs, of shallow loams (?Um1) and other, undescribed soils; and sandy banks, dunes, or sheets, often in the vicinity of streams, of siliceous sands (Uc1.2) or red earthy sands (Uc5.21). As mapped, small areas of all adjoining units are included. Occurs on sheet(s): 3"
"X12"
"Hilly to mountainous: chief soils are probably sandy neutral yellow mottled soils (Dy5.42) and (Dy5.32) with (Dy5.22) soils on the higher hill crests. Associated are various (Uc) and (Um) soils which could be very common in the more mountainous portions. These areas are not well known. Occurs on sheet(s): 4"
"X13"
"Low hilly terrain on granodiorite and diorite; river flats and terraces flanked by low convex hills with crests between 400 and 600 ft above sea level and gentle to moderate side slopes: chief soils are sandy neutral yellow mottled soils (Dy5.42) and (Dy5.22) on the slopes. Associated are: (Db3.12) and (Gn3.72) soils on slopes; (Gn3.11 and Gn3.12) on hill crests and fans; (Dy3.21) and (Db3.11) soils on intermediate terraces; and (Gn2.41) and (Gn3.22) soils on low terraces. Minor soil occurrences include: (Gn3.54) on old fans; (Gn2.94) and (Gn2.25) on young fans; (Gn3.94 and Gn3.92) on wet flats; and (Dy3.41), (Dr3.41), (Um2.12), and (Um4.1) on included shale hills. As mapped, small areas of unit Mp9 have been included. Occurs on sheet(s): 4"
"X14"
"Swampy plain with some granitic tors in the south-western portion: chief soils are sandy neutral yellow mottled soils (Dy5.42) and leached sands (Uc2.33). Associated are low ridges of (Dy) soils containing ironstone gravel as for unit Ca23. Occurs on sheet(s): 5"
"X15"

"Gently undulating sandy plains with low sand ridges: chief soils are sandy neutral and alkaline yellow mottled soils (Dy5.42 and Dy5.43). Associated are leached sands (Uc2.2) on sand ridges and deeper sandy areas generally; and some (Dy5.8) soils containing ironstone gravels with (KS-Uc2.12) gravels on spurs, buttes, and their slopes. The area seems to have an acid substrate of kaolinitic clays below 3-5 ft in depth. Occurs on sheet(s): 5"
"X16"
"Plains with many flats, swamps, lakes, and some dunes: chief soils seem to be sandy neutral yellow mottled soils (Dy5.42) with leached sands (Uc2.2 and Uc2.3). Associated are (Dy5.43) soils on poorly drained flats; (Dg4.42 and Dg4.43) in depressions; some (Ug5.2) soils on clay flats; and (Dy5.81), (Dy5.84), and (Dy3.8) soils on ridges. Generally similar to unit Wd7 but with many more swamps and lakes. Occurs on sheet(s): 5"
"X17"
"Slopes and valleys: chief soils are sandy neutral and alkaline yellow mottled soils (Dy5.42 and Dy5.43). Associated are various related (Dy) soils such as (Dy3.43) and (Dr) soils such as (Dr5.43); leached sands such as (Uc2.31); and areas of undescribed soils. There are similarities with unit Va66. As mapped, small areas of units JJ16, Ms8, Sl28, Sl29, and DD11 are included. Occurs on sheet(s): 5"
"Xc1"
"Low hills and ridges generally of a rolling terrain: chief soils are sandy neutral, and also acidic, yellow mottled soils (Dy5.62) and (Dy5.81), both containing ironstone gravels. Associated soils probably include (Uc4.1 and Uc4.2) and dark loams (Um4). Occurs on sheet(s): 5"
"Xd1"
"Gently undulating plain or plateau at low elevation with small granitic hills as for unit Ca26, some flats, seasonal swamps and talus; and some more strongly undulating land where dissection has begun: chief soils are sandy neutral yellow mottled soils (Dy5.82) containing variable amounts of ironstone gravel in the surface sand, with leached sands (Uc2.21 and Uc2.22) sometimes containing ironstone gravel and underlain by clay substrate at depths of 3-5 ft. The (Dy5) and (Uc2) soils Fade into each other. Associated are (Dy5.84) soils on the plain; (Dy5.43) soils in seasonal swamps; (Dy5.42) soils in shallow valleys; (Dy2.42 and Dy2.43) soils in depressions; and some (Ug5.2) and (Ug5.5) soils in seasonally waterlogged areas. In some localities there is a regular succession of alternating ridges of (Dy5.8) soils and flats of (Dy5.4) soils. The unit for the greater part seems to have a clay substrate but towards its boundary with unit Ca25 some very low (few inches) calcrete (kunkar) ridges occur. As ma. Occurs on sheet(s): 5"
"Xd2"
"Gently rolling terrain of smooth ridges and spurs separated by valleys showing recently developed salinity; breakaways occur infrequently: chief soils are sandy neutral yellow mottled soils (Dy5.82) containing some ironstone gravels. Associated are (Uc5.22) and (KS-Uc2.12) soils on the ridge crests with hardened mottledzone materials at depths of 12-30in.; (Dy3.43) soils on valley side slopes and valley floors; (Dr2.33) and (Dr2.43) soils on slopes; (Dr3.33) and (Dr3.43) soils on valley floors. Occurs on sheet(s): 5"
"Xd3"
"Gentle, but often somewhat uneven, irregular gullied slopes below breakaways: chief soils seem to be sandy neutral yellow mottled soils (Dy5.82) containing some ironstone gravels. Associated are leached sands (Uc2.2); patches of (Uc5.22) soils; and various (Dr) and (Dy) soils such as (Dy3.42) soils where creeks are incised on the dissection slopes. Occurs on sheet(s): 5"
"Ya1"
"Plain with swamps: sandy alkaline yellow mottled soils (Dy5.43) with small areas of leached sands (Uc2.2); other soils such as (Dy5.42) and (Dy5.8) occur also. Occurs on sheet(s): 1"
"Ya2"
"Low-lying, subcoastal plain: sandy alkaline yellow mottled soils (Dy5.43) and related soils (Dy5.4) and (Dy5.8); saline soils (undescribed) and alluvial soils (undescribed) in the lower-lying situations. Incomplete data. Occurs on sheet(s): 1"
"Ya3"
"Plain: sandy alkaline yellow mottled soils (Dy5.43) and related soils (Dy5.8), siliceous sands (Uc1.21), leached sands (Uc2.2 and Uc2.3), and small areas of shallow red-brown sandy soils (Uc6.13); exposed limestones; some areas affected by salinity. Limestone substrata through the area. Occurs on sheet(s): 1"
"Ya4"
"Corridor plains with swamps: sandy alkaline yellow mottled soils (Dy5.43) and highly alkaline and saline variations of these; small localized areas of (Ug5.11), (Uc6.13), (Um6.21), and peaty soils (O). Occurs on sheet(s): 1"
"Ya5"
"Lake and swamp plains of sandy alkaline yellow mottled soils (Dy5.43) and saline variations of these in association with saline soils (undescribed) and small areas of soils from adjacent map units. Incomplete data. Occurs on sheet(s): 1"
"Ya6"

"Undulating plains with hilly ridges: undulating, imperfectly drained plains of sandy alkaline yellow mottled soils (Dy5.43) with sandy alkaline gley soils (Dg4.43) and saline soils (unclassified) in lower-lying situations, and broken by tracts of hilly ridges of leached sands (Uc2.2), exposed limestones, and shallow red-brown sandy soils (Uc6.13). Area has shallow ground water. Occurs on sheet(s): 1"
"Ya7"
"Plains with tracts of dunes: plains of sandy alkaline yellow mottled soils (Dy5.43) and related soils (Dy5) and (Dy3.4) with small areas of (Dr2.23 and Dr2.33), (Gc1.12), (Uc6.13), and (Ug5.2) with various saline (unclassified) in the lower-lying situations; dunes of leached sands (Uc2.2) and (Uc6.13). Area has substrata of both limestone and clay. Occurs on sheet(s): 1"
"Ya8"
"Plains with swamps, lagoons, lunettes: sandy alkaline yellow mottled soils (Dy5.43) and leached sands (Uc2.2); minor areas of many different soils including (Dy5.6), (Dy5.8); and (Dr2.23), (Um6.24) on lunettes; saline soils and alluvial soils (undescribed) in lower-lying situations. Occurs on sheet(s): 1"
"Ya9"
"Plains with tracts of dunes: shallow forms of sandy alkaline yellow mottled soils (Dy5.43) with smaller areas of shallow forms of hard alkaline red soils (Dr2.33) and localized areas of (Gc1) on the plains; leached sands (Uc2.2) and shallow red-brown sandy soils (Uc6.13) on dunes. Area has limestone substrata which outcrop in places. Occurs on sheet(s): 1"
"Ya10"
"Broken--hilly land with some dune tracts: shallow forms of sandy alkaline yellow mottled soils (Dy5.43) with leached sands (Uc2.2) and shallow grey-brown sandy soils (Uc6.11) on gneissic and quartzitic hills and knolls. Incomplete data. Occurs on sheet(s): 1"
"Ya11"
"Hills and plains--a series of more or less north-south, hilly ridges with corridor plains: sandy alkaline yellow mottled soils (Dy5.43) with smaller areas of (Dy5.8) on the plains; leached sands (Uc2.21), exposed limestone, and smaller areas of shallow loamy soils (Um6.23) and (Um6.22) and shallow sandy soils (Uc6), (Uc2.1), and (Uc4). Area has substrata of both limestone and clay. Occurs on sheet(s): 1"
"Ya12"
"Plains with dune tracts and broken by hilly ridges: plains of sandy alkaline yellow mottled soils (Dy5.43) with (Dy5.8) and leached sands (Uc2.21), dunes of leached sands (Uc2.21); hilly ridges of exposed limestones with small areas of shallow soils (Uc6) and (Um6). Occurs on sheet(s): 1"
"Ya13"
"Plain: sandy alkaline yellow mottled soils (Dy5.43) with hard alkaline red soils (Dr2.23 and Dr2.33), and smaller areas of (Um6.13). Occurs on sheet(s): 1"
"Ya14"
"Basin plain: sandy alkaline yellow mottled soils (Dy5.43) with hard alkaline red soils (Dr2.23 and Dr2.33); shallow red-brown sandy soils (Uc6.13) and cracking grey clays (Ug5.2) provide local differences; saline soils (undescribed) occur in the drainage-ways. Occurs on sheet(s): 1"
"Ya15"
"Plain with swamps: sandy alkaline yellow mottled soils (Dy5.43) with hard alkaline yellow mottled soils (Dy3.43) and small areas of cracking grey clays (Ug5.2). Occurs on sheet(s): 1"
"Ya16"
"Undulating land suggestive of remnants of a dissected tableland: sandy alkaline yellow mottled soils (Dy5.43) and hard alkaline yellow mottled soils (Dy3.43) with smaller areas of cracking grey clays (Ug5.2), and other soils including (Dy5.6), (Dy3.6), and (Uc2.2). Many of these contain ironstone gravels in their A horizons. Incomplete data. Occurs on sheet(s): 1"
"Ya17"
"Undulating: sandy alkaline yellow mottled soils (Dy5.43) with hard alkaline yellow mottled soils (Dy3.43) and small areas of hard alkaline red soils (Dr2.23 and Dr2.33). Occurs on sheet(s): 1"
"Ya18"
"Plain: sandy alkaline yellow mottled soils (Dy5.43 and Dy5.83) with small areas of deep leached sands (Uc2.21) and exposed limestones. Area has limestone substrata. Occurs on sheet(s): 1"
"Ya19"
"Plain with swamps: sandy alkaline yellow mottled soils (Dy5.43 and Dy5.83) with smaller areas of cracking shallow dark clays (Ug5.11) in the lower-lying situations. Water-table within 6 ft of surface. Occurs on sheet(s): 1"
"Ya20"
"Undulating: sandy alkaline yellow mottled soils (Dy5.43 and Dy5.83) often associated with cracking grey clays (Ug5.2); other soils include (Dy3.43). Incomplete data. Occurs on sheet(s): 1"
"Ya21"

"Basin plain: sandy alkaline yellow mottled soils (Dy5.43 and Dy5.83), some containing ironstone gravels in their surface soils; saline soils (undescribed) in the sluggish and ill-defined drainage-ways. Occurs on sheet(s): 1"
"Ya22"
"Dune and swale, a few swampy areas: dunes of leached sands (Uc2.2) with shallow red-brown sandy soils (Uc6.13) and small areas of (Um6.13); swales of sandy alkaline yellow mottled soils (Dy5.43 and Dy5.83) and soils related to these and also with leached sands (Uc2.3). Occurs on sheet(s): 1"
"Ya23"
"Small plains: sandy alkaline yellow mottled soils (Dy5.43 and Dy5.83) with smaller areas of hard alkaline yellow mottled soils (Dy3.43). Other soils include neutral forms of the above three as well as leached sands (Uc2.2 and Uc2.3), (Dy3.6), and (Dy5.6). Individual areas are somewhat variable. Occurs on sheet(s): 1"
"Ya24"
"Undulating areas of sandy alkaline yellow mottled soils (Dy5.43) and other undescribed soils. Occurs on sheet(s): 2"
"Ya25"
"Gently undulating sandy plains: chief soils are sandy alkaline and neutral yellow mottled soils (Dy5.43 and Dy5.42). Associated are: slightly lower-lying, often wind-deflated plains of hard alkaline and neutral brown soils (Db1.33 and Db1.32) and (Db1.43), and occasionally similar (Dr) soils; some areas of grey cracking clays (Ug5.2) along present stream courses; very irregular dunes (?associated with prior streams) of siliceous sands (Uc1.2); and possibly some sand sheets or dunes of earthy sands (Uc5.21). Occurs on sheet(s): 3"
"Ya26"
"Very gently undulating with calcareous mounds or rises: chief soils are sandy alkaline yellow mottled soils (Dy5.43). Associated are the shallow soils of the mound springs, such as (Um6.21). Occurs on sheet(s): 5"
"Ya27"
"Sandy flats with salt lakes and swamps and their lunettes: chief soils seem to be sandy alkaline yellow mottled soils (Dy5.43) on the flatter areas, in association with lunettes and ridges of sandy alkaline red soils (Dr4.43), (Dr5.43), and hard alkaline red soils (Dr2.43). Other soils are likely. As mapped, areas of adjoining units may be included. Occurs on sheet(s): 5"
"Ya28"
"Sandy plains with some clay pans and small salt lakes, dunes, and lunettes: chief soils are sandy alkaline yellow mottled soils (Dy5.43 and Dy5.83). Associated are various (Dr) soils such as (Dr5.43); more saline (Dy) and (Dr) soils including (Dy1.43), (Dr1.43), and (Dr1.83); some calcareous earths (Gc1.12) and (Gc1.22); and various (Uc), (Um), and/or (Uf) soils on small dunes and lunettes. As mapped, areas of adjacent units are included. Occurs on sheet(s): 5,10"
"Ya29"
"Gently undulating plains characteristically studded with seasonal lakes and clay pans, lunettes, and dunes; calcrete (kunkar) underlies the soils in places and acid clays commonly occur below depths of 5-6 ft: chief soils of the plains are sandy alkaline yellow and yellow mottled soils (Dy4.43, Dy4.83, Dy5.43, and Dy5.83) and hard alkaline yellow and yellow mottled soils (Dy2.43, Dy2.83, Dy3.43, and Dy3.83). Associated are Feybrown highly calcareous earths (Gc1.12) on the plains; leached sands (Uc2.21) and other (Uc) soils such as (Uc1.23) on dunes and lunettes which are a feature of these areas; and small areas of many other soils including cracking grey clays (Ug5.2) or (Ug5.5) in low-lying sites subject to flooding. As mapped, areas of unit Lb1O are included. Occurs on sheet(s): 5"
"Ya30"
"Gently undulating plains with some seasonal lakes, clay pans, and low-lying areas subject to flooding, and some lunettes and dunes; acid clays commonly occur below 6 12 ft: chief soils on the plains are sandy alkaline yellow mottled soils (Dy5.43). Associated are other (Dy) soils, notably (Dy5.83) and (Dy3.43); grey-brown highly calcareous earths (Gc1.12) often in complex with the (Dy) soils; leached sands (Uc2.21) and other (Uc) soils such as (Uc1.2) on dunes and lunettes; and cracking grey clays (Ug5.2) or (Ug5.5) in low-lying sites subject to flooding and with some gilgai microrelief. As mapped, areas of units Lb1O and JY1 are included. Occurs on sheet(s): 5"
"Ya31"
"Gently undulating plains with very low flat to gently undulating remnants of the ironstone gravel plateau, and some swamps and lakes: chief soils seem to be sandy, and also hard, yellow and yellow mottled soils (Dy5.43, Dy5.33, Dy4.43, Dy3.43, and Dy3.33) with lesser areas of (Dr5.43, Dr2.42, Dr2.32, Dy3.42, Dy2.43, and Dy2.42) soils. Acidic clayey materials are common at depths of about 3 ft. Associated are small areas of (Dy2.41), (Dr2.31), (Dr2.41), and similar soils where acidic rocks are close to the surface; and ironstone gravelly rises similar to unit Uf3 and of quite variable size and extent. Occurs on sheet(s): 5"
"Ya32"
"Gently undulating plain underlain by calcrete (kunkar) at shallow depth (about 12 in.): chief soils are sandy red, brown, yellow, and grey alkaline soils (Dr5.43), (Db3.43), (Dy5.43), and (Dg3.43) which seem to occur as a toposequence, with the (Dr) soils in the relatively higher sites, the (Dg) soils in the relatively lower sites, and the

(Db) and (Dy) soils in intermediate locations. Small ridges of unit BB6 and islands of unit Xd1 are included. Occurs on sheet(s): 5"
"Yb1"
"Dunes and small plains: dunes of sandy alkaline yellow mottled soils (Dy5.83) and brown sands (Uc5.11 and Uc5.12); plains of (Dy5.83), very shallow forms of (Dr2.23), (Gc1.12), and outcrops of sandy ironstone. Other soils include (Dy4.83). Incomplete data. Occurs on sheet(s): 1"
"Z1"
"Plains: small basin plains of peaty (fen) soils (O). Occurs on sheet(s): 1"
"Z2"
"Plains: basin plains (swamps) of neutral to alkaline peaty (O) soils in association with a variety of other soils, including leached sands (Uc2.3) and sandy yellow mottled soils (Dy.5). Occurs on sheet(s): 2"
"Z3"
"Plains: basin plains (swamps) of acidic peaty (O) soils in association with a variety of other undescribed soils. Occurs on sheet(s): 2"
"Z4"
"Swampy plains with sand-ridges: swampy plains of peaty soils (O) and their burnt remains, with various other soils largely undescribed but including (Dy3) and (Dy5) with organic surface horizons; sand-ridges of leached sands (Uc2.2 and Uc2.3). Occurs on sheet(s): 2"
"Z5"
"Swampy plains, floodplains, and terrace remnants: swampy plains of peaty soils (O)--some of which are saline and dark cracking clays (Ug6.1) with smaller areas of plastic clay soils (Uf6) on the levees and better drained portions of the floodplain; and with cracking clays (Ug5)--often showing gilgais--on the terrace remnants. Occurs on sheet(s): 2"
"Z6"
"Low-lying coastal plain consisting essentially of freshwater swampland behind the modern beach dunes; mud flats; saline marshes: chief soils are acid peats (O) of the swamplands, some developed on sphagnum moss Associated are (Uc1.2) and (Uc2.2) soils on dunes and (Uc2.33) soils on lower slopes of dunes. Other soils occur. Data are very limited. Occurs on sheet(s): 4"
"Z7"
"Swamps: chief soils more or less centrally covering the floor of the swamps are neutral to alkaline marly peats (O). Associated are acid to very acid peats (O) more or less between the marly peats and the marginal sandy rises of (Uc2.3) and related soils in which some (Um) soils may occur. A sand substrate underlies the area. Occurs on sheet(s): 5"
"Z8"
"Swamps of neutral to alkaline marly peats (O) as for unit Z7 but with intervening dune-swale areas of leached sands (Uc2.33) and (Uc2.22) as for unit Cb39. Occurs on sheet(s): 5"
"Z9"
"Level alluvial plains with some low stream levees and prior stream channels: dominant are deep loamy organic soils (O) with a deep strongly structured A horizon. On the slightly elevated stream levees are deep friable loams (Um6.34, Um6.33) and (Um4.43) and associated soils of unit Gh1. Occurs on sheet(s): 7"
"Z10"
"Swampy lands inundated for considerable periods of the year: dominant are loamy organic soils (O) with some areas of peat. The organic soils have a deep (15-24 in.) strongly structured A horizon overlying gleyed clays. Loamy gleyed duplex soils (Dg4.41) and (Dg4.31) and other duplex soils (Dy3.41) and (Dy3.31) occur on slightly higher areas. Deep friable loams (Um6.34, Um6.33) of unit Gh1 occur on the levee banks of streams and on small areas of higher flood-plain included in the unit. Occurs on sheet(s): 7"

Appendix 5 - Geology

APa	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	High-grade metamorphics, granite, gabbro in Arunta Block
APc	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Migmatite, granite, gneiss, in Pine Creek Geosyncline
APh	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, limestone, dolomite, acid and basic volcanics in Halls Creek province
APl	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granitic rocks, migmatite in Litchfield Block
APm	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Gneiss, granite in Arnhem Block
APt	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, shale, acid and basic volcanics in The Granites-Tanami Block
Aav	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Acid and minor intermediate volcanic and intrusive rocks
Abi	PRECAMBRIAN BASIC/ULTRAMAFIC INTRUSIVES	Basic and ultramafic intrusive rocks
Abv	PRECAMBRIAN BASIC VOLCANICS AND SEDIMENTS	Basic volcanics, banded chert and iron-formations, minor clastic rocks; highly metamorphosed in southwest
Ag	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granite
Am	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Granitic gneiss, migmatite
Ar	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Low-grade metamorphics, granite in Litchfield and Rum Jungle Blocks
As	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Argillite, sandstone, conglomerate, minor andesitic pyroclastics; highly metamorphosed in southwest
CPs	PALAEOZOIC SEDIMENTS AND VOLCANICS	Conglomerate, sandstone in Amadeus Basin
Cc	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, conglomerate, siltstone, limestone, shale in Bonaparte Gulf Basin
Cg	PALAEOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
Ci	PALAEOZOIC ACID/INTERMEDIATE INTRUSIVES	intermediate intrusive rocks
Cs	PALAEOZOIC SEDIMENTS AND VOLCANICS	Dolomite, sandstone, siltstone, shale, limestone in Carnarvon and Canning Basin

Cus	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, mudstone, siltstone
Cuv	PALAEOZOIC SEDIMENTS AND VOLCANICS	Acid volcanics
Cuv?	PALAEOZOIC SEDIMENTS AND VOLCANICS	Acid volcanics
DCs	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, shale, conglomerate, siltstone in Ngalia and Amadeus Basins
DCw	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, shale in Officer Basin
De	PALAEOZOIC BASIC/ULTRAMAFIC INTRUSIVES	Ultramafic intrusive rocks
Dlg	PALAEOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
Dls	PALAEOZOIC SEDIMENTS AND VOLCANICS	Siltstone, shale, sandstone
Dlv	PALAEOZOIC SEDIMENTS AND VOLCANICS	Acid and intermediate volcanics
Ds	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, conglomerate in Ord, Bonaparte Gulf, Wiso and Georgina Basins
DuCls	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, shale, chert, limestone, phyllite, schist
DuClv	PALAEOZOIC SEDIMENTS AND VOLCANICS	Acid and intermediate volcanics and pyroclastics
Dug	PALAEOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
Dw	PALAEOZOIC SEDIMENTS AND VOLCANICS	Limestone, dolomite, sandstone, in Canning and Carnarvon Basins
EOc	PALAEOZOIC SEDIMENTS AND VOLCANICS	Limestone, shale, siltstone, dolomite, mudstone in Daly River, Georgina and Wiso Basins
EOm	PALAEOZOIC SEDIMENTS AND VOLCANICS	Schist, quartzite, phyllite, gneiss, metabasalt
EOs	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, chert
EOv	PALAEOZOIC SEDIMENTS AND VOLCANICS	Acid volcanics
Eb	PALAEOZOIC BASIC VOLCANICS AND SEDIMENTS	Basic volcanics in Officer Basin
Ees	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, chert, limestone
Eg	PALAEOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
Eg?	PALAEOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
Elv	PALAEOZOIC BASIC VOLCANICS AND SEDIMENTS	Basalt, pyroclastics, sandstone, siltstone
Es	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, shale, limestone, siltstone, conglomerate in Arafura, Amadeus, Ord, Bonaparte Gulf and Arrowie Basins and Kanmantoo Fold Belt
Ev	PALAEOZOIC BASIC VOLCANICS AND SEDIMENTS	Metabasalt, acid volcanics
JKs	MESOZOIC SEDIMENTS AND VOLCANICS	Mudstone, siltstone, sandstone
Jd	MESOZOIC BASIC/ULTRAMAFIC INTRUSIVES	Basic intrusive rocks
Js	MESOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, mudstone

Jv	MESOZOIC SEDIMENTS AND VOLCANICS	Intermediate and basic volcanics
Jw	MESOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, limestone in Canning, Officer, Carnarvon and Perth Basins
Kc	MESOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, mudstone, conglomerate
Kg	MESOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
Ks	MESOZOIC SEDIMENTS AND VOLCANICS	Shale, siltstone, sandstone, limestone
Kv	MESOZOIC SEDIMENTS AND VOLCANICS	Acid and intermediate volcanics and intrusives
Kw	MESOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, shale, limestone, marl minor basalt in southwest; in Officer, Canning, Perth and Carnarvon Basins
M	MESOZOIC SEDIMENTS AND VOLCANICS	Sandstone, conglomerate, siltstone in Canning Basin
Ms	MESOZOIC SEDIMENTS AND VOLCANICS	Sandstone, conglomerate, siltstone
N	Undefined	Not described
ODs	PALAEOZOIC SEDIMENTS AND VOLCANICS	Schist, phyllite, sandstone, mudstone
OSs	PALAEOZOIC SEDIMENTS AND VOLCANICS	Slate, siltstone, chert, phyllite, sandstone, conglomerate
Ob	PALAEOZOIC SEDIMENTS AND VOLCANICS	Intermediate and basic volcanics
Og	PALAEOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
Om	PALAEOZOIC METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Gneiss in Kanmantoo Fold Belt
Os	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, quartzite, slate, conglomerate, limestone
Ow	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone conglomerate in Canning Basin
POa	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, shale, limestone, dolomite, conglomerate, phosphorite, evaporite in Amadeus and Ngalia Basins
Paa	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, conglomerate, dolomite, siltstone in Victoria River Basin
Pab	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, dolomite; minor phyllite, schist in Adelaide Fold Belt
Pab?	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, dolomite; minor phyllite, schist in Adelaide Fold Belt
Pac	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, quartzite, dolomite, siltstone acid and basic volcanics in Adelaide Fold Belt and Stuart Shelf

Pae	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Low and high grade metamorphics, minor granitic rocks in Tyenna and Rocky Cape Blocks
Paf	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, conglomerate in Victoria River Basin
Pag	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granite in Musgrave Block
Pah	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone dolomite, siltstone, limestone, shale in Birrindudu and Victoria River Basins
Pak	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Dolomite, limestone, shale, Sandstone, quartzite in Amadeus and Ngalia Basins
Pak?	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Dolomite, limestone, shale, Sandstone, quartzite in Amadeus and Ngalia Basins
Pal	PRECAMBRIAN BASIC/ULTRAMAFIC INTRUSIVES	Dolerite in McArthur Basin
Pam	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granitic rocks, migmatite in Musgrave Block
Pap	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, shale, tillite, dolomite in Kimberley, Victoria River, Georgina, Ngalia and Amadeus Basins and Mt Isa Block
Paq	PRECAMBRIAN BASIC/ULTRAMAFIC INTRUSIVES	Gabbro, basalt, conglomerate, quartzite, acid volcanics, ultramafics in Musgrave Block
Par	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, conglomerate, shale in McArthur, South Nicholson and Georgina Basins
Pas	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, shale, acid and basic volcanics, pyroclastics in Musgrave Block
Pat	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, mudstone in Tyenna and Rocky Cape Blocks
Pau	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Tillite, shale, limestone, sandstone in Adelaide Fold Belt
Paw	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, shale, limestone in Adelaide Fold Belt and Stuart Shelf
Pca	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granitic rocks, minor acid volcanics in Arunta Block
Pcb	PRECAMBRIAN BASIC/ULTRAMAFIC INTRUSIVES	Dolerite in Pine Creek Geosyncline
Pcc	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, shale, conglomerate, dolomite, acid volcanics in McArthur and South Nicholson Basins and Mt Isa Block
Pcf	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granitic rocks in Gawler, Broken Hill and Mt Painter Blocks
Pcj	PRECAMBRIAN BASIC VOLCANICS AND SEDIMENTS	Basalt, basic pyroclastics; sandstone, limestone, siltstone, minor acid volcanics in McArthur and South Nicholson Basins and Mt Isa Block

Pcm	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Gneiss, schist, quartzite, amphibolite, granite in Musgrave Block
Pcn	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Rhyolite, acid pyroclastics in McArthur and South Nicholson Basins
Pco	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Gneiss, granite, schist, in Musgrave Block
Pcr	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granitic rocks in Nicholson, Mt Isa, Georgetown and The Granites-Tanami Blocks, Pine Creek Geosyncline and McArthur Basin
Pcs	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Siltstone, sandstone, quartzite, limestone, dolomite, conglomerate, shale in McArthur and South Nicholson Basins and Mt Isa Block
Pct	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Conglomerate, dolomitic shale, quartzite in Gawler Block
Pcu	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, shale, siltstone, dolomite in Birrindudu and Victoria River Basins
Pcv	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Acid volcanics, basalt pyroclastics, sandstone, conglomerates in McArthur Basin and Georgetown Block
Pcx	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Acid volcanics in Pine Creek Geosyncline, Arnhem, Mt Isa and Nicholson Blocks
Pcy	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granite in Mt Isa Block
Pcz	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Acid volcanics and pyroclastics in Gawler Block
Pcz?	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Acid volcanics and pyroclastics in Gawler Block
Pla	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, shale, dolomite, limestone in Tennant Creek Block
Plb	PRECAMBRIAN BASIC VOLCANICS AND SEDIMENTS	Basic volcanics and pyroclastics in Hamersley Basin
Plc	PRECAMBRIAN BASIC/ULTRAMAFIC INTRUSIVES	Gabbro, dolerite in Tennant Creek Block
Pld	PRECAMBRIAN BASIC/ULTRAMAFIC INTRUSIVES	Dolerite in Yilgarn and Pilbara Blacks and Hamersley Basin
Ple	PRECAMBRIAN BASIC VOLCANICS AND SEDIMENTS	Basalt, andesite in Tennant Creek Block
Plf	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Acid volcanics, sandstone, siltstone, shale in Pine Creek Geosyncline and Tennant Creek Block
Plg	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granitic rocks in Gascoyne Block, Paterson Province and Nabberu Basin
Plg?	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granitic rocks in Gascoyne Block, Paterson Province and Nabberu Basin

Plh	PRECAMBRIAN BASIC/ULTRAMAFIC INTRUSIVES	Basic intrusives in Halls Creek province
Pli	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Chert, banded iron-formations, dolomite, shale in Hamersley and Nabberu Basin
Plj	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Quartzite, schist, gneiss, amphibolite in Gawler, Broken hill, Wonominta, Mt Painter and Denison Blocks
Plk	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granitic rocks in Arnhem and Tennant Creek Blocks and Halls Creek province
Plm	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	High-grade metamorphics in Gascoyne Block and Paterson Province
Plm?	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	High-grade metamorphics in Gascoyne Block and Paterson Province
Pln	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Low and high-grade metamorphics in Arnhem, Mt Isa, Georgetown, Coen, Nicholson and Yambo Blocks
Plo	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Migmatite, gneiss, granite in Pine Creek Geosyncline
Plp	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Conglomerate, chert, sandstone, dolomite in Pine Creek Geosyncline and Tennant Creek Block
Plq	PRECAMBRIAN BASIC/ULTRAMAFIC INTRUSIVES	Dolerite in Kimberley Basin
Plr	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Quartzite, schist, slate, conglomerate in Arunta Block
Pls	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Shale, quartzite, sandstone, dolomite, conglomerate i
Pls?	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Shale, quartzite, sandstone, dolomite, conglomer
Plt	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Gneiss, migmatite, amphibolite in Halls Creek Province
Plu	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Rhyolite in Tennant Creek Block
Plv	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Acid volcanics in Hamersley Basin
Plw	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, acid volcanics, conglomerate in the Granites-Tanami and Arnhem Blocks and Kimberley basin
Plwv	PRECAMBRIAN BASIC VOLCANICS AND SEDIMENTS	Basic volcanics in Kimberley basin
Plx	PRECAMBRIAN BASIC VOLCANICS AND SEDIMENTS	Basic volcanics, andesites, tuffaceous sediments
Ply	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Acid volcanics, dolerite, dacite in Halls Creek province
Plz	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granite in Halls Creek province

Pmc	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Sandstone, siltstone, minor limestone, conglomerate in Hamersley and Nabberu Basins
Pmd	PRECAMBRIAN BASIC/ULTRAMAFIC INTRUSIVES	Dolerite sills and dykes in Bangemall, Hamersley and Nabberu Basins
Pmg	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granitic rocks in Albany-Fraser Province and Northampton and Leeuwin Blocks
Pmg?	PRECAMBRIAN ACID/INTERMEDIATE INTRUSIVES	Granitic rocks in Albany-Fraser Province and Northampton and Leeuwin Blocks
Pmm	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	High-grade metamorphics in Albany-Fraser Province and Northampton and Leeuwin Blocks
Pmm?	PRECAMBRIAN METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	High-grade metamorphics in Albany-Fraser Province and Northampton and Leeuwin Blocks
Pmw	PRECAMBRIAN SEDIMENTS AND VOLCANICS	Quartzite, shale, chert, dolomite, in Bangemall, Officer and Perth Basins and Albany-Fraser Province
Qb	CAINOZOIC BASIC VOLCANICS	Basalt, minor pyroclastics in western Victoria and north eastern Queensland
Qc	CAINOZOIC SEDIMENTS	Calcareous sand +/- limestone: coastal aeolian
Qc/Es	CAINOZOIC SEDIMENTS	Calcareous sand +/- limestone: coastal aeolian OVERLYING Sandstone, shale, limestone, siltstone, conglomerate in Arafura, Amadeus, Ord, Bonaparte Gulf and Arrowie Bas
Qc/Kw	CAINOZOIC SEDIMENTS	Calcareous sand +/- limestone: coastal aeolian OVERLYING Sandstone, siltstone, shale, limestone, marl minor basalt in southwest; in Offic
Qc/Pcf	CAINOZOIC SEDIMENTS	Calcareous sand +/- limestone: coastal aeolian OVERLYING Granitic rocks in Gawler, Broken Hill and Mt Painter Blocks
Qc/Pmm?	CAINOZOIC SEDIMENTS	Calcareous sand +/- limestone: coastal aeolian OVERLYING High-grade metamorphics in Albany-Fraser Province and Northampton and Leeuwin Blocks
Qc/Tc/Plj	CAINOZOIC SEDIMENTS	Calcareous sand +/- limestone: coastal aeolian OVERLYING Limestone: marine, lacustrine OVERLYING Quartzite, schist, gneiss, amphibolite in Gawler, Broken hi
Qe	CAINOZOIC SEDIMENTS	Gypsum, halite, clay, sand: evaporitic
SDs	PALAEOZOIC SEDIMENTS AND VOLCANICS	Siltstone, mudstone, sandstone, shale, schist

Sg	PALAEOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
Sm	PALAEOZOIC METAMORPHICS (REACHING HIGH GRADE) AND ASSOCIATED GRANITES	Gneiss, schist, phyllite
Ss	PALAEOZOIC SEDIMENTS AND VOLCANICS	Siltstone, shale, sandstone, limestone
Sv	PALAEOZOIC SEDIMENTS AND VOLCANICS	Acid volcanics
Sw	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, shale, evaporite in Perth and Carnarvon Basins
TRg	MESOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
TRs	MESOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, mudstone
TRv	MESOZOIC SEDIMENTS AND VOLCANICS	Acid and intermediate volcanics and pyroclastics
TRw	MESOZOIC SEDIMENTS AND VOLCANICS	Sandstone, shale, limestone, siltstone, lamproite intrusions; in Canning and Perth Basins
Tb	CAINOZOIC BASIC VOLCANICS	Basalt, minor acid volcanics
Tb/OSs?	CAINOZOIC BASIC VOLCANICS	Basalt, minor acid volcanics OVERLYING Slate, siltstone, chert, phyllite, sandstone , conglomerate
Tb/pc	CAINOZOIC BASIC VOLCANICS	Basalt, minor acid volcanics OVERLYING Sandstone, siltstone, tillite, conglomerate
Tc	CAINOZOIC SEDIMENTS	Limestone: marine, lacustrine
Tc/Ks	CAINOZOIC SEDIMENTS	Limestone: marine, lacustrine OVERLYING Shale, siltstone, sandstone, limestone
Tc/Kw	CAINOZOIC SEDIMENTS	Limestone: marine, lacustrine OVERLYING Sandstone, siltstone, shale, limestone, marl minor basalt in southwest; in Officer, Canning, Perth and Carnarvon Basins
Tc/Pmm	CAINOZOIC SEDIMENTS	Limestone: marine, lacustrine OVERLYING High-grade metamorphics in Albany-Fraser Province and Northampton and Leeuwin Blocks
Tc/pw	CAINOZOIC SEDIMENTS	Limestone: marine, lacustrine OVERLYING Sandstone, siltstone, shale, tillite, limestone Officer, Canning Carnarvon and Perth Basins
Tf	CAINOZOIC SEDIMENTS	Sandstone, conglomerates: fluvial
Tf/Pab	CAINOZOIC SEDIMENTS	Sandstone, conglomerate: fluvial OVERLYING Sandstone, siltstone, dolomite; minor phyllite, schist in Adelaide Fold Belt

Tf/Paw	CAINOZOIC SEDIMENTS	Sandstone, conglomerate: fluvial OVERLYING Sandstone, siltstone, shale, limestone in Adelaide Fold Belt and Stuart Shelf
Tf/Pcf	CAINOZOIC SEDIMENTS	Sandstone, conglomerate: fluvial OVERLYING Granitic rocks in Gawler, Broken Hill and Mt Painter Blocks
Ts	CAINOZOIC SEDIMENTS	Sandstone, siltstone, mudstone: marine
Ts/Ks	CAINOZOIC SEDIMENTS	Sandstone, siltstone, mudstone; marine OVERLYING Shale, siltstone, sandstone, limestone
Ts/Kw	CAINOZOIC SEDIMENTS	Sandstone, siltstone, mudstone; marine OVERLYING Sandstone, siltstone, shale, limestone, marl minor basalt in southwest; in Officer, Canning, Perth and Carnarvon Basins
Ts/Pab	CAINOZOIC SEDIMENTS	Sandstone, siltstone, mudstone; marine OVERLYING Sandstone, siltstone, dolomite; minor phyllite, schist in Adelaide Fold Belt
pTRg	MESOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
pTRs	PALAEOZOIC SEDIMENTS AND VOLCANICS	Siltstone, sandstone, limestone, conglomerate in Bonaparte Gulf Basin
pc	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, tillite, conglomerate
pc?	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, tillite, conglomerate
pe	PALAEOZOIC BASIC/ULTRAMAFIC INTRUSIVES	Ultramafic intrusive rocks
pg	PALAEOZOIC ACID/INTERMEDIATE INTRUSIVES	Granitic rocks
ps	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, mudstone, tillite, limestone
pv	PALAEOZOIC SEDIMENTS AND VOLCANICS	Acid, intermediate and minor basic volcanics, pyroclastics
pw	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, shale, tillite, limestone Officer, Canning Carnarvon and Perth Basins
pzs	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, mudstone, conglomerate
pzs?	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, mudstone, conglomerate
pzw	PALAEOZOIC SEDIMENTS AND VOLCANICS	Sandstone, siltstone, limestone, conglomerate in Officer Basin