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Floristic Survey of Remnant Vegetation in the Bindoon to Moora Area, Western Australia

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Dryland Salinity Theme - Project 3

Disclaimer

The contents of this report were based on the best available information at the time of publication. It is based in part on various assumptions and predictions. Conditions may change over time and conclusions should be interpreted in the light of the latest information available.

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A. Abstract

A study involving the documentation of the floristic diversity of Crown and private remnants between Bindoon and Moora is described. The Study Area has attracted botanists since soon after European settlement, but no description of the area's values has been prepared.

A rich vascular plant flora in excess of 1000 taxa was compiled for the area. This confirmed the area as a node of species richness in the south-west of Western Australia. Included were a number of rare and geographically restricted species. The distribution of many species reflected the Study Area being the junction between three botanical districts.

The Study Area also proved rich in Vegetation Types with 45 different Types identified and many of these variable enough to recognise Sub-types and variants. A significant proportion of the vegetation types were correlated with geological substrates.

It was possible to identify Floristic Regions based on the distribution of vegetation types. These were significantly related to the geological structure of the Study Area. The regions identified only partly agreed with previous studies but reflected their general thrust. Justifications were made for a review of the boundaries of Botanical Districts in the area.

The conservation status of the floristic regions and Vegetation Types was documented. Many Vegetation Types and most Floristic Regions were poorly represented in conservation reserves. Although there were few other Crown reserves in the area, some were recommended for inclusion in the conservation estate. Many of the privately owned remnants were highly significant for the conservation in the area. Owners have been notified accordingly.

Only a few of the conservation reserves are on the Register of the National Estate hence most of the others and some of the private remnants have been recommended for inclusion.

The distribution of remnant vegetation was variable, mainly reflecting part disfavour of certain lands for agriculture. There has been a small amount of clearing in recent years, mainly some of the gravelly but presumably less fertile upland areas.

Remote sensing techniques did not prove satisfactory in mapping remnant vegetation for this study. The limitations of this technique in this application is discussed.

Notes on the prevalence of salt affected land and implications of continued salination for remnants and conservation reserves was made.

The need for Heritage Agreements for remnants is discussed.

B. Recommendations

1. Most Crown reserves in the Study Area which are not currently in the conservation estate should have Conservation of Flora (or Conservation of Flora and Fauna) added as a purpose.

2. Reserve C2334 (Water Catchment) at Mooliabeenee should be vested in the National Parks and Nature Conservation Authority as a Class A nature reserve.

3. The values of specific remnants should be disseminated to the relevant private owners who should be encouraged to implement appropriate protection methods.

4. The Western Australian Government should provide through legislation the opportunity for Heritage Agreements to be made over private remnants which would provide similar recognition and protection as does Nature Reserve status.

5. Most conservation reserves and certain privately owned remnants should be listed on the Register of the National Estate.

6. A study should be initiated which would better define the boundary between the Avon and Darling Botanical Districts.

7. A study should be initiated on the decline of the fringing vegetation of Lake Wannamal and any link to saline drainage, and

8. Remote sensing techniques should not be considered as a suitable method of mapping remnant vegetation unless accompanied by interpretation by experienced field personnel.

C. General Introduction

The present Study Area has not commonly been recognised as an important botanical area as has the neighbouring Northern Kwongan (or Sandplains) (e.g. George et. *al.* 1979). Hopper and Muir (1984) recently identified the Mogumber to Toodyay area as one of six nodes of richness as measured by numbers of rare or geographically restricted species. Other such areas included Mt Lesueur, the Wongan Hills, the Fitzgerald River area and the Stirling Ranges. Marchant (1973) speculated that deeper valleys of the Darling Scarp could have been a refugial area for plant species in past geological times when climate was more harsh. Parts of the Study Area might fit this model.

The area has had a long history of botanical collecting. James Drunimond collected in the area in the 1830s to 1850s (Erickson, 1969). Doctors Diels and Pritzel (Diels, 1906), W.V. Fitzgerald (Fitzgerald, 1904), A. Morrison (Morrison, 1912) and a number of others collected in the area around the turn of the century. Charles Gardner collected between Bindoon, Mogumber and New Norcia from the 1920s to the 1960s. W.E. Blackcall collected in the same area in the 1930s, sometimes with Gardner. Father William Giinenez OSB, a friend of Gardner, collected in the New Norcia area in the 1920s.

There has been significant recent collections in the 1970s and 1980s by numerous botanist.

Despite this long history of Botanical interest, there has been little documentation of the botanical values of the area. Beard (l979a, 1979b) included the area in vegetation maps of the scale of 1:250,000. No other vegetation studies are known specific to the area. Griffin (1990) studied an adjoining area around Dandaragan. The nearest other detailed vegetation study was of the Moondyne Nature Reserve (near Avon Valley National Park) (B. and K. Dell in Appendix VII of Moore et. *al.,* 1984). Very few specimens from Julimar Forest are represented in collections of the Western Australian Herbarium.

Barrett (1982) and Gillen (1982) documented the distribution of some of the rare and geographically restricted species in part of the Study Area. Miller (1982), Burgman (1983) and Partick (1984) assessed the conservation status of a few of these in detail. More recently Kelly et. *al.* (1990) updated the information on the rare species in CALM's Northern Forest Region including the southern part of the Study Area. The northern part of the Study Area is included in a similar study of CALM's Moora Region (S. Partick pers comm.)

The number of conservation reserves in the Study Area is low and except for the Julimar Forest they are quite small. Only two of these conservation reserves are listed on the Register of the National Estate (Bindoon and Chittering Lakes, and Lake Warinanial). None of the conservation reserves have management plans. The amount of other types of Crown land in the area is small and, therefore, there is little opportunity for new conservation reserves to be created by changing their purpose.

There have always been people in the rural community to whom native vegetation has a value of its own. Awareness has developed in a wider section of the community of the value of native vegetation for the productivity of rural lands. Without doubt the latter has meant that more people have come to realise the intrinsic values of the native flora and fauna. The Dandaragan area, for example, includes groups and individuals who are working to maintain a balance between the natural biota and the farming areas so that both can have a viable future. Several Land Care District Committees have been established in that area.

The Study Area has a wide range of vegetation and soil types. Seemingly because of that, it has had a long history of rural development. It was amongst the earliest areas settled in Western Australia at about 1841 (Cameron 1979). Even so there are still areas being cleared. The highly dissected topography, typical of parts of the area, has probably contributed to the area being incompletely cleared to date.

Coates (1987) documented the remnant vegetation in a portion of the wheatbelt. A survey of the attitude of farmers to these remnants was also described. Griffin (1990) identified remnants, described the regional nature of floristic variation and reported on farmers attitudes to remnants in the Dandaragan area. The present project was designed to document the areas which are still not cleared, identify the regional patterns in the floristic composition of the vegetation and promote the values of the natural flora.

The project was divided into two aspects:

- floristic survey, and
- mapping of remnant patches.

Study Area

The focus of the Study Area was chosen because of the geological and topographical variability and because of the history of botanical collections in the area. The boundaries were chosen to integrate with the Department of Agriculture's remnant vegetation mapping.

The Study Area, therefore, was between 116° 00' and 116° 15' east longitude, 30° 30' and 31° 30' south latitude, covering four 1:50,000 map sheets. This was from just north of Moora to just south of Bindoon and from west of the Midlands railway line to about Walebing and New Norcia (Figure 1). It covered parts of the Moora, Victoria Plains, Chittering and Toodyay Shires.

Physiography

The Darling Plateau is the predominant feature in the Study Area (Figure 1). No precise subdivisions of this plateau have been made. Several authors (e.g. Muichay, 1967 and Finkle, 1979) have divided the Plateau into several zones with differing degrees of stripping of the ancient lateritic profile. The north-east of the Study Area has been largely stripped, while the remainder has been stripped significantly less.

West of the Darling Plateau is the Dandaragan Plateau, only a little of which is within the Study Area. Terminology in this area is inconsistent. Carter and Lipple (1982) recognise an alluvial belt (Yarra Yarra Region) between these two plateaus. To the south of this Wilde and Lowe (1978) recognised a narrow band between the two plateaus, in part similar to the Yarra Yarra Region, but they included it into a unit they called the Darling Scarp. Churchward and McArthur (1980), whose mapping covers only the lower third of the Study Area, defined several landforms in the Dandaragan Plateau. Again these were not consistent with other work.

Geology

The rocks of the Archaean Shield in the Study Area are complex. Only a brief synopsis of the treatments of this subject by Wilde and Lowe (1978) and Carter and Lipple (1982) is provided here. Figure 2 is a simplification of the distribution of rock types in the Study Area. Slight differences of interpretation between the above authors made it necessary to use a little licence in the preparation of this figure.

Granitic rocks provide the basic structure of the shield in the south and migmititic in the north. The most conspicuous features of the Study Area are the major metamorphic intrusive belts. These are the converging Jimberding and Chittering Metamorphic Belts in the south and the Berkshire Valley Succession in the north. These areas have apparently consistent differences in the proportions of schist, gneiss, banded iron formations and other rock types. Characteristic are the generally narrow bands of each rock type.

In the south of the Study Area the Darling Fault separates these Archaean rocks from the Mesozoic rocks of the Perth Sedimentary Basin. In the north of the Study Area, however, the Proterozoic sedimentary rocks of the Moora Group lie east of the Darling Fault partly separated from the Archaean rocks by a series of poorly defined faults. The Moora Group are a variety of sandstones, siltstones, limestone and even chert rocks. The residual surface rocks, often quartzite rich, exhibit a strike parallel to the Darling Fault.

The Mesozoic rocks are poorly exposed in the Study Area. Those immediately underlying the soil are Cretaceous and presumably the sandstones and siltstones of the Osborne Formation.

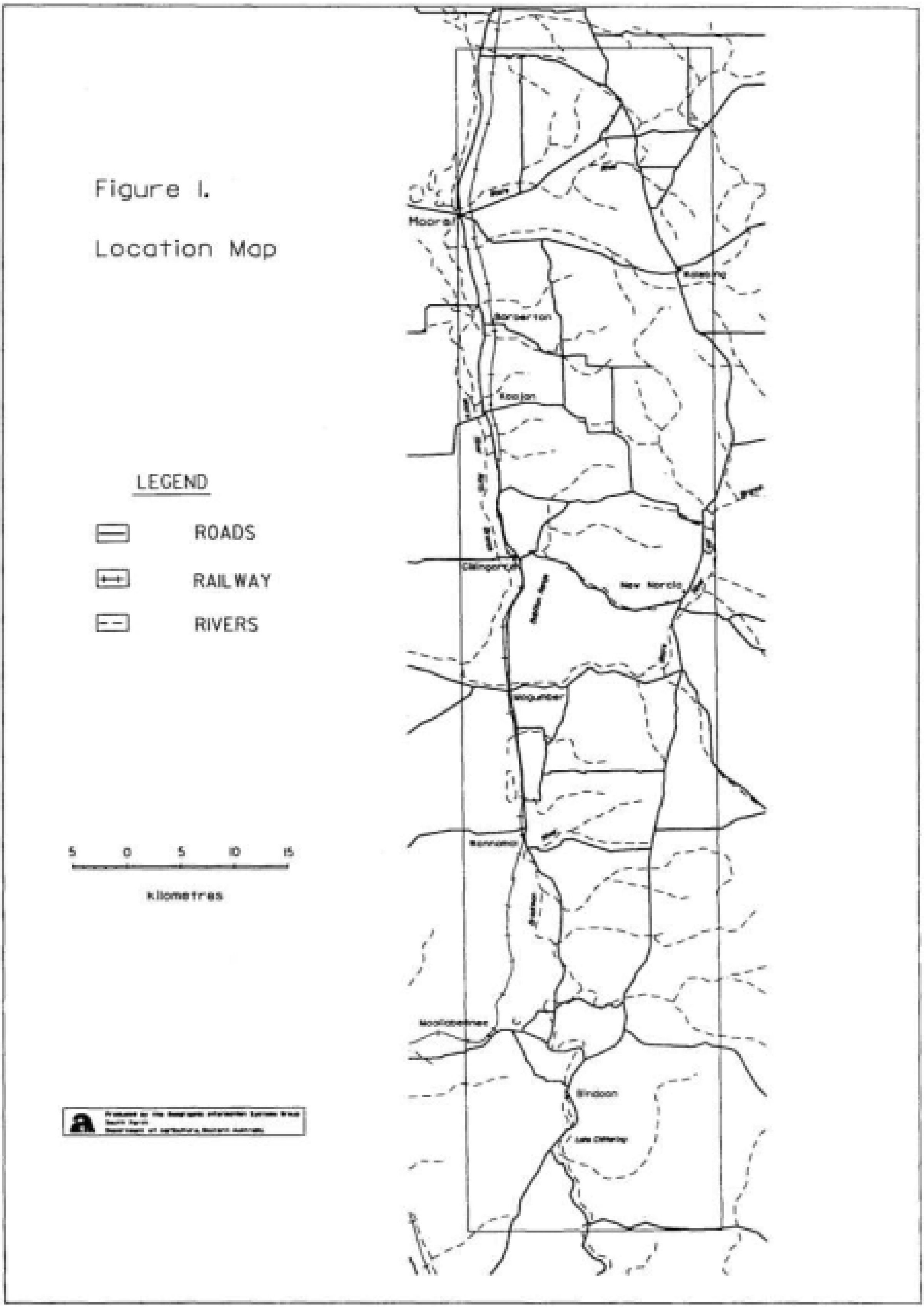


Figure 1.

Location Map

Figure 2.
Solid Geology

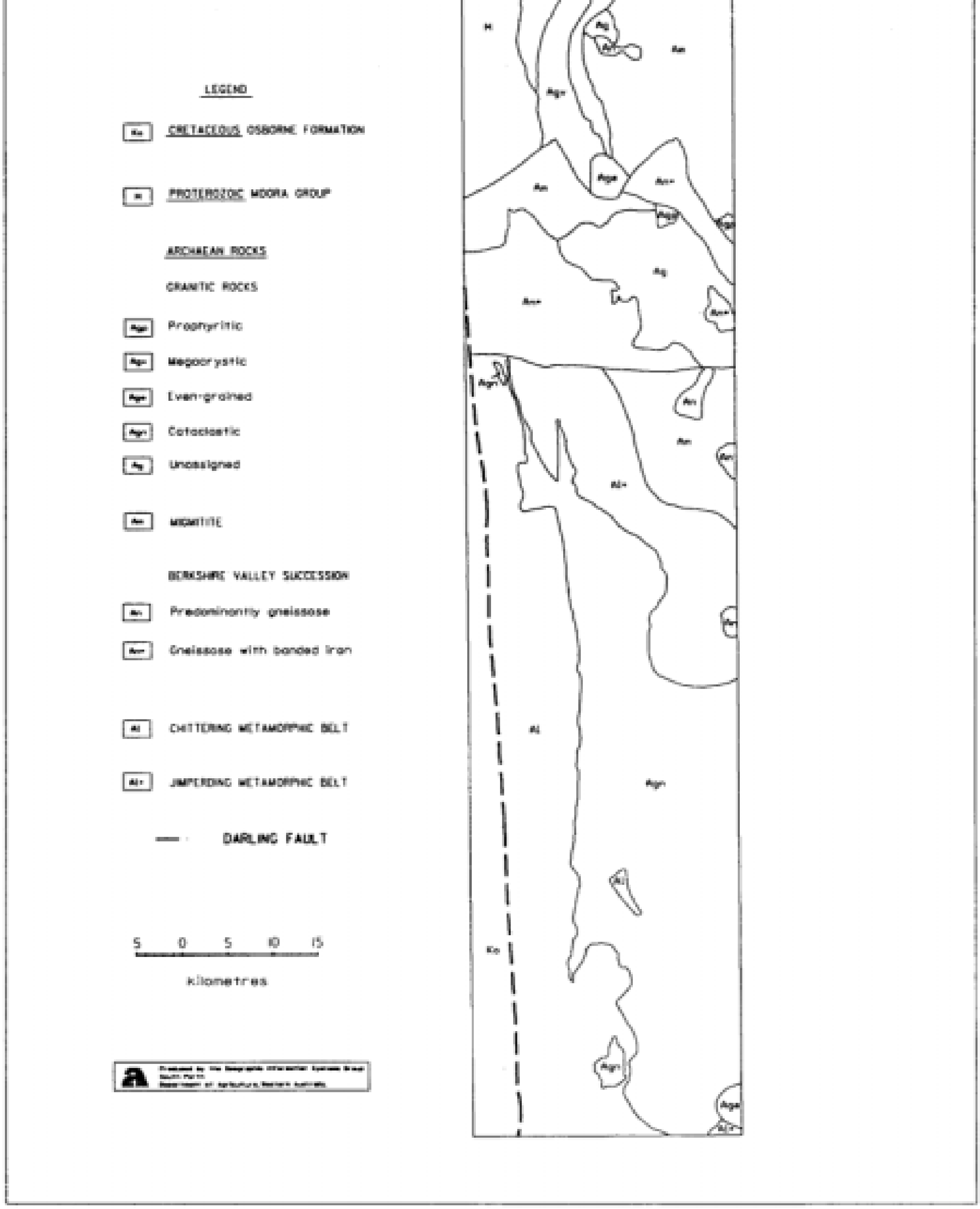


Table 1. Geological Units mapped in the Study Area (from Wilde and Lowe, 1978 and Carter and Lipple, 1982)

OUATERNARY	
Qrw	Swamp and lacustrine deposits — peat, peaty sand and clay
Qra	Alluvium — clay, sand and loam
Qrc	Colluvium, including valley-fill, variably lateritized and podsolized
Qc	Colluvium — unassigned clay sand and gravel
Qcf	Colluvium — rock fragments
Qcs	Colluvium - lithic sand
Qa	Alluvium and minor colluvium developed on laterite of the Darling Range
Qpo	Colluvium, soil and undifferentiated sand over laterite of Coastal Plain. Includes minor alluviated areas
?TERTIARY	
Czl	Laterite - chiefly massive, but includes overlying pisolitic gravel and lateritized sand
Czs	Sand over laterite — yellow, white or grey and often associated with drainage lines
MESOZOIC	
Ko	Osborne Formation: glauconitic siltstone, claystone, shale and sandstone
PROTEROZOIC	
Moora Group	
P0cc	Noondine Chert: chert, orthoquartzite, with minor siltstone, sandstone, claystone and dolomite
Poci	Mokadine Formation: arkose with sandstone, siltstone, claystone and chert
Pobd	Dalaroo Siltstone and Capalcarra Sandstone (undifferentiated): siltstone and claystone, with basal arkose, sandstone and conglomerate
ARCUAEAN	
Granites	
Ag	Granitic rocks, unassigned
Age	Even—grained granitic rocks — fine to coarse—grained granodiorite, adamellite and granite
Agp	Porphyritic granite - medium to coarse-grained granite with microcline megacrysts
Agv	Fine to medium-grained adamellite and granite with scattered microcline megacrysts
Agni	Mixed granitic rocks, chiefly interdeveloped even-grained and porphyritic granite
Agn	Gneissic granite, with cataclastic foliation
Migmitite	
Am	Migmatite - banded and nebulitic, often strongly contorted
Ainm	Migmatite; stromatic, banded
Gneiss	
An	Gneiss, unassigned
Anp	Porphyritic granitic gneiss, coarse-grained with abundant tabular microcline megacrysts
Ans	Felspar—pyroxene—quartz—sphene augen gneiss
Ana	Augen gneiss, coarse—grained with microcline augen, strong cataclastic foliation
Anb	Quartz-felspar-biotite gneiss, generally well banded, may contain garnet
Anl	Quartz—felspar (—garnet—biotite) gneiss, leucocratic, often with elongate felsic areas
Anf	Quartz—felspar—biotite granofels, inelanocratic and poorly banded
Anc	Interbedded quartz-hornblende-biotite-garnet gneiss, quartz—felspar gneiss and amphibolite, some mylonite zones

amphibolite, some mylonite **zones**

And quartz-felspar-hornblende-biotite gneiss and schist

Schist

Al	Schist, unassigned
Alb	Quartz—mica schist, biotite generally in excess of muscovite
Alk	kyanite bearing schist
Alq	Quartz (-mica-felspar) schist with quartz—mica—felspar gneiss and quartz—mica—felspar granofels
Alm	Muscovite-chlorite phyllitic schist

Intrusives and miscellaneous

Au	Ultramaf Ic dykes and sills - peridotite and pyroxenite, often foliated and variously altered to green schist fascies metamorphic assemblages
Aa	Ainphibolite, hornblende-plagioclase, some cuinmingtoniteplagioclase rocks, also include minor hornblendite
Aqo	Quartzite, metamorphosed orthoquartzite, often with green chrome muscovite
Al	Undifferentiated — includes quartz-magnetite-grunerite assemblages
Aiw	Quartz-magnetite-hypersthene rock
	Aiq banded magnetite-bearing quartz ite

It was intended to reproduce the relevant portions of the surface geology in this report. Limitations of resources to prepare the figure and the inconsistencies in naming geological units mentioned above made this impractical. The surface geology mapping exemplifies the complex nature of the geology in the Study Area (one of the reasons for the study). For the convenience of other parts of this report, Table 1 is provided to briefly outline and describe the geological units mapped in the Study Area.

A high proportion of the Study Area has exposed rocks (or areas only covered with a thin veneer of soil). The degree of exposure mainly reflects the resistance of the different rock types to weathering and erosion. The metamorphic belts are the ones most exposed and generally through which the major drainage lines flow. The granitic rocks in the south east form the core of the lateritic uplands.

The quaternary units are broadly of two types; the residual deposits and the transported deposits. The residual uplands are mostly pisolitic laterites and associated sands. The same lateritic unit (Czl) is mapped to occur over a wide range of parent materials. This is in spite of the earlier recognition that the composition of residual laterites reflect the composition of the parent rocks (Davy 1981). There are also small areas of residual sands on the uplands.

Much of the Study Area is covered by transported deposits. Colluvial sand and gravel clothe many of the slopes particularly in the north and especially over the Mesozoic rocks of the Perth Sedimentary Basin. Various alluvial clays and swamp deposits are present in the major drainage lines.

Soils

The soil mapping in the Study Area (Churchward and McArthur 1980, Northcote et. *al.* 1967) shows a strong reliance on interpretation of landforms. There are some regional patterns reflecting major geological substrate differences. Soil units of major landforms such as drainage lines and lateritic uplands were analogous with certain surface geology units. However, for the most part there is little obvious accord between other soil units and the solid geology units. Part of this may reflect the different intensity and scales of study.

The mapping of Churchward and McArthur (1980) is more detailed than that of Northcote et. *al.* (1967) but the former covers only the lower third of the Study Area. Figure 3 is a map of the soil units of Northcote et. *al.* (1967). Stoneman (1990) provides details of some of the major soil types in the Noora area.

The soils of the Dandaragan Plateau were predominantly sandy laterites on the low ridges and grey sands over yellow on the lower slopes. Leached grey sands are present in some wetlands and associated dunes. Others have loamy yellow mottled soils and gravel.

The southern part of the Study Area on the Darling Plateau is dominated by a lateritic upland with gravel, generally fine, with a sandy matrix. The upper valleys are usually flat and poorly incised. They have sandy (generally yellow) gravelly duplex soils with some rock outcrop. The slopes of the major tributaries to the Brockman River are moderate with yellow duplex soils with some rock outcrop. The valley of the Brockman River has slopes which are steep with shallow red and yellow earths and much rock. There is commonly an apron of similar soils gently sloping down to alluvial terraces. These have yellow, red or brown soils and some swamps.

Further north the proportion of residual lateritic uplands declines. Thus the lateritic soils and the shallow upper valleys are less important. The yellow gravelly, sandy duplex soils of the upper valleys are the most important. Steeper slopes commonly have gneissic outcrops. In the Wannamal area there are small hills with granitic exposures flanked by shallow sandy soils. The riverine terraces of the southern branch of the Moore River are duplex soils with a red clayey sub-soil.

In the north of the Study Area the proportion of residual lateritic uplands is very small. Yellow duplex soils predominate including areas with gneissic outcrops. Small residual hills of quartzite with shallow earthy gravelly sands occur north of Moora. These correspond to parts of the Noondine Chert (a member of the Moora Group of rocks). Duplex soils with yellow clayey sub-soils predominate in the major trunk valleys of the North Branch of the Moore River.

Drainage

The Moore and the Brockman are the principal rivers in the Study Area (Figure 1). Like most drainage patterns of the south west coast of Australia they essentially from east to west. Despite this, they drain southward through part of their trunk valleys. Drainage is seasonal following winter rain and many tributaries are dry during summer.

The drainage patterns in the Study Area are well defined. The degree of incision varies greatly depending on the geology of the area through which they pass. Along the Darling fault there is poorly integrated and sluggish drainage leading to swamps and seasonally wet areas. In eastern parts of the Study Area there are some areas with sluggish but integrated drainage. Both these appear to represent remnants of ancient, perhaps Tertiary, drainage patterns. Varying degrees of rejuvenation have developed mainly in the south east of the study area. These have produced correspondingly integrated and effective drainage patterns in V-shaped valleys.

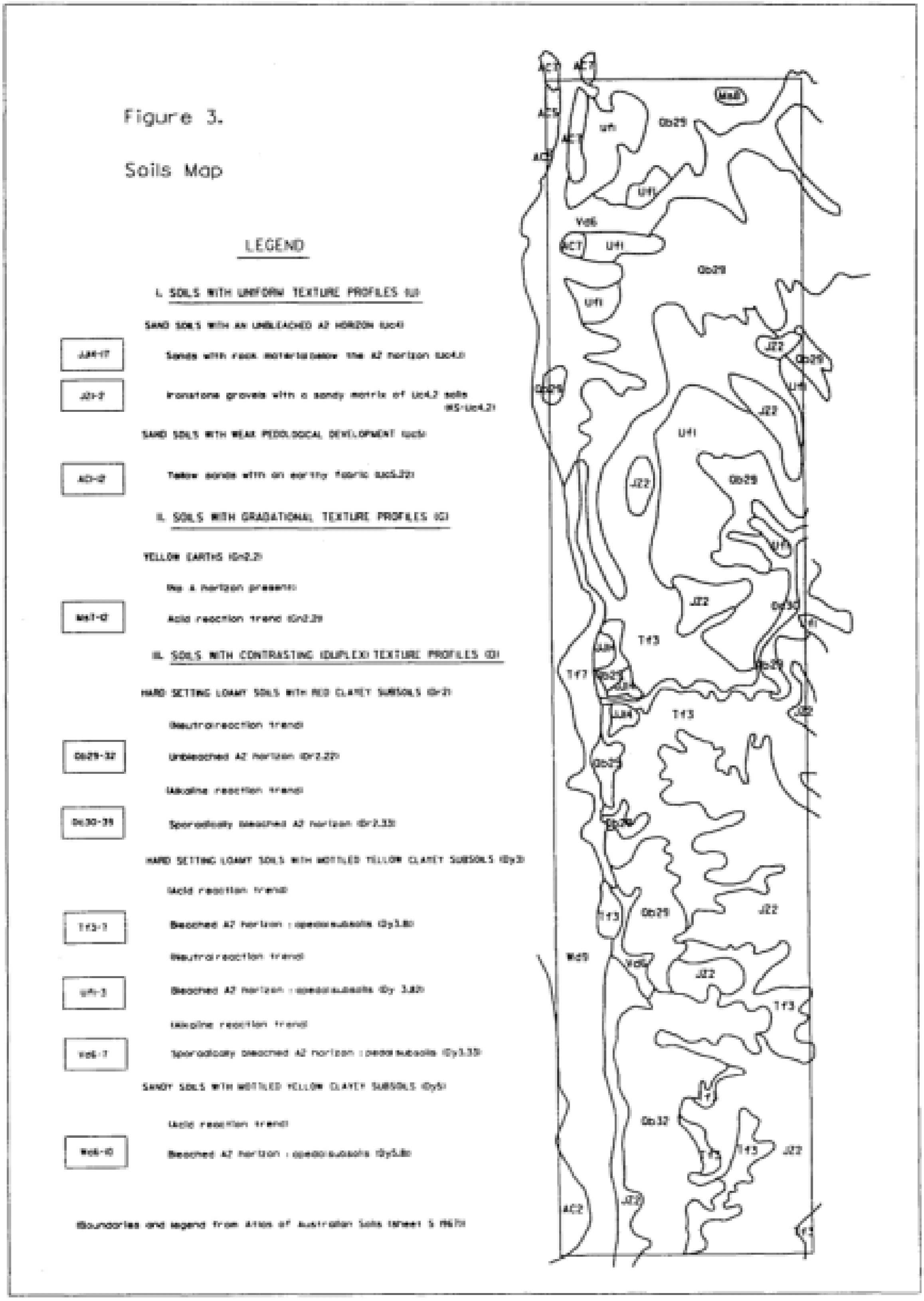


Figure 3.
Soils Map
LEGEND
I. SOILS WITH UNIFORM TEXTURE PROFILES (U)
SAND SOILS WITH AN UNBLEACHED A2 HORIZON (Uc4)
Sands with rock material below the A2 horizon (Uc4.1)
Ironstone gravels with a sandy matrix of Uc4.2 soils
SAND SOILS WITH WEAK PEDOLOGICAL DEVELOPMENT (Uc5)
Yellow sands with an earthy fabric (Uc5.22)
II. SOILS WITH GRADATIONAL TEXTURE PROFILES (G)
YELLOW EARTHS (Gn2.2)
Acid reaction trend (Gn2.29)
III. SOILS WITH CONTRASTING (DUPLEX) TEXTURE PROFILES (D)
HARD SETTING LOAMY SOILS WITH RED CLAYEY SUBSOILS (Dr2)
(Neutral reaction trend)
Ob29-32
Unbleached A2 horizon (Dr2.22)
(Alkaline reaction trend)
Sporadically bleached A2 horizon (Dr2.33)
HARD SETTING LOAMY SOILS WITH MOTTLED YELLOW CLAYEY SUBSOILS (Dy3)
(Acid reaction trend)
Bleached A2 horizon : apedal subsoils (Dy3.81)
(Neutral reaction trend)
Bleached A2 horizon : apedal subsoils (Dy 3.82)
(Alkaline reaction trend)
Sporadically bleached A2 horizon : pedal subsoils (Dy3.33)
SANDY SOILS WITH MOTTLED YELLOW CLAYEY SUBSOILS (Dy5)
(Acid reaction trend)
Bleached A2 horizon : apedal subsoils (Dy5.81)
(Boundaries and legend from Atlas of Australian Soils (Sheet 5 1967))
Ob29
Uf1
J22
Tf3
Vd6
Wd9
AC2
AC7
Ob30
Ob32

Vegetation and Flora

The native vegetation of the whole Study Area has been mapped at the scale of 1:250,000 by Beard (Beard, l979a, 1979b)(Figure

4). The vegetation of a portion of the south of the Study Area was also described at this scale by Heddle et. *al.* (1980) using the same units as Churchward and McArthur (1980). These studies were in general agreement.

In the north and north east of the Study Area the native vegetation is dominated by different combinations of wandoo and York gum and Salmon gum. The centre of the study area was madded as having wandoo and York Gum with *Dryandra* species dominating heaths on lateritic ridges. Further south Marri joins wandoo on the ridges and these are joined further south by Jarrah.

In the south the lower slopes of the main valleys have wandoo and York gum. The main trunk valleys have *Melaleuca* shrublands and woodlands, particularly surrounding the occasional lake. A narrow strip on the south west has *Banksia* woodlands with in places wetlands dominated by *Melaleuca* shrublands.

Climate

According to the scheme of Bagnouls and Gaussen (1957) the climate of the Study Area can be defined as Warm Mediterranean in the south and Dry Warm Mediterranean in the north east. The boundary represents 6 months of dry weather. Beard (1979a) equated this to the 450mm rainfall isohyet.

There are significant gradients in climatic variables in the area. Bullsbrook has an average annual rainfall of about 700 mm, while Moora has about 460 mm and Walebing 490 mm (Figure 5). Bullsbrook and Moora have similar temperatures but Bullsbrook tends to be slightly warmer in winter and slightly cooler in summer.

Figure 6 shows that an east — west gradient is also noticeable with rainfall declining from west to east. The Gingin Scarp produces a distortion of this gradient, apparently an oreographic influence by which rainfall along the scarp is slightly higher than on the coast. Evapotranspiration increases in a general west to east direction.

Figure 4. Vegetation Systems

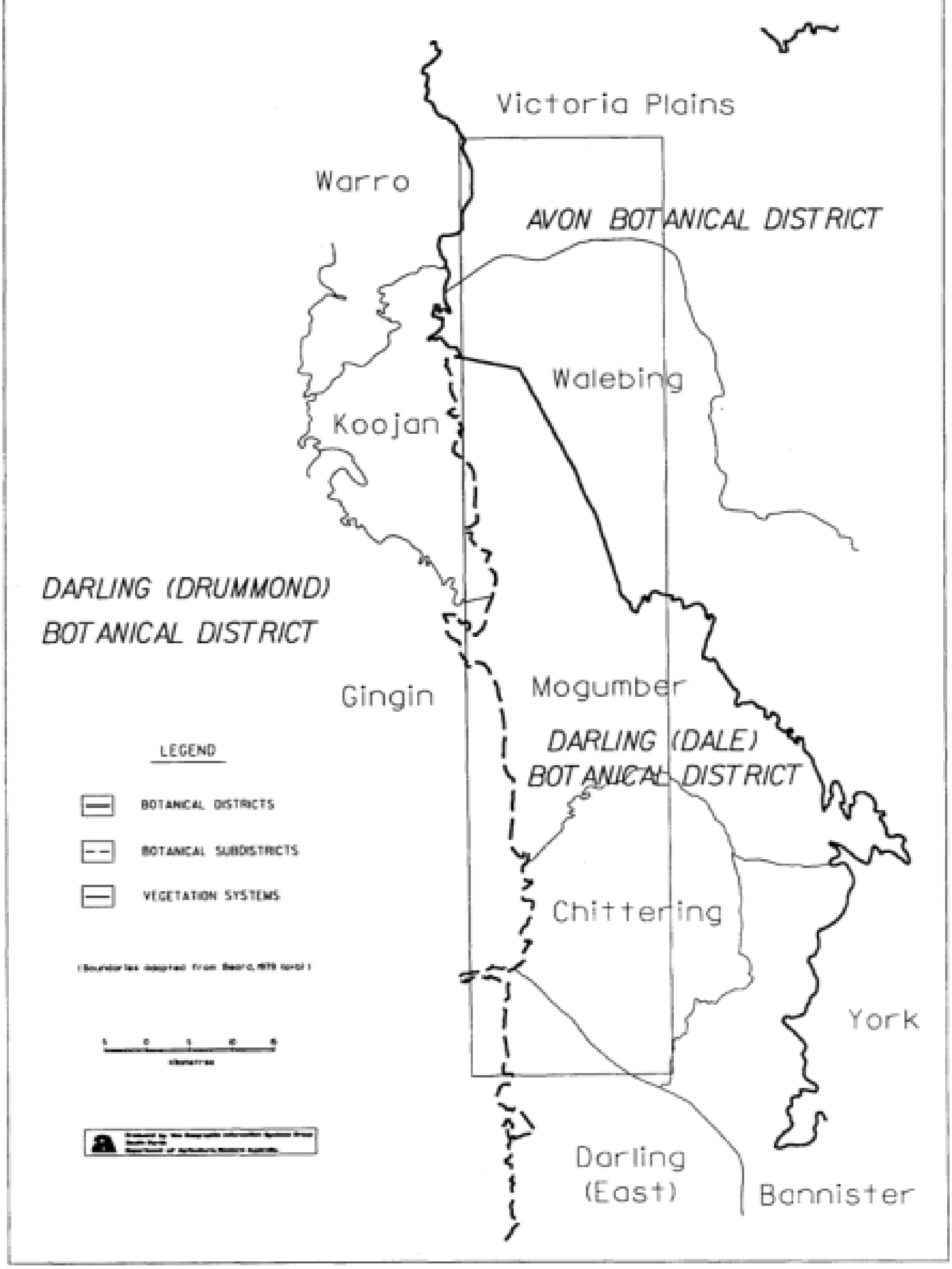
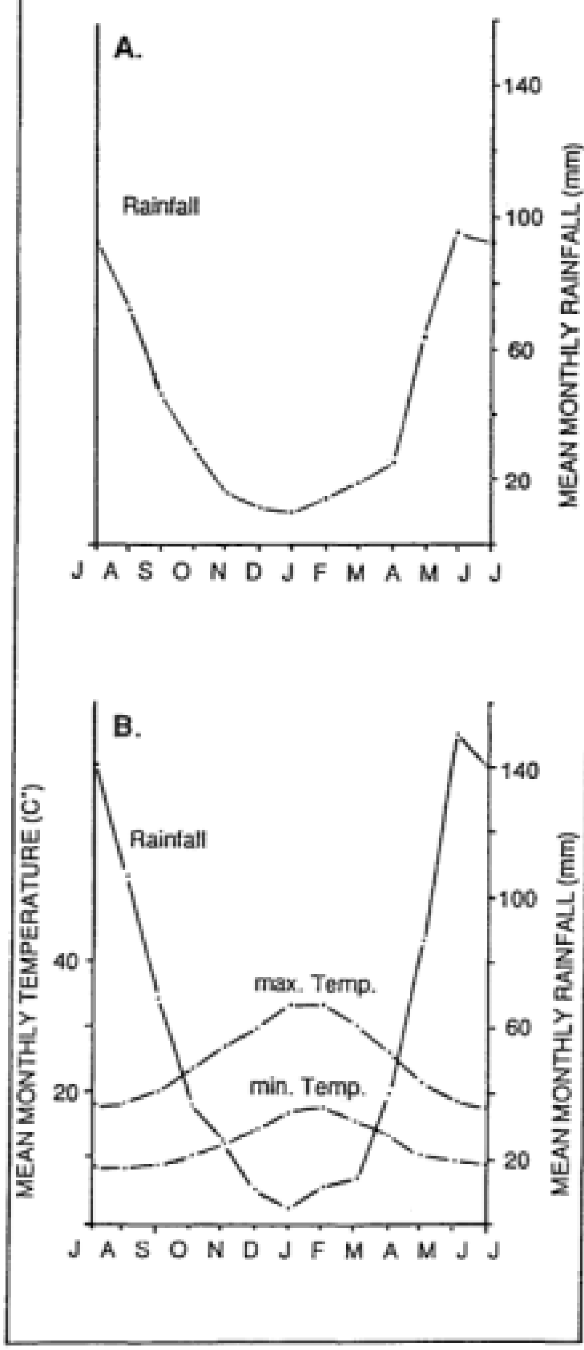


Figure 5. Ombrothermic Diagrams

(A. - Walebing, B. - Bullsbrook, C. - Moora)



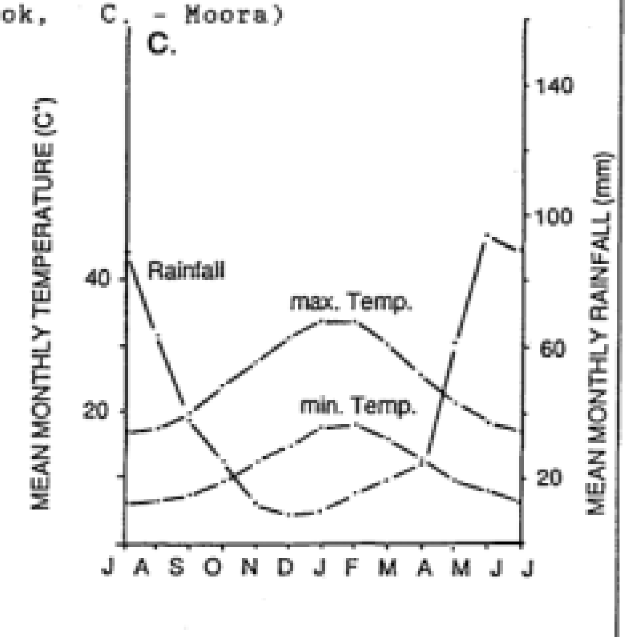
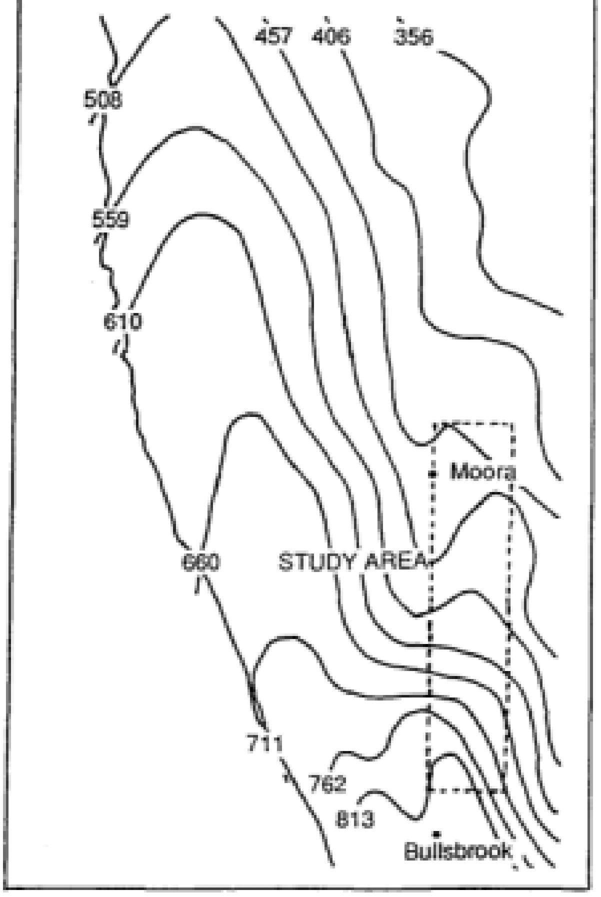


Figure 6. Rainfall Isopleths

(Extracted from Bureau of Meterology, 1968.
Isopleths converted from inches to mm, interval 2")



Land use

The study area is primarily private property, with only minor amounts of Crown reserves and vacant Crown land (Figure 7). The long history of agricultural settlement has meant that much of the private land has been cleared for crops and pasture.

The Crown land is concentrated in the south east of the Study Area. This is essentially the Julimar Forest which until recently was part of the State's timber estate. A few small nature reserves are present including Mt Byromanning, Gillingarra, Lake Wannamal and Hay Flat.

As mentioned earlier only Bindoon and Chittering Lakes and Lake Wannamal Nature Reserves are listed on the Register of the National Estate. Listing indicates Federal Government recognition that the places have values and warrant special consideration. Registration is principally a method by which listed areas are brought to the attention of Federal Government Departments and Agencies who, if they propose actions which would disturb a place, must seek advice on their values. Private property as well as Crown land (e.g. conservation reserves) may be included on the Register. Entry in the Register is on the basis of objective evaluation against formal criteria. These criteria may include things other than nature conservation significance; for example cultural factors may be included.

Crown lands are used to a minor extent by beekeepers and wildflower pickers. Their activities together with those of the mineral explorers and off—road vehicle use may have an adverse impact on the flora and fauna in the area especially (but not only) through the spread of plant pathogens (e.g. *Phytophthora* spp.).

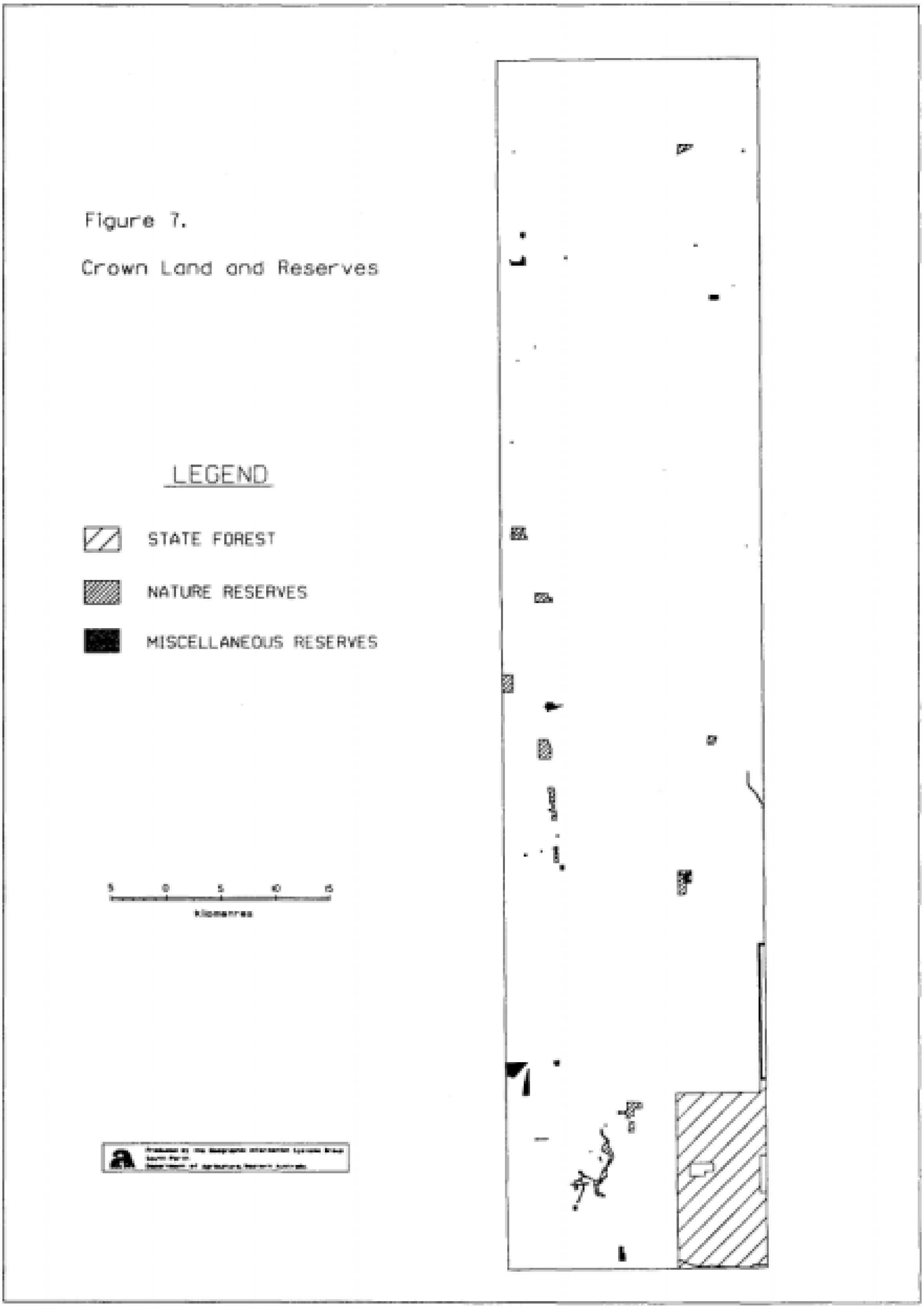


Figure 7.

Crown Land and Reserves