PRELIMINARY DELINEATION OF CONSANGUINEOUS WETLAND SUITES BETWEEN WALPOLE AND FITZGERALD INLET, SOUTHERN WESTERN AUSTRALIA

Report to:

Waters and Rivers Commission
3 Plain St
Perth, W. A., 6001

Report by:

V & C Semeniuk Research Group
21 Glenmere Rd.,
Warwick, W.A., 6024

JUNE 1998

TABLE OF CONTENTS

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1.0 INTRODUCTION

1.1 General introduction

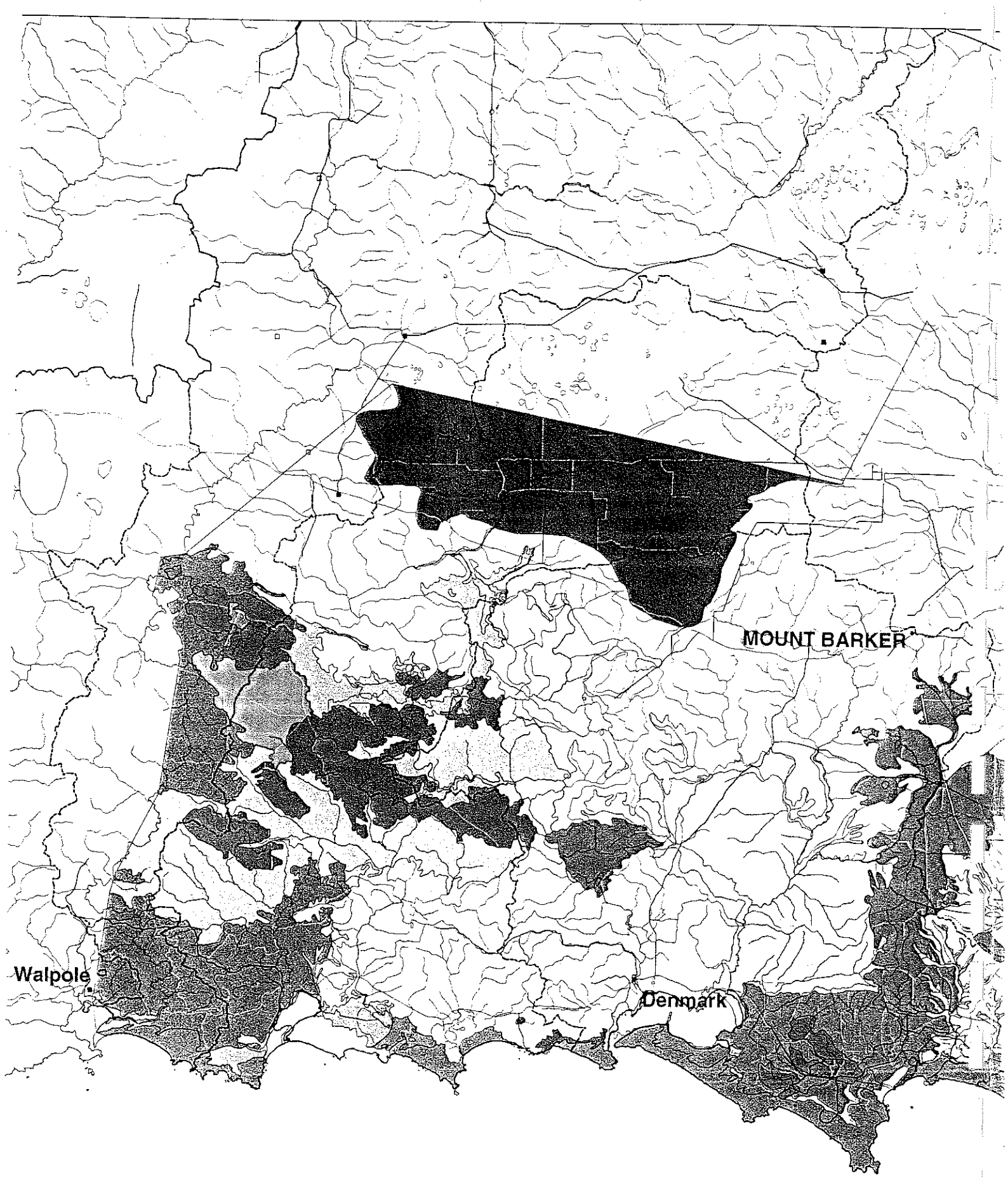
The need for regional wetland evaluation was first recognised in 1995. Community assistance was sought to develop a plan for managing natural resources on the south coast of Western Australia, and this became the South Coast Regional Land and Water Care Strategy (Southern Prospects Strategy). The area designated as the focus of this strategy was defined as the catchments of all the southerly flowing rivers between the Frankland-Gordon River in the west, and Cape Arid in the east. The Waters & Rivers Commission were contributors to initial survey and classification work for the project. As part of the ongoing programme, Waters & Rivers Commission contracted V & C Semeniuk Research Group to extend and refine some of the preliminary wetland investigation, so that it would include classification of wetlands into suites, using a technique similar to the one applied to the area between Augusta and Walpole (VCSRG 1997), where wetlands had been mapped and described at a site-specific level and into Consanguineous Suites at a regional level.

The original area for this current project was subdivided into two parts, loosely annotated the "Albany Region" and the "Esperance Region," in order to facilitate the considerable task. The subject of this report is the "Albany Region".

1.2 Location

The area under survey, in this study, encompasses the southern coastal plain and coastal edge of the Yilgarn Plateau between Walpole and Fitzgerald Inlet at the mouth of the Fitzgerald River, on the south coast of Western Australia. It includes the catchments of part of the Frankland River, part of the Pallinup, Bremer, Gairdner and Fitzgerald Rivers, and all of the Denmark, Hay, Kent, Kalgan Rivers. It also encompasses the Stirling Ranges and the Porongurup Ranges (Fig.1). The study area for this report is covered by the following 1:100,000 map sheets:

Figure 1 is missing



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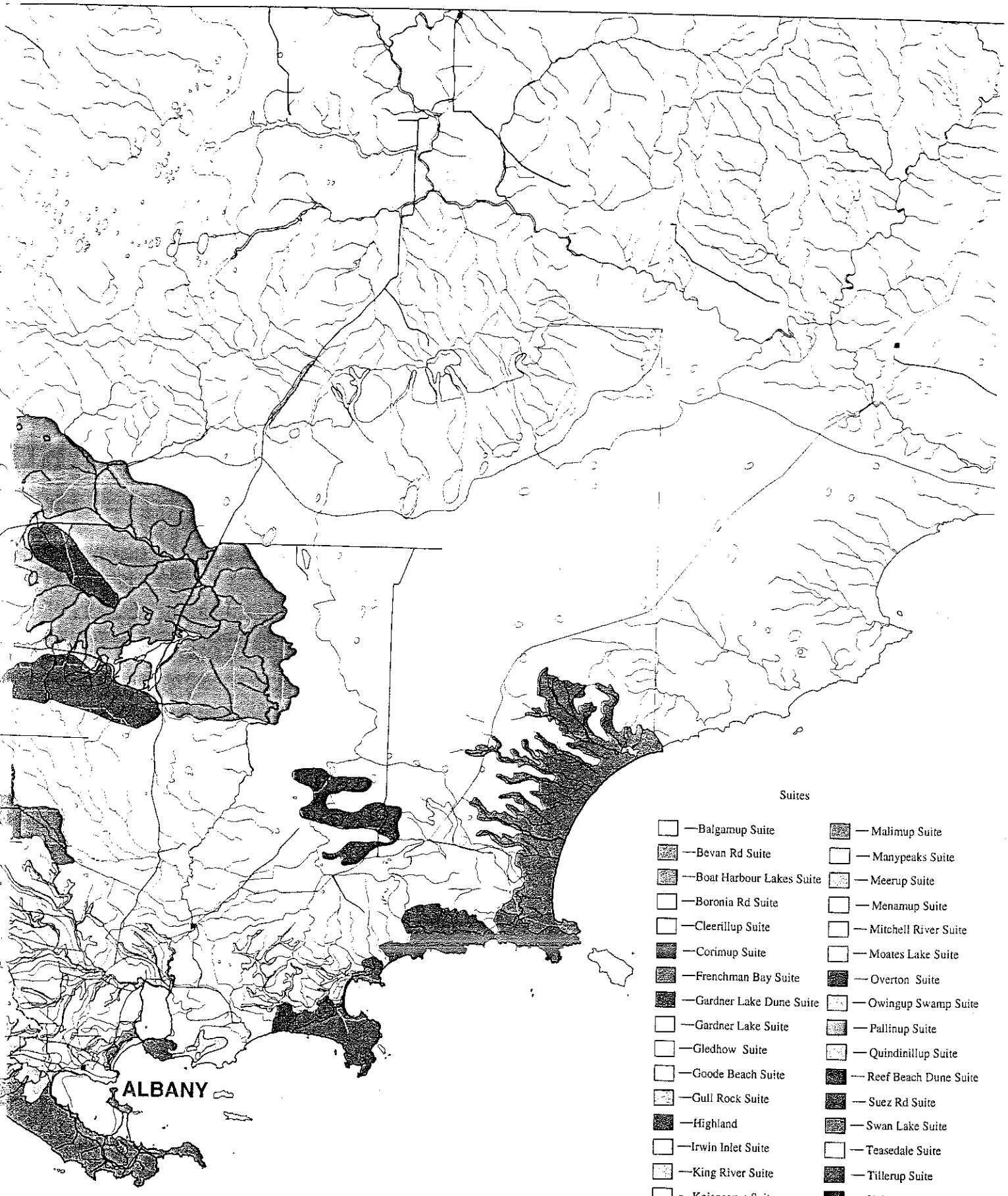

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Consanguineous Wetland Suites
- Walpole to Hassell Bay -

- Deep River 2228
- Rame Head 2227
- Frankland 2329 south of the Gordon River
- Denmark 2328
- Parry Inlet 2327
- Tambellup 2429 south of latitude 34°20'
- Mount Barker 2428
- Albany 2427
- Borden 2529 south of latitude 34°20'
- Manypeaks 2528
- Breaksea 2527
- Pallinup 2629
- Cheyne 2628
- Bremer 2729
- Hood Point 2829

Although initially intended for inclusion, an area covered by two map sheets, Pallinup 2629 and Cheyne 2628 has been omitted for this study for two reasons: firstly, aerial photo coverage for this sector was procured too late within the project to be re-scheduled; secondly, considerations associated with management objectives appeared more significant after discussions held at a workshop in Albany, and resources were allocated to these issues.

1.3 Previous work and scope for this study

Previous work has been carried out on wetlands in this region. Very preliminary work was commenced on description of the physical attributes (climate, drainage, and soil-landform) of the region, and this resulted in recognition of six physiographic sub-regions (RAP & SCRIPT 1996, 97). Within this framework, some preliminary identification of significant wetland groups and outstanding sections of rivers was undertaken, together with documention of the condition and management status of the major rivers in the region e.g., the Frankland-Gordon, the Denmark, Hay and Kalgan Rivers (revised draft EPP SW agricultural zone 1995, RAP & SCRIPT 1996).

A significant amount of work has also been carried out on the south coast estuaries (Hodgkin & Clarke 1988, 90) as a contribution to the State Conservation Strategy. As a result of these previous studies, channels and estuaries were placed outside the scope of this present study, which focused on the following wetland types:

- inland wetlands (palusmonts, paluslopes, lakes, sumplands, damplands, floodplains and palusplains), and
- estuaries which are semi-closed to closed.

1.4 Objectives

There were four major objectives to the study:

- identification of wetland regions,
- classification of wetlands into Consanguineous Suites,
- identification of wetlands of significance.
- identification of significant wetlands which are at risk

These objectives are hierarchical, and must be addressed in the order in which they are listed. Identification of wetland regions is the first objective. As will described later, a wetland region is defined as an area which exhibits similarity of natural features and processes at a regional scale e.g., climate, geology, geomorphology, hydrology, pedology, and physical and chemical processes. This provides a context of current regional processes which contribute to wetland development, and indicates some important aspects of evolutionary history which continue to influence wetland development and maintenance in the present.

The second objective is to classify wetlands into Consanguineous Suites within the wetland regions. This requires a similar approach to identifying wetland regions, but at a more detailed scale. Wetland suites resulting from this procedure contain wetlands which are fundamentally related.

The third objective is to identify wetlands of outstanding importance by applying evaluation criteria identified by wetland scientists over the last two decades in accordance with the current social and scientific philosophy. The fourth objective is to identify wetlands at risk due to poor management practises, inadequate reserves, and potential risks, and, for wetlands of importance, suggest general guidelines for improvement.

2.0 METHODS

The investigation for this study was largely based on a desk study of maps and aerial photographs, supplemented by limited field surveys, and a review of research publications on natural aspects of wetlands in this region.

The map resource included 1:100,000 topographic maps, the 1:250,000 geological series.

Aerial photographic interpretation was based on 1993,1996,1997 1:25,000 stereoscopic colour aerial photographs (in preference to Panorama).

No water level data were collected as the period allocated to the study was too short to capture the range of seasonal variability. Water sampling was not undertaken. Water chemistry data were accessed from the literature and are therefore incomplete.

Data on stratigraphy and geology were obtained from published sources such as maps and research journals, supplemented by limited field surveys to obtain regional and site specific information where crucial.

Data on vegetation assemblages and condition were collected in the field during very brief site inspections.

Information on waterbirds was obtained by literature search and Birds Australia database access and retrieval carried out by Australasian Ecological Systems (J. Raines).

Information on restricted flora was obtained through the Manjimup office of Dept. of Conservation and Land Management (Mr R Hearn).

Methods in this study in relationship to delineating wetland regions involved desk study of climate, geology, hydrology, geomorphology, and any relevant wetland work, as well as topographic maps and aerial photographs, and field work (visiting wetlands in their geologic/ geomorphic setting to determine their origin, the nature of the hydrologic mechanisms maintaining them, drilling/augering wetland to determine the nature of the sedimentary fill, and sampling water to determine its salinity).

3.0 REGIONAL SETTING

3.1 General introduction

The study area encompassed in this project is the southern part of Western Australia between Walpole and Fitzgerald Inlet, incorporating humid to semiarid climates, and enclosing the land systems of the southern part of the Yilgarn Plateau, the Ravensthorpe Ramp, the Stirling Ranges, Pallinup Sand Plain, amongst others, and this section of the report examines the larger scale groupings of wetlands in area, and following the concept of *natural wetland region*, as defined by VCSRG (1996), describes the larger scale setting for the wetlands within this region.

The wetland classification of C.A. Semeniuk (1987) deals with classifying individual wetlands at a site-specific level, and that of C.A. Semeniuk (1988) deals with aggregating and classifying groups of individual wetlands at a larger scale, i.e., within frames of reference of 10 km x 10 km (involving medium to large scale groupings), while the approach in this section of the report is to identify the megascale setting of wetland systems, involving large scale to regional scale groupings.

The definition of a wetland region is re-iterated here:

> *A natural wetland region is an area wherein there are similar or related wetlands because of their broadly similar geologic, physiographic, climatic, and hydrologic setting.*

For instance, in arid regions with their extensive linear dune fields, wetlands occur as round to oval basins in the interdune swale depressions. The wetlands are in a relatively homogeneous setting in terms of physiography, climate, and hydrology. Similarly, in semi-arid to arid regions, salt lakes form meandering networks reflecting origin as former river valleys, non-fluvial valley systems, and lines of drainage negotiating obstructive dune fields. The salt lake systems are another natural wetland region that have broadly similar setting of geology, geomorphology, climate and hydrology.

To describe wetland regions and to place them in a subcontinetal setting, it is necessary in the first instance to describe the physical landform, hydrological and climatic setting of the area. Therefore this section of the report is structured as follows:

- Regional setting and background on formative processes
- The continental wetland regions
- The coastal wetland regions

3.2 Regional setting and background on formative processes

In the Study Area of this project, there are a range of subcontinental to regional physical features and patterns which are important to understanding the development of wetland types and their distribution. The more important physical features are:

- geology and geomorphology
- climate
- hydrologic patterns.

These features can directly control the development of wetlands, and their variation either regionally or locally can produce variability of wetland types. The geology and soils of the region have been described by Northcote et al (1967), Playford et al (1976), Biggs et al (1980), and Wilde & Walker (1984), Thom & Chin (1984), Muhling & Brakel (1985), and Churchward et al (1988).

3.2.2 Geology and geomorphology:

Regional geology has a major influence on the pattern of landforms of the area, and consequently many authors have used a geological framework as the basis of primary classification of landform and soil units, or for the subdivision of terrain units (e.g., Churchward & McArthur, 1980; Playford et al 1976). Landform units, which occur within the study area, are related to the main rock types that underlie a given geologic unit, as well as the structural features such as major faults and splinter faults.

At the subcontinental to regional scale, the main geological units in the study area are the Yilgarn Craton, the Albany-Fraser Orogen, and the Bremer Basin. These units, and their interfaces, determine to a large extent the disposition of major landforms in the region.

The Precambrian rocks in the region are mainly located in the Albany-Fraser Orogen, a terrane of Proterozoic granite and gneiss. The Yilgarn Craton and the Albany-Fraser Orogen contact along an east-west oriented interface. The Bremer Basin is a Tertiary basin that is juxtaposed along the southern coast, its contact with Precambrian rocks oriented east-west. Materials filling the Basin are shallow water marine and coastal terrestrial deposits.

In the Study Area, the main regional scale geomorphic units (and their related geologic setting) are as follows (Fig. 3):

- Ravensthorpe Ramp
- Pallinup Sand Plain
- D'Entrecasteaux-Albany Coastal Zone
- Hassel Beach-Bremer Bay Coastal Zone

Table 1: Description of megascale geomorphic units, this study

Geomorphic Unit	Description
Ravensthorpe Ramp	terrain gradually descending from the Darling Plateau some 100 km inland, to the coastal zone; the terrain is dissected with steep valleys and broad valley tracts; locally bedrock monadnocks protrude over the general level of the terrain
Pallinup Sand Plain	terrain generally flat, extending from the coastal region to some 100 km inland, forming a plain underlain by Tertiary sediments, and sand, with local emergent Precambrian knoll; the plains have very subdued drainage and locally incised rivers/creeks;
D'Entrecasteaux-Albany Coastal Zone	the coastal complex of headlands, rocky shores, inlets, deltas, barrier dunes, and local monadnocks
Hassell Beach-Bremer Bay Coastal Zone	the coastal complex of local headlands, , small inlets, short drainage lines, long sweeping beaches and barrier dunes

Each of these has a distinctive suite of large, medium and small scale landforms and soils as a result of local geomorphic and pedologic processes. In addition, because of their setting and distinctive stratigraphy, the units may influence development of varying types of small scale hydrologic patterns. These geomorphic and hydrologic features determine the type and distribution of wetlands at the small and medium scale within the region. A brief description of the geomorphology at these scales is presented below, to provide an understanding of wetland types therein.

During the Tertiary and Quaternary, with tectonic and/or glacially induced sea level fluctuations, the near-coastal and coastal zone has accumulated a variety of sediments. These include Tertiary and Quaternary estuarine sediments located within valley tracts and other lowlands that would have been flooded by the higher sea levels, and Quaternary dune and estuarine deposits that are restricted to the current coastal zone. During the Quaternary, there have been alternating glacial and interglacial periods that resulted in low sea levels and continental aridity, and high sea levels and relative continental humidity, respectively. Mobilisation of desert dunes from the continental interior to the coast during arid glacial periods resulted in outliers of mounds of desertic dune quartz sand in the near-coastal setting, and mobilisation of coastal dunes to inland under the effect of strong onshore winds during interglacial periods resulted in outliers of dune calcareous and quartz sand mounds resting inland on Precambrian bedrock or saprolite.

Geomorphologically, at the largest scale, the Ravensthorpe Ramp is a broadly southerly-sloping dissected terrain that descends from the Yilgarn Plateau and the Darling Plateau to the coast. This region had been subdivided into two units by Jennings & Mabbut (1977): 1. the southern Collie-Kalgan Slopes for the inland terrain, and 2. the Albany Headlands and Inlets for the coastal zone. Wilde & Walker (1984), however, described the terrain descending from the Yilgarn Plateau to the coast as the Ravensthorpe Ramp, which effectively is the southern part of the Collie-Kalgan Slopes of Jennings & Mabbut (1977). In keeping with the style of megascale geomorphic nomenclature, V & C Semeniuk Research Group (1997) expanded and renamed the coastal zone unit "Albany Headlands and Inlets" of Jennings & Mabbut (1977) to the D'Entrecasteaux-Albany Coastal Zone.

The Ravensthorpe Ramp, located along the southern part of the Darling Plateau, bound to its north by a flexure (the Jarrahdale Axis), is underlain by Proterozoic rocks of the Albany-Fraser Orogen. The terrain gently descends from a relief of 200 m down to near sea level, and is characterised by separate small plateaux, hills and monadnocks. Drainage is incised by deep younger rivers and by broad valley tracts. Locally, there are elevated valley-tract systems of Tertiary estuarine deposits forming lowlands within the plateau system.

In terms of its local landforms and soils, most of the region of the Ravensthorpe Ramp can be described in general as a terrain of Precambrian gneiss hills and saprolite-mantled gneiss hills, locally with a thin local cover of sandy soil, partly derived from the saprolite, or closer to the coast, with a thicker light grey aeolian (dune) sand. In continuing with the regional pattern, the terrain of the Ravensthorpe Ramp is dissected by subdued drainage that forms narrow fluvial channels bordered by broad valleys, forming broad dendritic to rectilinear drainage lines and valley tracts. Lowlands in the valley tract systems are underlain by sediment such as sand or mud, or peat.

The Pallinup Sand Plain, as noted above, essentially is a generally flat terrain, forming a plain underlain by Tertiary sediments filling the Bremer basin. These sediments include spongolite, siltstone and sandstone of the Pallinup Siltstone and Werillup Formation and other undifferentiated sedimentary formations of the Plantagenet Group. The surface of the plain is veneered by sand, hence the name the Pallinup Sand Plain. Since the Tertiary sediments underlying the plain onlap an irregular Precambrian rock terrain, there are local emergent Precambrian knolls within this system. In terms of drainage, the Pallinup Sand Plain exhibits two types: 1. very subdued drainage forming inter-connected low relief valley tracts and chains of basins, and 2. locally incised rivers/creeks such as the Fitzgerald River.

The style of terrain of hills and valley tracts, described above for the Ravensthorpe Ramp and the Pallinup Sand Plain, has been inundated in the near-coastal region by the rising seas following the ending of the last glacial period, resulting in the development of inlets that form the estuaries of this study, e.g., the Walpole Inlet and the Nornalup Inlet.

The D'Entrecasteaux-Albany Coastal Zone in this region consists of some headlands and rocky shores, as well as inlets such as Broke Inlet, Walpole Inlet, Nornalup Inlet, and Irwin Inlet, within which there are estuarine deposits and deltas. High-relief barrier dunes occur along the coast and bar the entrances to any inlet, and locally dunes are climbing and are perched upon bedrock terrain or limestone. Also locally within the coastal zone, there are low monadnocks of bedrock.

The Hassell Beach-Bremer Bay Coastal Zone is a coastal complex of local headlands, short drainage lines entering the sea, small inlets, sweeping laterally extensive beaches, and barrier dunes. The barrier dunes barring the short drainage lines have developed small estuaries.

3.2.3 Climate:

The key features of the regional climate in the development of landforms, hydrology, and wetlands are:

- rainfall
- evaporation
- wind

Rainfall influences the development of landforms and wetlands through run-off and erosion, in recharging the groundwater aquifers, and in maintaining wetland hydrology. Evaporation influences wetland formation through development of increasing salinity, and through salt-weathering. Wind influences evolution of landform and wetlands though development of aeolian landforms (e.g., linear dunes), development of deflation flats, and in the formation of beachridges and lunettes that fringe and/or isolate wetlands. Climate history is important in the understanding of wetlands in that many wetlands have been through changes in climate, and hence their form is relict from previous climate regimes and their concomitant processes. For instance, many of the wetlands currently lodged in humid regimes had formed in earlier arid stages in the Cenozoic.

The climate of the study area is variable with gradients in rainfall and evaporation, and changes in wind patterns, from west to east and from southwest to northeast. The most humid part of the State, located in the southwest corner, has a rainfall of c. 1400 mm/yr and evaporation of 1000 mm/yr. Rainfall decreases to 400 mm/yr and evaporation increases to 2000 mm/yr in the coastal eastern part and northeastern part of the Study Area. Wind patterns also change in the different parts of the Study Area, depending on whether location is in coastal or inland, humid or arid, areas.

The climate patterns are described in 3 major areas, as influenced by proximity to the coast, by latitude (and hence the major climatic belts), and in relation to the regional cyclonic/anticyclonic belts. These areas are:

1. the western Ravensthorpe Ramp System
2. the semiarid inland northeastern zone
3. the south coastal eastern region

The bulk of the climate description will be centred on the Ravensthorpe Ramp System, and the other regions will be described in supplementary form where they differ from this central pattern.

The climate of the Ravensthorpe Ramp System is typically Mediterranean (Gentilli 1972) with north-south and east-west gradients in precipitation, evaporation, temperature and wind. The north of the Ravensthorpe Ramp System is semiarid to subhumid, the central part is subhumid to humid, and the south is humid (Gentilli 1972). Rainfall exceeds 1000 mm/yr in southern areas, and decreases to *c* 600 mm/yr both in northern areas and eastwards toward the wheatbelt (Gentilli 1972; Bureau of Meteorology 1975). Rainfall is markedly seasonal, occurring mostly during May to October (Bureau of Meteorology 1973). Evaporation ranges from 1000 mm/yr in the south of the Darling System to *c.* 1400 mm/yr in the north. In this region, wind generates waves on standing water of lakes, sumplands and estuaries, and these waves effect sediment winnowing, transport and the development of peripheral beachridges. Wind in the coastal zone is important in developing marine and coastal landforms and their accompanying distinctive wetlands. For instance, dune blowouts developed by wind can form into wetlands; swales in beachridge plains may also develop distinctive wetlands; and, at the large scale, coastal landforms such as barrier dunes (Semeniuk 1985) develop and protect large scale wetlands and estuaries. Winds of the this region are controlled by eastward migrating anticyclonic pressure cells (Gentilli 1972) and landbreeze - seabreeze systems. There are winds from the southeast, east and northeast in summer and, during the winter there are light and variable wind mainly from the eastern and western sectors, with storms from south and northwest. During summer, landbreezes - seabreezes control the wind in coastal areas, with landbreezes emanating from southeast, east and northeast and seabreezes emanating from southwest and south.

The semi-arid to subhumid northeastern part of the Study Area is similar to the region described above except for the following important parameters: the region is drier, with rainfall in the 400-600 mm/yr range, evaporation is higher, 1400-1600 mm/yr, and winds are less influenced by the coastal zone, and more by the inland effects such that winds from the easterly quadrants become more prominent.

The semiarid coastal zone of the eastern part of the Study Area is similar to Ravensthorpe Ramp Region described above except for the following important parameters: the region is much drier, with rainfall in the 500-600 mm/yr range, evaporation in the range of 1600 mm/yr , and winds are more intense and southerly in the summer.

3.2.4 Hydrology:

The aspects of hydrology relevant to understanding the development and maintenance of wetlands are recharge mechanisms, storage systems, discharge mechanisms, longevity of water retention and water quality. These differ between wetlands located in the various geomorphic settings, and even between wetlands within the same geomorphic setting, and this can influence the development of different types of wetlands and their biological response. Hydrologic setting in this region is described in 6 main types:

- main regional groundwater and the watertable (Figure 2)
- perched water on muddy sediments within valley tracts
- seepage zones
- artesian/subartesian water
- perched water on Pallinup Sand Plain
- creek discharge on Pallinup Sand Plain

The location of these hydrologic types and a brief description are provided in the Table below:

Table 2: Features of the main hydrologic settings in the Study Area

Hydrologic setting	Location and description
main regional groundwater and the watertable	located as the water table within the fractured rocks of the Precambrian rocks, the valley fills, and the Tertiary sediments of the Bremer Basin; as such, this is ubiquitous; depending on climate setting and proximity to the surface, it may be fresh, brackish, or saline (Figure 3A, 3B, 3C)
perched water on muddy sediments within valley tracts	located as shallow groundwater perched on the muddy sediments or on ferricrete within valley tracts incised into Precambrian rock within the region of the Ravensthorpe Ramp; this water is usually fresh (Figure 3D)

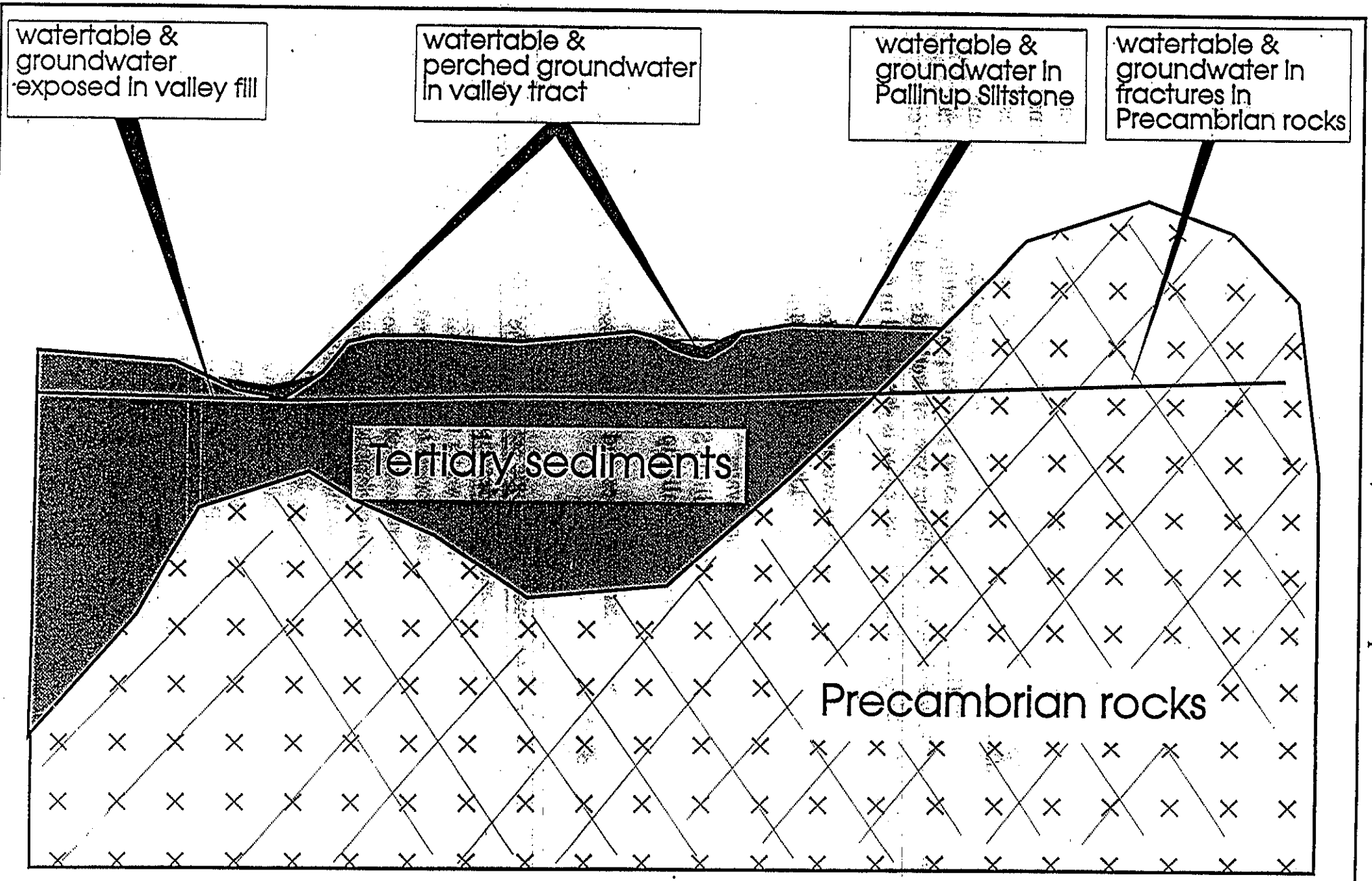


Fig.2: Regional types of groundwater in the study area

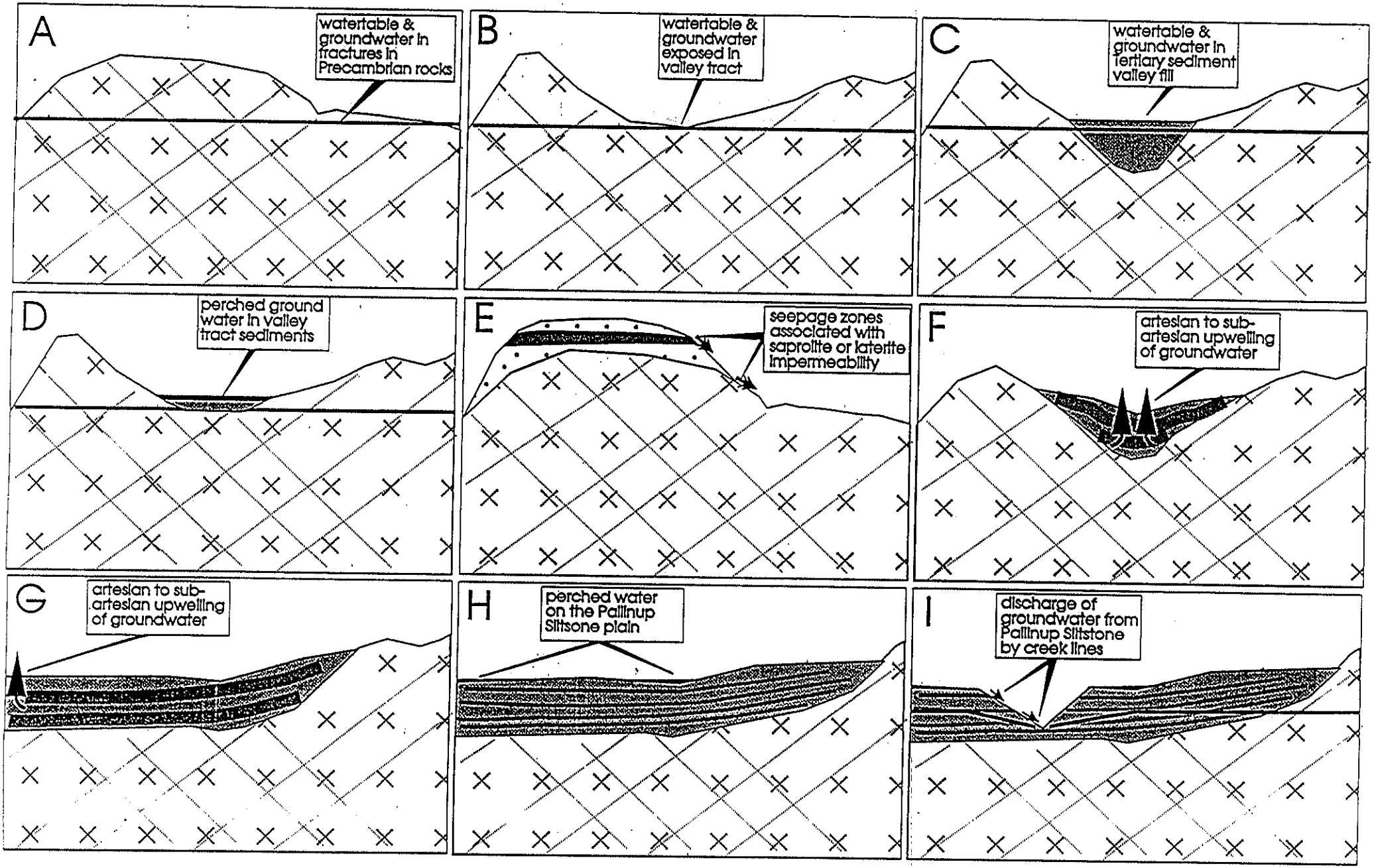


Fig. 3: Specific hydrologic settings for wetlands

Table 2: Features of the main hydrologic settings in the Study Area

seepage zones	within the region of the Ravensthorpe Ramp, there are local stratigraphic settings that result in perched water seeping to the surface; seepages usually are related to porous sands (the perched groundwater aquifer) overlying saprolite; this water is usually fresh (Figure 3E)
artesian/subartesian water	also within the region of the Ravensthorpe Ramp, there are local straigraphic settings that result in artesian to subartesian upwellings of groundwater; these situations are usually related to confined and semi-confined aquifers within valley tracts or local outliers of sedimentary rock, or ferricrete layers; this water is usually fresh (Figure 3F, 3G)
perched water on Pallinup Sand Plain	located as ponded water and shallow groundwater perched on the muddy sediments within very shallow, broad valley tracts or within local basins within the region of the Pallinup Sand Plain; the broad drainage lines and basins are developed on the weathered sedimentary rocks of the Plantagenet Beds; this water varies in salinity from fresh to saline (Figure 3H)
creek discharge on Pallinup Sand Plain	creeks incising into the Pallinup Sand Plain create significant discharge zones for the regional groundwater residing in the Tertiary rocks of the Plantagenet Beds (Figure 3I)

3.2.5 Evolution of landforms:

Later Cenozoic (i.e., Pleistocene to early/mid Holocene) geomorphic and hydrologic processes may be important in the development and evolution of wetlands through land-forming, sedimentary or other physical processes; these include:

- valley incision
- crest and slope stripping
- valley fill with sand
- estuarine valley fill
- coastal zone effects
- Pallinup Sand Plain ponding
- Pallinup Sand Plain incision and discharge

Valley incision has been an inportant process during the Cenozoic in this area in all the wetland regions. Valley incision has resulted at one extreme in the development of valley tracts, and at the other extreme through geomorphic evolution in the formation of shallow valley tracts and chains of wetland basins. The valley incisions and the resultant valley tracts have formed the template for marine incursions along the coastal zones during the Tertiary, Pleistocene and Holocene, for the development of estuaries and estuarine fills.

During the latter Cenozoic, the original stratigraphy of bedrock overlain by saprolite, then laterite, and then quartz sand has been eroded and stripped from the uplands of the Ravensthorpe Ramp system. This has resulted in several effects:

- hill crests are generally bare of sand, and have bedrock or laterite duricrusts exposed;
- slopes are covered in detrital laterire and sand;
- valley tracts contain ribbons of quartz sand derived from the hill crests and slopes

While in terrestrial settings the valley fills are of sand, in near-coastal geographic locations, and in terrain generally lower than 200 m, valleys were inundated by Tertiary seas, and consequently the lower parts of valley fills may be estuarine. In such situations, the valley fills comprise a lower sequence of estuarine sediment, an upper section of fluvial sediment, and an uppermost section of Quaternary sediments, including the currently forming fluvial sediment.

Along the Quaternary coast, with sealevel at about its present position, there have been coastal zone effects that have generated specific coastal and near-coastal lanforms. These include the development of massive barrier dune fields, the development of tombolos, spits, and cuspate forelands, and the development of seacliffs cut into Precambrian rock, Tertiary rock, or Quaternary materials, and the inland ingress of dunes to form isolated sand mounds.

The sedimentary rocks of the Plantagenet Group form a generally horizontally disposed package, and their upper surface overall conforms to the present attitude, geometry, relative relief, and extent of the Pallinup Sand Plain. In this context, it is evident that the upper part of the Plantagenet Group, when composed of fine grained sedimentary rock, (for example, the Pallinup Siltstone), ponds surfical water in local pockets. This ponding results in the devlopment of perched wetlands in this region. Elsewhere, where the Pallinup Siltstone underlies broad valleys, there is development of flat-floored valley tracts (corresponding broadly to the upper surface of the Pallinup Siltstone), and a similar perching of water to develop wetlands.

In the region of the main outcrop of the Pallinup Siltstone, to form the Pallinup Sand Plain, there is local incision of the horizontally layered Tertiary sedimentary rock package by creeks and rivers. This incision results in distinctive landforms of short rivers and creeks, and also results in hydraulic discharge of groundwater from the Pallinup Siltstone.

4.0 WETLAND REGIONS

4.1 Types of regions

Wetland regions are subdivided in the first instance into continental regions and coastal regions, for the following reasons:

- inland areas are subject to climatic patterns of rainfall and evaporation, consistent for a given region over distances of tens to hundreds of kilometres
- the geologic and associated hydrologic patterns for inland situations relate to the regional geology, geomorphology, and Cenozoic history in a given area
- coastal areas develop coastal landforms and sedimentary style determined by coastal processes, which in turn are dictated by wave regimes, coastal winds, Pleistocene coastal history, and, to some extent, the magnitude and style of fluvial input interacting with the coastal zone.

In effect, the coastal zone wetland regions are ribbon-like, shore-parallel features shaped largely by marine influences interacting with the mainland, whereas inland wetlands are more laterally extensive areas, the product of geology and landscape interacting with climate and hydrology.

The delineation and description of wetland regions in southwestern Australia accordingly is presented as :

- continental (or inland) wetland regions, and
- coastal wetland regions.

4.1.1 Continental wetland regions

Based on the preceding information and concepts, the southern portion of Western Australia, bounded by the coast between Walpole and Bremer Bay, and inland to the Stirling Ranges, is subdivided into 5 natural wetland regions on criteria of geologic setting, assemblage of hydrologic mechanisms, geomorphology/physiography, and climate. Many of the regions are sharply defined because they are bounded by faults on one side and oceans on the other, or by scarps on one side and oceans on the other. Others that are defined by climate and geomorphology may be gradational.

The continental (inland) natural wetland regions identified on a preliminary basis to date are as follows:

1. Yilgarn Plateau
2. Ravensthorpe Ramp
3. Stirling Range Region
4. Pallinup Sand Plain

A brief description of each of these regions in terms of location, boundary features, climate, main distinguishing features and characteristics, and wetlands therein, is presented below.

Yilgarn Plateau: The Yilgarn Plateau region is located in inland southwestern Australia. It is bounded by the Darling Plateau region on the west and southern sides. The region is developed on Yilgarn Craton crystalline bedrock and overlying laterite. The terrain is composed of plains, undulating plains, and local rocky ranges and ridges. Creek/wadi lines are filled with alluvial sediments, and basin wetlands are filled with mud and/or peat. The main features of this region are:

- subdued landscape, with broad drainage lines
- semiarid climate
- broad channels alternating along their length with salt lakes
- saline groundwater system, with local perched freshwater systems
- wetlands generally are saline to brackish creeks, wadis, palusplains, barlkarras, floodplains, damplands, sumplands, lakes, and playas; many of the wetland basins have developed by beachridge partitioning along former drainage lines.

Ravensthorpe Ramp: The Ravensthorpe Ramp region is located along the southern part of the Yilgarn Craton. It is underlain by rocks of the Albany-Fraser Orogen, and is bounded to the north by the flexure known as the Jarrahdale Axis. The region is very similar to the Yilgarn Plateau, in that it is developed on crystalline bedrock with overlying laterite. Locally, there are areas where Tertiary age alluvial and/or marine deposits are present - these form high level plains.

Overall, the terrain of the Ravensthorpe Ramp is composed of dissected ranges and plateaux, with steep valley sides, and laterite-capped valley tops.

In contrast to the Yilgarn Plateau, this region has short drainage lines formed parallel to the ramp slope, formed as consequent streams after the development of the ramp feature. Rivers and creeks are filled with alluvial sediments, floodplains associated with such drainage lines are veneered by alluvial sediments, and local wetland basins are filled with mud and/or peat. The groundwater through this area rises progressively from near-MSL to over 200 m inland. It is mainly fresh, in response to a humid climate, but there is a gradient towards the north of the area from fresh to brackish water. The main features of this region are:

- dissected steep landscape, with short length deep drainage lines
- humid climate
- deeply incised channels, but floodplains and palusplains are developed along their length
- locally, plains founded on Tertiary deposits
- groundwater system is mostly fresh, with local brackish water to the north
- wetlands are generally fresh to brackish incised rivers and creeks, and their associated floodplains and palusplains; in the wet regions there also are local paluslopes, damplands, sumplands, and lakes; in the drier regions there are rounded basins relict from earlier arid climate phases.

Stirling Range Region: The Stirling Range region is located along the contact of the Albany-Fraser Orogen and the Yilgarn Craton. It comprises the high relief Stirling Ranges (composed of Proterozoic quartzite), which are dissected by creeks, and ringed by an apron of alluvial fans. Rocks of the Stirling Ranges are fault-bounded to the north by the Yilgarn Craton, to the east and west, and partly the southern, by the Albany-Fraser Orogen, and onlapped by sediments of the Bremer Basin which underlie a plain to the south. The terrain encompasses a steep climate gradient from subhumid in the south to semiarid in the north. Groundwater salinity reflects this gradient: it is fresh in the southern parts of the area, and more saline to the north. Wetlands in the region are of 5 types: creeks traversing the ranges, paluslopes within the ranges, sumplands within the ranges, creeks that traverse the alluvial fans, and salt lakes that fringe the outer periphery of the alluvial fans. The main features of this region are:

- dissected steep ranges of quartzite, with a fringe of alluvial fan deposits, and an outer fringe of salt lakes
- subhumid to semiarid climate
- locally, plains developed on Tertiary deposits
- mostly fresh groundwater, with local brackish/saline water to the north;
- wetlands which are dominantly creeks through the ranges and the alluvial fans, and basins along the periphery of the fans; wetlands generally fresh to brackish incised and creeks; salt lakes (playas) which are saline

Pallinup Sand Plain: The Pallinup Sand Plain is a low level gently undulating plateau bounded by splinter faults and underlain by Tertiary marine sedimentary rocks of the Bremer Basin, with a surface, some 200m above sealevel. Drainage is subdued.. Locally, the Pallinup Sand Plain is a laterite capped surface, but is less dissected than the Darling Plateau. The character of the rocks and their weathering/erosion patterns has a major influence on the development of wetland types. Sand plain processes have predominated, and because of the relatively low internal relief, rivers and creeks are not deeply incised and tend to be broad-based with wide floodplains, gently grading upward into valley slopes. The main features of this region are:

- low plain underlain by sand or Tertiary spongolite, with scattered Precambrian hills; low broad valleys and undulating plain; locally, creeks are moderately incised into the Tertiary rock system
- subhumid to semiarid climate
- mostly fresh groundwater, with local brackish/saline water to the north, and with saline water where groundwater is ponded;
- wetlands are localised along valley tracts in diffuse drainage lines, or are moderately deeply incised into the Tertiary rock plain; wetlands generally fresh to brackish along incised creeks, and more saline in the diffuse basins along the valley tracts.

4.2 Coastal wetland regions:

Most of the coastal zone of southern Australia comprises beaches and rocky shores, and strictly should not be viewed as wetland types (though the Ramsar Bureau classifies such coastal zones as wetlands). In this study, for the microtidal system of southern Australia, the coastal wetlands are estuaries and their shorelines, which form discordant to shore-parallel systems, dependent on host landscape and coastal setting. The estuarine types in the Study Area encompass the *different geologic/geomorphic settings of estuaries in southern Western Australia*, and to a limited extent inland, the riverine catchments that feed the estuaries. The various geological settings, various geomorphic settings, climate regime, oceanographic regime, styles of fluvial input, and interaction of rivers with coastal dunes, result in 2 coastal wetland regions, which are:

1. the D'Entrecasteau-Albany region
2. the Albany-Esperance region

The D'Entrecasteaux-Albany region contains a range of estuaries and coastal lagoons and basin wetlands developed along a coastline cut into Precambrian rock, or developed as a result of coastal evolutionary processes.

The Nornalup-Walpole estuaries represent the types that are located along this part of the Study Area. The best examples of estuaries within this coastal region are located between Walpole and Albany. The estuaries generally are located in a humid environment, and their upland drainages are located largely in a humid to subhumid environment (within the Ravensthorpe Ramp), though some are sourced ultimately in semiarid areas. The unifying feature of these estuary types is that they are located within a granite shore complex, where quartz sand has been mobilised during the Quaternary, and where the Southern Ocean shore dynamics of onshore winds and waves are dominant in building/shaping the coast. Consequently, there are a distinctive assemblage of inlets, bays, estuarine channels, bedrock islands, tombolos and barrier dune ridges. The estuarine forms and their mouths are fixed as a broad, inlet-and-bay shore-normal system, semi-barred to fully barred by tombolos and barrier ridges. The estuary mouths are located in wave-dominated environments, and as such, the estuaries periodically are barred by a mouth bar, that is breached during riverine flood and rebuilt during wave active periods. Peripheral wetlands in this system are narrow shore-fringing flats (floodplains and palusplains) formed along riverine channel; there also are mid-estuarine shoals, and mid estuarine

bedrock islands, and where creeks and rivers enter the inlets, estuarine deltas.

The coastal lagoons and wetland basins developed in the D'Entrecasteaux-Albany region result from the coastal evolution associated with barrier sand dunes and beachridge plains. Barrier dunes form coastal wetlands either through processes of barring creeks and rivers, forming coastal lagoons, or within the barrier dune system through aeolian excavation of basins, or through coastal progradation of beachridges abutting the main barrier. Wetland basins also form as swale systems within beachridge complexes.

The Albany-Esperance region also contains a range of estuaries and coastal lagoons and basin wetlands, and these tend to be more varied and complicated than those outlined above, in that they may be developed along a coastline cut into Tertiary rock, or cut into Precambrian rock, or developed as a result of coastal evolutionary processes.

5.0 CONSANGUINEOUS SUITES

5.1 The concept and its usefulness

Consanguineous wetlands are inter-related wetlands. As described by Semeniuk (1988), they may have a similarity because they occur in the same geomorphic, geologic, and hydrologic setting, or because they have been formed by the same underlying process. The notion of Consanguineous Suites essentially recognises that there are different types of wetlands residing in different settings. Recognition of these differences is important for comparative, for managerial, and for representative conservation purposes. Thus the identification of Consanguineous Suites is a powerful first step to comparing similar or "like" wetlands for evaluation and assessment procedures

5.2 The criteria

In general, seven criteria are used to establish wetland consanguinity (Semeniuk 1988):

1. *Wetlands should occur in reasonable proximity*
2. *Wetlands should be similar in size and shape*
3. *A recurring pattern of similar wetland forms or a spectral range of inter-related wetland forms resulting from a dynamic process*
4. *Wetlands should have a similar stratigraphy*
5. *Wetlands should have similar water salinity regimes*

6. *Wetlands should have similar hydrological dynamics*
7. *Wetlands should have similar origin*

To determine consanguinity, sources other than extensive field investigations, were used in this project, because of constraints of time and budget. These were, principally, VCSRG R & D data (in-house drill core data and information from previous field investigations), and information obtained from the literature. One of the criteria, pertaining to water salinity, was not applied, because of the generally incomplete data set. The extent to which the criteria were applied, and the sources of data, are explained below.

1. *Wetlands should occur in reasonable proximity*
   Fully applied.

2. *Wetlands should be similar in size and shape*
   Fully applied.

3. *There should be a recurring pattern of similar wetland forms or a spectral range of inter-related wetland forms resulting from a dynamic process*
   Fully applied. Information was obtained from geomorphic setting.

4. *Wetlands should have a similar stratigraphy*
   Information was obtained from the following sources: published geology and soils maps and field investigations.

5. *Wetlands should have similar water salinity regimes*
   No information was accessed for application.

6. *Wetlands should have similar hydrological dynamics*
   Limited data was obtained from geomorphic setting and field investigations of selected wetlands.

7. *Wetlands should have similar origin*
   Limited data was obtained from publications and field investigations.

5.3 Geologic/geomorphic setting of the wetland suites

As the occurrence of Consanguineous Suites is related to the very different geomorphic/geologic units in his region, and/or the contacts between them, they are described systematically using the modified geologic/geomorphic framework of Wilde & Walker (1984), Thom & Chin (1984) and Muhling &Brakel (1985). This has been structured as follows:

1. Precambrian granitic and gneisic hills and monadknocks
2. Proterozoic Kundip quartzite hills
3. Proterozoic sandstone and shale hills
4. Contact between Proterozoic granite and Tertiary laterite
5. Tertiary siltstone flats (Pallinup Siltstone)
6. Tertiary colluvium flats and slopes
7. Tertiary alluvial deposits in plateau depressions
8. Tertiary slopes/flats underlain by sand, laterite, and Pallinup Siltstone
9. Tertiary slopes/flats underlain by sand over laterite
10. Tertiary estuarine flats
11. Reworked Tertiary alluvial deposits on valley floors
12. Contact of Tertiary valleys and undulating plain and Pleistocene slopes
13. Contact of Pleistocene sand dunes and Tertiary flats
14. Contact of Proterozoic granite hills, and Pleistocene dunes and slopes
15. Contact of Pleistocene sand dunes, Tertiary flats underlain by Pallinup Siltstone and Proterozoic granite hills
16. Contact of Holocene sand dunes, Tertiary flats and slopes underlain by Pallinup Siltstone and Tertiary laterite
17. Contact between Tertiary plain and Pleistocene dunes
18. Pleistocene undulating plain
19. Contact between Pleistocene colluvium and Pleistocene dunes
20. Pleistocene colluvial slopes and flats
21. Pleistocene limestone ridges
22. Pleistocene dunes overlying limestone
23. Pleistocene alluvial valley floors
24. Contact of Proterozoic granite hills/Holocene estuarine flats
25. Contact of Pleistocene colluvial slopes/Holocene estuarine flats
26. Holocene estuarine flats and basins
27. Holocene calcareous sand swales and depressions

5.4 The resultant wetland suites

As a result of applying the above criteria to the wetland patterns of the region between Walpole and the Fitzgerald Inlet area, forty-six suites were identified in the previously unclassified southern portion of the study area. Forty of these wetland suites are new and are related to the very different geomorphic systems occurring in this area. The suites are:

1. Frenchman Bay Suite
2. Mount Bland Suite
3. Coyanarup Suite
4. Cleerillup Suite
5. Pallinup Suite
6. Swan Lake Suite
7. Fitzgerald Inlet Suite
8. Walpole River Suite
9. Bevan Road Suite
10. Corimup Suite
11. Manypeaks Suite
12. Pabelup Suite
13. Kojaneerup Suite
14. Inlet River Suite
15. Boronia Road Suite
16. Suez Road Suite
17. Quindinillup Suite
18. Unicup Suite
19. Lake Barnes Suite
20. Mitchell Creek Suite
21. Balgamup Suite
22. Overton Suite
23. Owingup Swamp Suite
24. Moates Lake Suite
25. Qualinup Suite
26. Marendiup Suite
27. Boggy Spring Suite
28. Lake William Suite
29. Teasedale Suite
30. Blue Lagoon
31. Warrup Suite
32. Malimup Suite
33. Gardner Lake Dune Suite
34. King River Suite
35. Menamup Suite
36. Gull Rock Lake Suite
37. Gladhow Suite
38. Tillerup Suite
39. Lake Seppings Suite
40. Gardner Lake Suite
41. Lake Saide Suite
42. Goode Beach Suite
43. Boat Harbour Lakes Suite
44. Wilson Inlet Ridge/Swale Suite
45. Meerup Suite
46. Reef Beach Dune Suite

The relationship of the suites to the geomorphic settings listed above are outlined in the Table below. It should be noted that more than one suite can occur within any of the above settings. Their relationship to geologic/geomorphic setting is tabled below.

Geologic/geomorphic setting	Consanguineous Suite therein
Precambrian granitic and gneisic hills and monadknocks	Frenchman Bay Suite
Proterozoic Kundip quartzite hills	Mount Bland Suite
Proterozoic sandstone and shale hills	Coyanarup Suite
Contact between Proterozoic granite and Tertiary laterite	Cleerillup Suite
Tertiary siltstone flats (Pallinup Siltstone)	Pallinup Suite Swan Lake Suite Fitzgerald Suite
Tertiary colluvium flats and slopes	Walpole Suite
Tertiary alluvial deposits in plateau depressions	Bevan Rd Suite
Tertiary slopes and flats underlain by sand, laterite, and Pallinup Siltstone	Corimup Suite
Tertiary slopes and flats underlain by sand over laterite	Manypeaks Suite Pabelup Suite Kojaneerup Suite
Tertiary estuarine flats	Inlet River Suite
Reworked Tertiary alluvial deposits on valley floors	Boronia Rd Suite Suez Rd Suite Quindinillup Suite Unicup Suite Lake Barnes Suite
Contact of Tertiary valleys, Tertiary undulating plain and Pleistocene slopes	Mitchell Creek Suite
Contact of Pleistocene sand dunes and Tertiary flats	Balgamup Suite
Contact of Proterozoic granite hills, Pleistocene Dunes and Pleistocene valley slopes	Overton Suite
Contact of Pleistocene sand dunes, Tertiary flats underlain by Pallinup Siltstone and Proterozoic granite hills	Owingup Swamp Suite
Contact of Holocene sand dunes, Tertiary flats and slopes underlain by Pallinup Siltstone and Tertiary laterite	Moates Lake Suite Lake Powell Angove Lake

Contact between Tertiary plain and Pleistocene dunes	Qualinup Suite
Pleistocene undulating plain	Marendiup Suite Boggy Spring Suite
Contact between Pleistocene colluvium and Pleistocene dunes	Lake William Suite
Pleistocene colluvial slopes and flats	Teasedale Suite
Pleistocene limestone ridges	
Pleistocene dunes overlying limestone	Warrup Suite Malimup Suite Gardner Lake Dune Suite
Pleistocene alluvial valley floors	King River Suite
Contact of Proterozoic granite hills/Holocene estuarine flats	Menamup Suite
Contact of Pleistocene colluvial slopes/Holocene estuarine flats	Gull Rock Lake Suite
Holocene estuarine flats and basins	Gladhow Suite Tillerup Suite Lake Seppings Suite Gardner Lake Suite Lake Saide Suite Goode Beach Suite Boat Harbour Lakes Suite Wilson Inlet Ridge/Swale Suite
Holocene calcareous sand swales and depressions	Meerup Suite Reef Beach Dune Suite

All suites have been named after a local landmark wherein the suite is developed, and their location and extent is shown on Fig. 1. The description of each suite is structured in the following way:

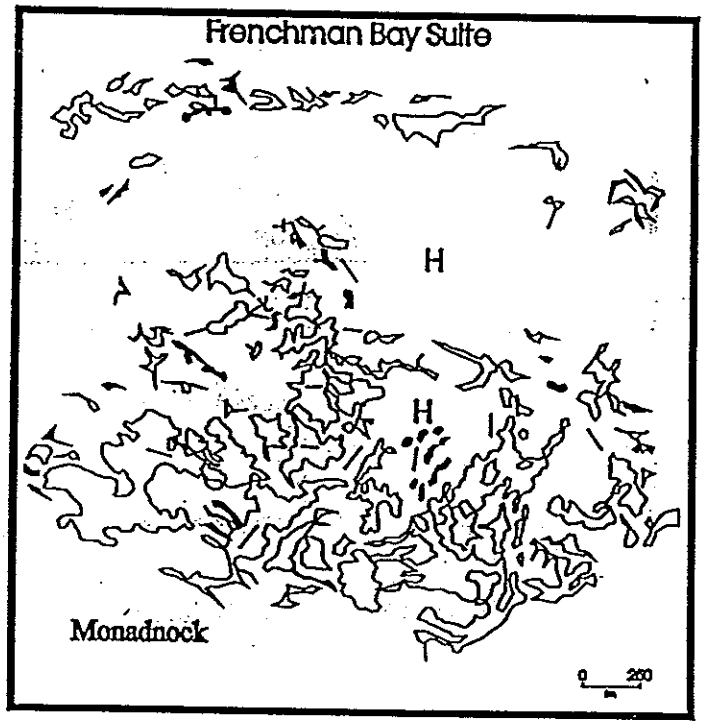
- description of small scale geomorphology and geomorphic processes
- description of wetland types
- description of stratigraphy
- description of hydrological mechanisms
- description of vegetation - pattern, structure, composition
- a diagram illustrating a representative area of each suite to illustrate the types, scale, and geometry of wetlands

Departures from this format occur where information is deficit resulting from the fact that this project was intended to be mainly desk-based, and that it was to provide a preliminary first-stage assessment of the variability ofnthe Consanguineous Suites in this region.

SUITES WITHIN THE PROTEROZOIC ROCK SETTINGS
PROTEROZOIC GRANITIC MONADNOCK

1. - FRENCHMAN BAY SUITE.

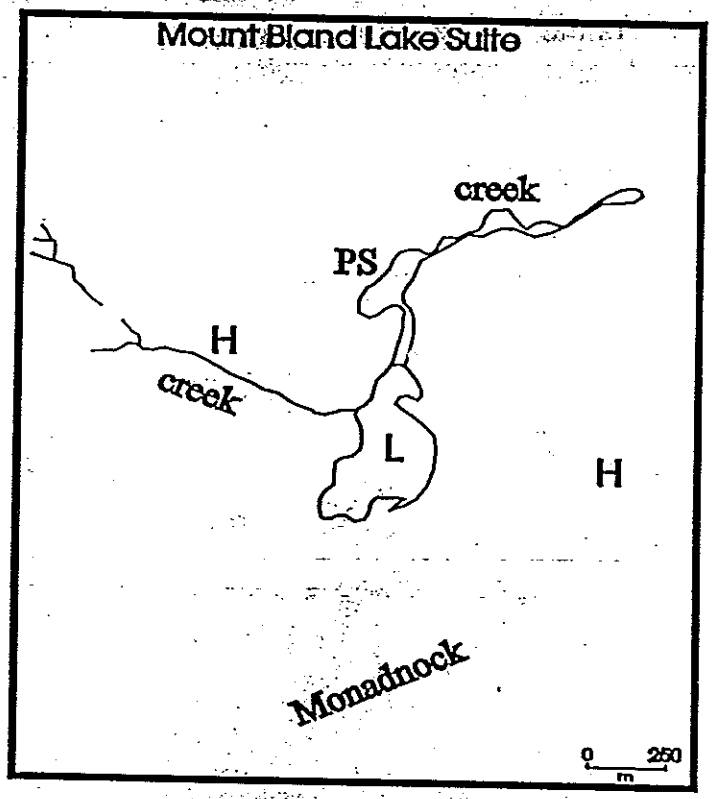
This suite is composed of microscale paluslopes and creeks cut into weathered granitic surfaces of the monadnock and on scree slopes at the base. The suite is underlain by saprolite and shallow quartz and humic sands overlying granite. The surface water is fresh. The vegetation comprises several heaths composed of *Callistemon, Anarthria scabra,* and a mixed community of *Eucalyptus stearii, Banksia littoralis, Adenanthos, Astartea, and Agonis parviceps.*



PROTEROZOIC KUNDIP QUARTZITE HILLS

2. - MOUNT BLAND LAKE SUITE.

This suite is composed of a creek, paluslope and a microscale lake in a valley on the lower slopes of Mt Bland. The valley is initially very narrow at the creek's headwaters, but widens out at the break in slope and is filled by the pear shaped lake. Although this site was not visited, the lake is probably underlain by colluvial materials which range from muddy sand and silt to a fine quartz sand. The vegetation is zoniphytic, and appears to comprise shrublands and sedgelands.



PROTEROZOIC SANDSTONE AND SHALE HILLS

3. - COYANARUP SUITE

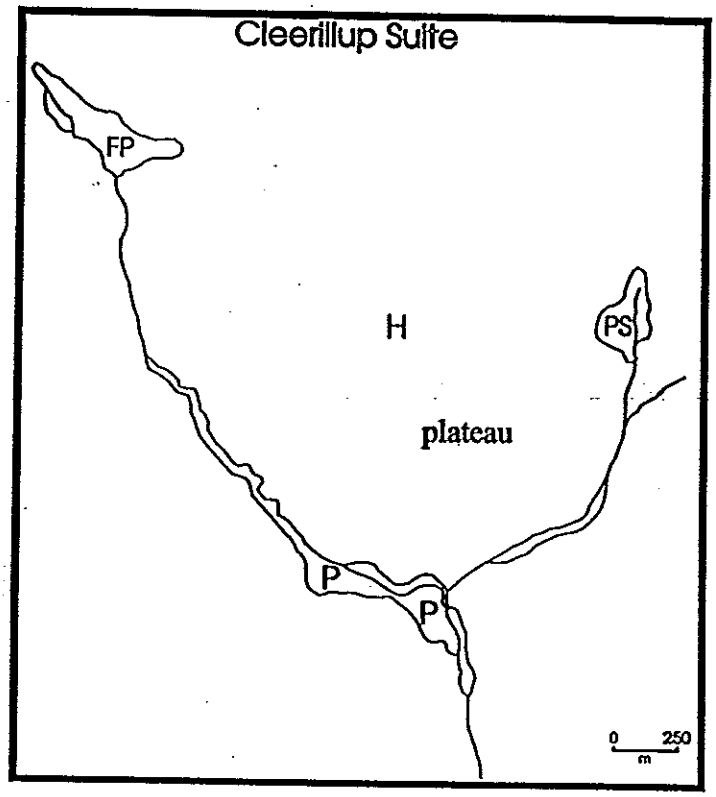
This suite is composed of microscale paluslopes associated with seepage and creeks in the area between Coyanarup Peak and Bluff Knoll in the Stirling Ranges. The wetlands are described as bogs by Keighery & Beard (Thomson et al 1993). The wetland deposits are peat, and the water is fresh.

The vegetation is herbland and low heath, and comprises species of the herb, *Xyris* and the myrtaceous heath, *Homalospermum* (Thomson et al 1993).

CONTACT BETWEEN PROTEROZOIC GRANITE AND TERTIARY LATERITE

4. - CLEERILLUP SUITE

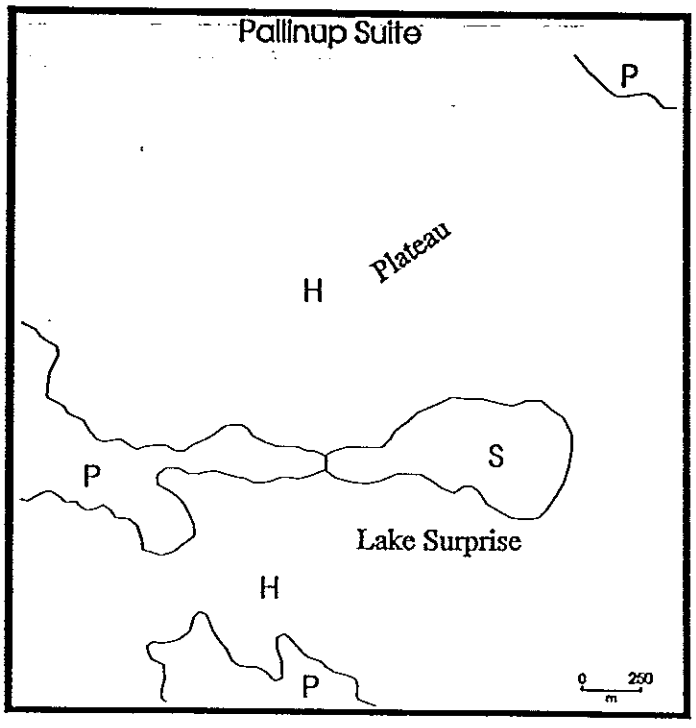
This suite is typified by the Cleerillup Creek system. It comprises leptoscale channels incised into the laterite and bedrock, and their associated very narrow floodplains. Vegetation comprises scattered patches of *Agonis juniperina, Eucalypt* and *Melaleuca* species. Where the floodplain widens, low heaths (*M. rhaphiophylla, M. viminea, M. diosmifolia, Hakea varia, Daviesia sp., Baeckea sp.*) or open shrublands (*Melaleuca viminea* and *M. rhaphiophylla)* develop.



SUITES WITHIN TERTIARY ROCK SETTINGS
TERTIARY SILTSTONE FLATS

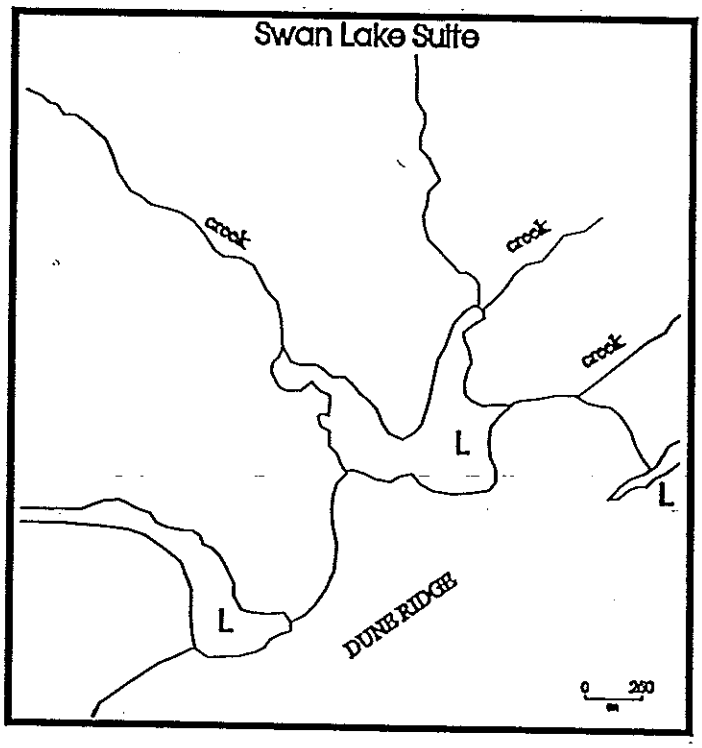
5 - PALLINUP SUITE.

This suite is composed of valleys which were probably Tertiary wetlands and which retain palaeogeographic features such as former watercourses which still operate to preferentially direct water flow even though the present fluvial system may be discordant. The wetlands are palusplains, and sumplands such as Lake Surprise, which are discharge basins for ephemeral drainage. Although the suite is underlain by the Pallinup Shale, colluvial materials, which range from muddy sand and silt to a white fine quartz sand make up the surface material. The sand is iron stained and variably iron cemented. Localised peat occurs as basin fill. Some perching occurs above the shallow (0.9m-1.2m) iron indurated layer. The groundwater is fresh to subhaline. The vegetation comprises sedgeland and shrubland of *Anarthria, Leptocarpus, Evandra, Restio, Melaleuca, Beaufortia, Xanthorrhoea, Adenanthos, Kunzea, Acacia, Hakea, Calothamnus, Pericalymma, Agonis, Homalospermum* and *Banksia.* Basin vegetation is gradiform, comprising sedgelands (*Baumea articulata*) in the centre and low open woodland to shrubland (*Melaleuca preissiana, Callistachys lanceolata)* around the margins.



6. - SWAN LAKE SUITE

This suite includes Hunter River Estuary, Charles Bay Estuary, Swan Lake, Well Creek Swamp and Mirrambeen Lake. The basins range from microscale to macroscale, and, as they are located in valleys, exhibit an irregular branching shape, oriented north-west to south-east. They are barred from the Southern Ocean by a Holocene or Pleistocene dune barrier, and therefore, are classified as closed. They are located at the mouths of short creeks (e.g., Hunter River and Mullocullop Creek). They are bordered by steep slopes cut into Pallinup Siltstone, granite and limestone. The water is hyposaline (Hodgkin & Clark 1990). The fringing slopes support open shrubland (*M. cuticularis*) with an understorey of sedge (*Baumea articulata).*

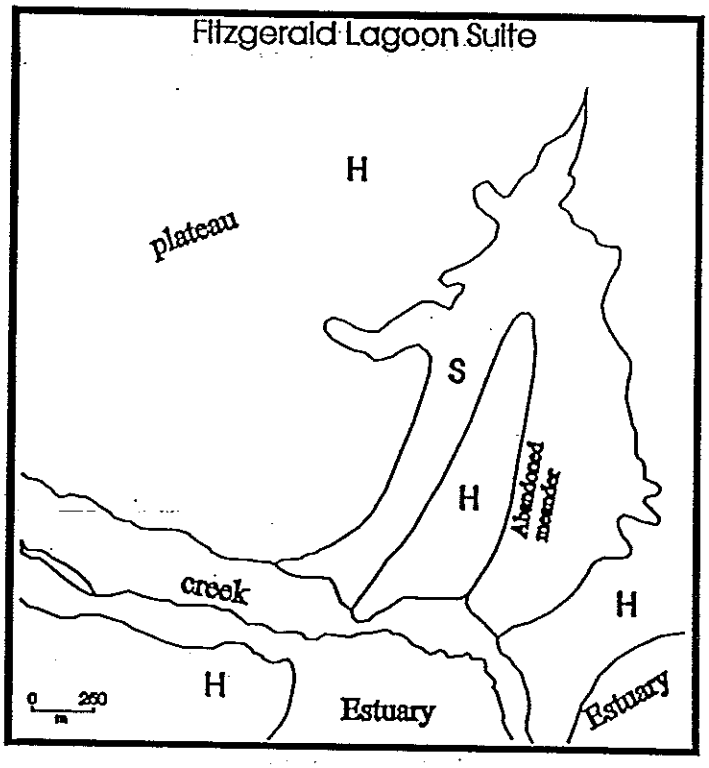


7. - FITZGERALD INLET SUITE

This suite contains Fitzgerald Inlet. The inlet is macroscale, and irregularly elongate-, located in a deeply dissected valley, oriented north-west to south-east. It is separated from the Southern Ocean by a wide Pleistocene dune barrier, and is semi-closed. At the northwest end of the Inlet, there are two features which distinguish it from others in a similar setting: an abandoned meander loop which now acts as a receiving basin for northern tributaries

and which connects to the main estuarine basin, and two basins within the main inlet which have become segmented.

It is located at the mouth Fitzgerald River which is classified as a creek. It is bordered by steep slopes cut into Pallinup Siltstone exposing spongelite, and is underlain by organic muds (Treloar 1977), sandy mud and shell gravel (ANCA 1996). The water is hyposaline to hypersaline (Hodgkin & Clark 1987, 1990). The vegetation has been described by J Chambers in Hodgkin & Clark (1987, 1990). The flats and meanders support low heath (*Sarcocornia quinqueflora, Sarcocornia blackiana, Atriplex cinerea, Halosarcia indica* subsp. *bidens, Suaeda australis* and *Samolus repens*), and closed heath to open shrubland (*M. cuticularis).*

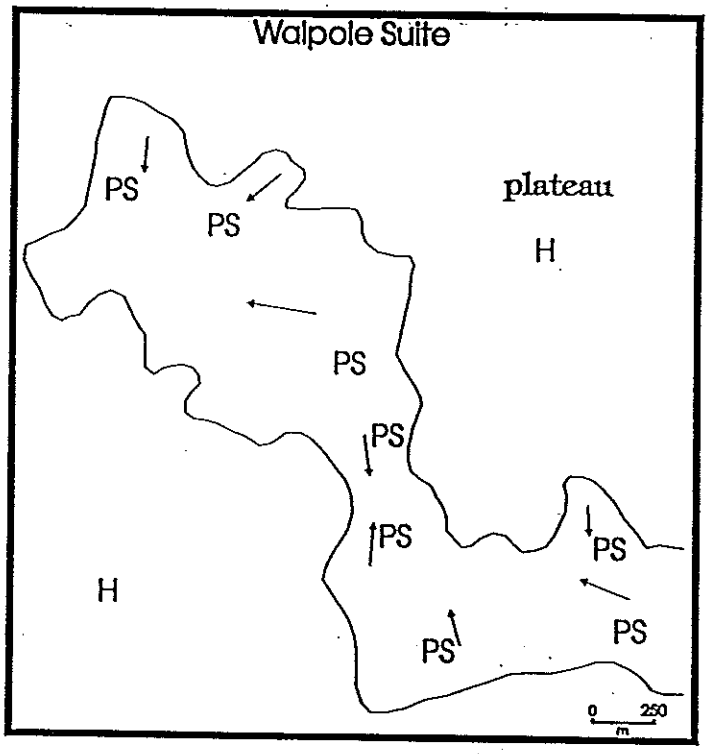


TERTIARY COLLUVIUM FLATS AND SLOPES

8. - WALPOLE RIVER SUITE (now re-named WALPOLE SUITE)

This is a suite of paluslope and occasional palusmont wetlands. The wetlands are sometimes associated with microscale creeks as in the Walpole River location, but may also occur independently. The wetland slopes are underlain by fine white quartz sand with layers of very coarse to gravel size quartz sand, overlying sandy mud and silt, or, in wetter areas, by a sequence

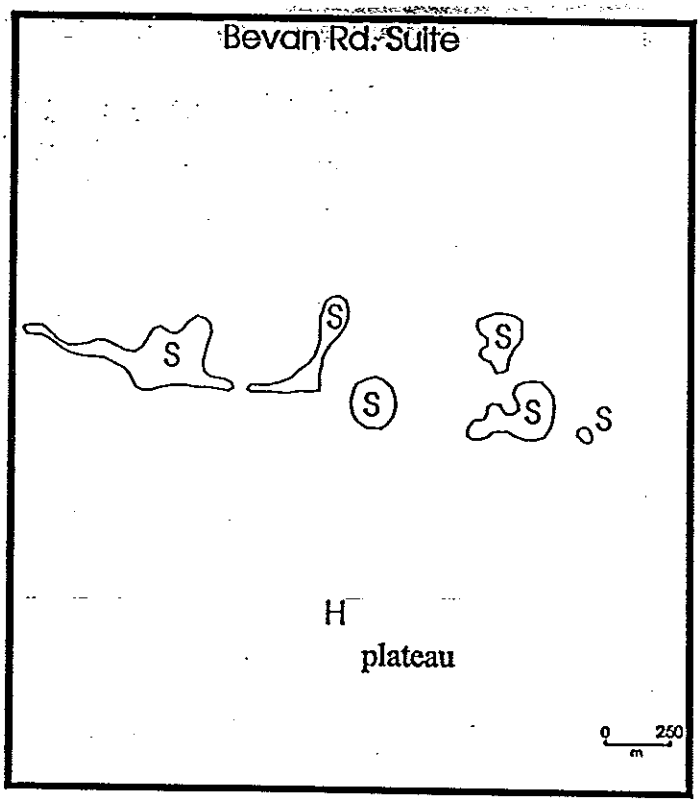
of black peat overlying peaty sand and sand. The creeks in the Walpole region are underlain by peaty sand overlying layers of black to brown muddy sand and black terrestrial clay, overlying quartz sand. These sand horizons create a shallow aquifer perched above the regional water table. The groundwater is fresh. The wetland vegetation is maculiform, and comprises patches of scrub of *Agonis juniperina* with an understorey of low heath, grassland, or sedgeland, comprising species of *Kangaroo paw, Homalospermum, Beaufortia, Calistemon, Callistachys, Agonis, Astartea, Adenanthos, Amphipogon, Dasypogon, Diaspasis, Leucopogon, Evandra, Anarthria, Leptocarpus.* There are also occurrences of *Reedia spathacea.*



TERTIARY ALLUVIAL DEPOSITS IN PLATEAU DEPRESSIONS

9. - BEVAN RD. SUITE

Wetlands in this suite are leptoscale sumplands and damplands located in depressions in the plateau surface. They are underlain by humic sands and muddy sands. Recharge is most likely through direct precipitation. Sumplands are concentrically zoned with a central zone of low heath (*Melaleuca rhaphiophylla* and *M. lateritia*) and a margin of low woodland (*M. preissiana and Banksia littoralis*). Damplands support a low open woodland of *M. preissiana* with an understorey of upland species.

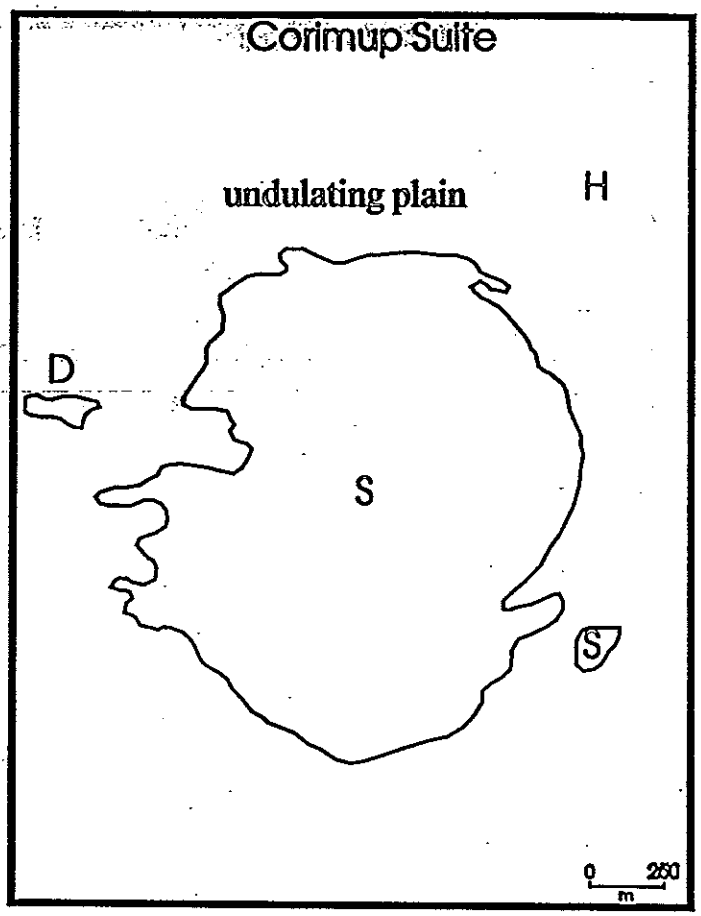


TERTIARY UNDULATING FLAT UNDERLAIN BY SAND, LATERITE AND PALLINUP SILTSTONE

10. - CORIMUP SUITE

This suite contains macroscale circular lakes and sumplands in the poorly drained depressions of the plateau surface. They are underlain by sand which overlies laterite and Pallinup Siltstone. The wetlands are windows to a local water table. Local precipitation is perched above thelaterite and siltstone and this groundwater fluctuates in the overlying superficial sand

aquifer (approximately 3 m thick). The wetlands are freshwater. The wetlands are concentriform with a large central zone of sedgeland (*Baumea articulata* with emergent shrubs of *Melaleuca cuticularis)*, and a narrow marginal zone of patches of *Melaleuca preissiana.*

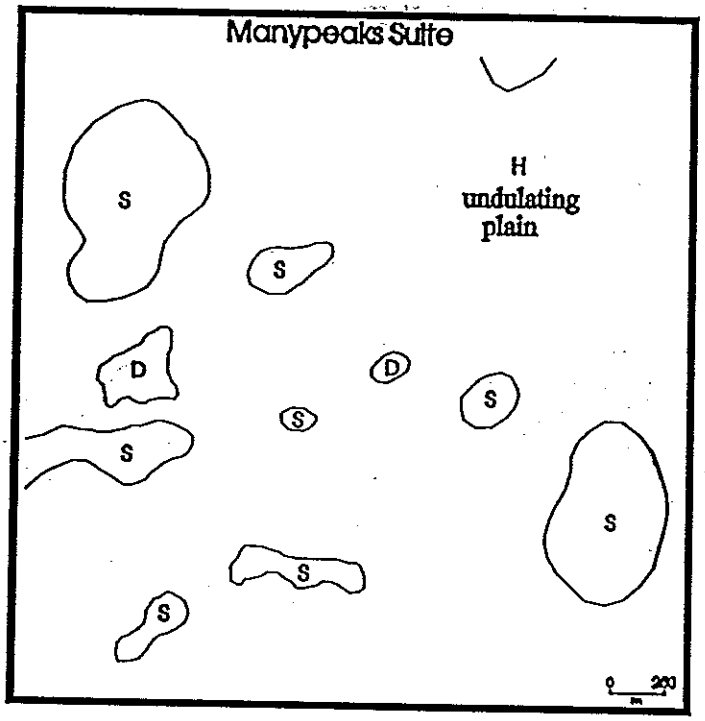


TERTIARY UNDULATING FLAT UNDERLAIN BY SAND OVERLYING LATERITE

11. - MANY PEAKS SUITE

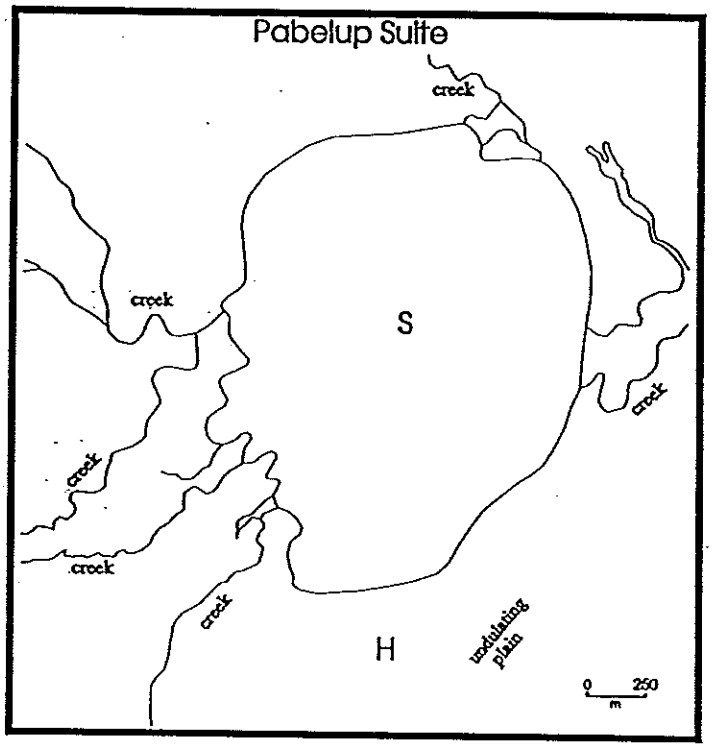
This suite contains macroscale to microscale circular sumplands in the poorly drained depressions of the plain surface. They are underlain by a range of sediments: quartz sand which often overlies laterite or saprolite, exposed saprolite, ferruginised chert, nodular granular clay and Pallinup Siltstone, depending on the local setting of the depression and the sediment exposed. Local precipitation is perched above the laterite and clay and this water fluctuates in the superficial sand aquifer (up to 3 m thick). The recharge water is fresh, but becomes brackish through evapo-transpiration. The wetlands range from latiform forest of *Eucalyptus occidentalis*, to

zoned and mixed assemblages of *Eucalypt* forest, woodland and shrubland *of Melaleuca cuticularis,* with an understory of *Baumea juncea* or *Baumea articulata* sedgeland and heaths containing species of *Daviesia, Regelia* and epacrids.



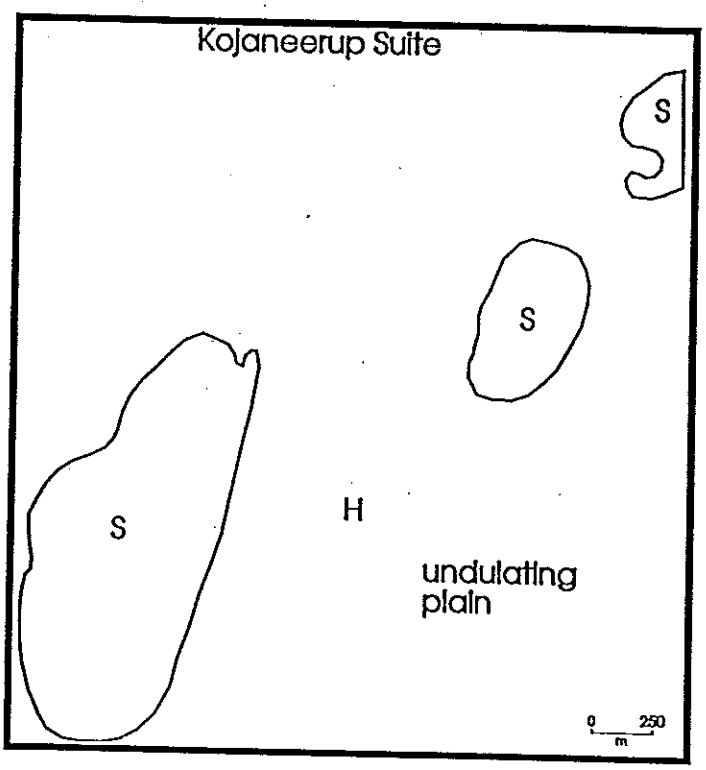
12. -.PABELUP SUITE

This suite contains leptoscale creeks which discharge into macroscale to microscale circular sumplands. The basins are underlain by clays, muddy sands, quartz sand and **ferricrete.** Precipitation and runoff are often perched or impeded. The water ranges from brackish (5,000 ppm at Coromandel) to saline depending on its source, the types of wetland sediments, and the amount of salts accumulated through long-term evapo-transpiration. Wetland vegetation is often zoned. The most common assemblages are forests of *Eucalyptus occidentalis, E. cornuta* or *E. decipiens* and open woodland and scrub of *Melaleuca cuticularis* with an understorey of sedgelands of either *Baumea juncea* or *Gahnia trifida.* Other assemblages which occur, are heaths, comprising species of *Hakea* and *Verticordia,* and low heaths or herblands of species of *Halosarcia, Suaeda and Wilsonia.*



13. - KOJANEERUP SUITE

This suite contains a linear chain of macroscale ovoid sumplands rimmed by shoreline beach ridges, which are located at the base of the alluvial fans of the Stirling Ranges. They are underlain by quartz sand and clays, and by gypsum precipitated by the saline groundwater. They are discharge basins for microscale creeks draining the Stirling Ranges, and subterranean flow through alluvial fan detritus. Local precipitation, seepage and run-off are perched and this water becomes saline to hypersaline due to evapo-transpiration.. The wetlands are vegetated by low heaths of samphire genera such as *Halosarcia* and *Sarcocornia* and the succulent *Disphyma clavellatum,* sedgelands of *Gahnia trifida,* open shrubland of *Melaleuca cuticularis* and narrow bands of forest of *Eucalyptus occidentalis* with an understorey of grassland of *Stipa teretifolia* (Thomson et al 1993).



TERTIARY ESTUARINE FLATS

14. - INLET RIVER SUITE

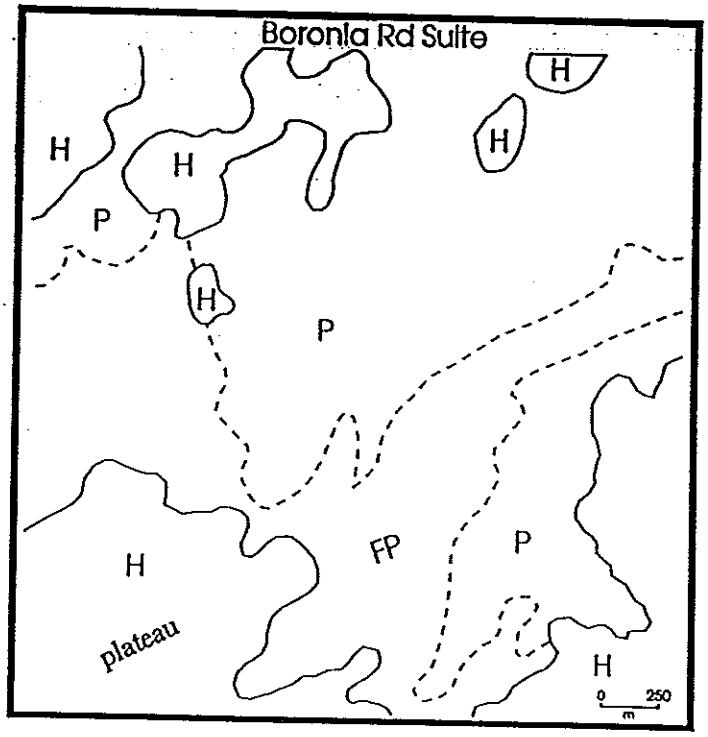
This is a suite of palusplain underlain by estuarine sediments, transected by creeks, and interrupted by granite outcrops from which seepage occurs. The creeks are leptoscale and meandering. Quartz sand is overprinted with iron mottling and staining or interlayered with ferricrete gravel and ferricrete

sheets. Peat overlies the sand in some areas. The riparian vegetation is indistinguishable from palusplain vegetation i.e. a low heath of *Beaufortia, Acerosa, Hakea, Adenanthos, Homalospermum, Lepidosperma* species. The groundwater under the palusplain is fresh.

REWORKED TERTIARY ALLUVIAL DEPOSITS ON VALLEY FLOORS

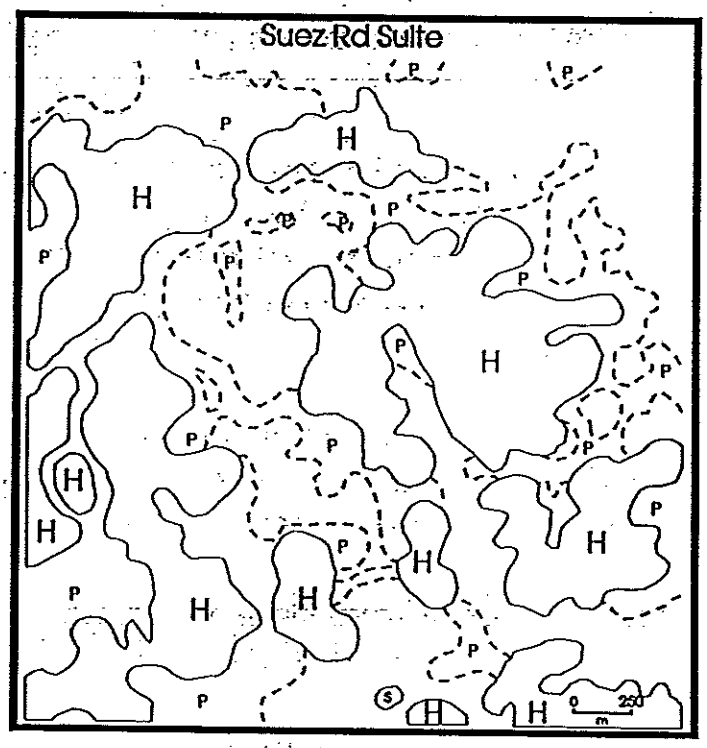
15. - BORONIA RD SUITE

This suite may be best described as a large scale meandering flat at about 100 m AHD. It is interspersed with granitic hills approximately 100 metres high. The flat is dissected by microscale dunes and basins, and channels. The suite includes broad floodplains and palusplains, minor slopes, leptoscale creeks, and microscale to mesoscale basins. It is underlain by a variety of sediments including fine white quartz sand, quartz and lateritic gravels, muddy sands, and ferricrete. The groundwater is always near the surface and is fresh. Thewetlands are recharged by a number of mechanisms: surface runoff, seepage, localised perching of surface water and localised groundwater rise. The vegetation is commonly maculiform with patches of scrub (species of *Agonis*), low open woodland (species of *Melaleuca*) and a very diverse heath (including species of *Evandra, Anarthria, Banksia, Astartea, Callistemon, Lepidospermum, Homalospermum, Beaufortia, Hakea,*).



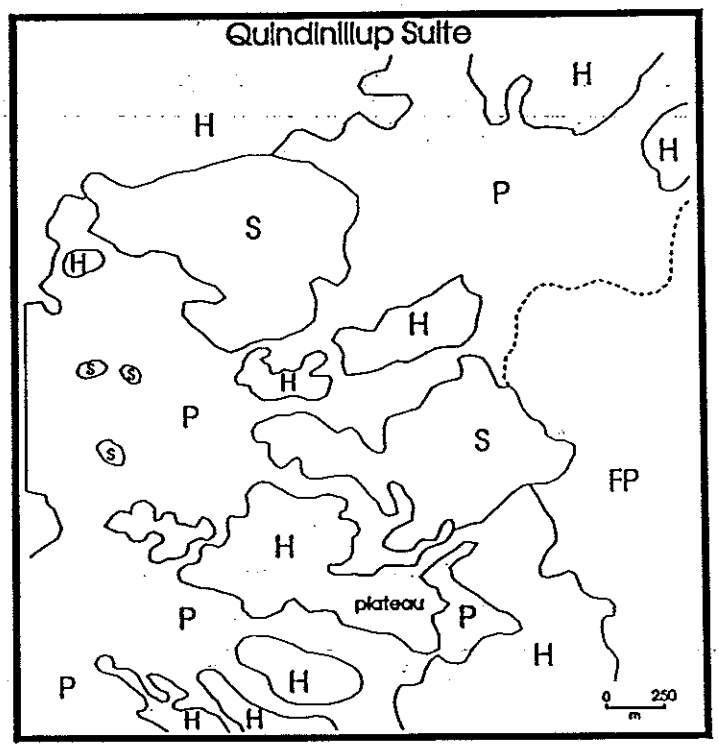
16. - SUEZ RD SUITE

This suite is similar to the previous suite of wetlands described as the Boronia Suite, however, in the Suez Rd Suite, the flats are narrow, granite outcrops are closer together and of lower relief, paluslopes are more common, and the dunes and basins are not present. Much of the underlying stratigraphy, and the vegetation assemblages are similar to the Boronia suite due to similar setting. However, the geomorphological differences have resulted in hydrological differences such as the reduced number of creeks, and a reduction in aquifer types due to less stratigraphic complexity. The groundwater is fresh.



17. - QUINDINILLUP SUITE

This suite contains microscale to macroscale flats, macroscale to microscale sumplands and lakes. The flats are floodplains caused by drainage retardation of surface water by the underlying clay and fine muddy sand substrate. The water is saline. The vegetation comprises patches of low woodland (*M. rhaphiophylla, M. cuticularis* u/s sedgeland) or heath (*Melaleuca leptoclada, M. diosmifolia, M. viminaria, Hakea varia, Baeckea sp., Calothamnus lateralis, Gahnia trifida).*



18. - UNICUP SUITE

The Unicup suite contains lakes, sumplands, floodplains, palusplains and creeks. The Unicup suite is located within the Tertiary plateau. The range of wetlands is associated with a former drainage pattern which has been modified by changing climatic/ geomorphic/hydrologic patterns from the Tertiary to the present. Wetlands exhibit gradation from creeks, to broad valley flats and slopes, to basins. This probably represents an evolutionary sequence where creeks continue to geomorphically degrade to become broad valley flats and slopes which in turn eventually clog to form irregular shaped basins. During intermittent cyclesof inundation and in conditions of variable winds, sedimentary processes result in the basins becoming excavated, ringed by beach ridges, and finally circular. Thus the wetlands display a history of evolutionary formative processes from the Tertiary to the present.

The surface waters of the wetland basins in this suite range from fresh to hyposaline (<1000 ppm -10,000 ppm). The wetland basins are underlain by peat over grey sand over laterite, or peat over black mud over laterite, or shelly mud over clay over muddy sand. The wetland fill overlies a shallow sand layer on saprolite.

Creeks and flats that are in natural vegetated situations had fresh surface water in winter. Creeks and flats are underlain by quartz sand on laterite which in turn overlies the regional saprolite lithosome.

The vegetation of the lakes and sumplands in this suite varies from patchy to peripheral cover while damplands are usually completely vegetated.

Pardelup Lagoon is periform and consists of forest *(Melaleuca rhaphiophylla, E. rudis u/s Centella asiatica and Juncus sp.)*.

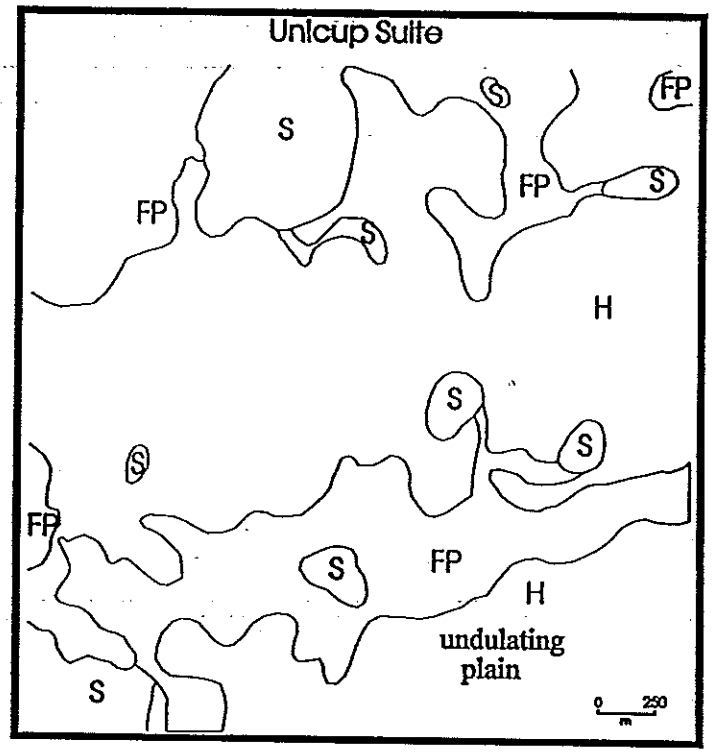
Tootanellup Lagoon is concentriform. It is composed of sedgeland *(B.articulata, Tricostularia neesii)*, forest *(M. preissiana, B. littoralis)*.

Randell Rd sumpland is also concentriform and is composed of shrubland(*M. cuticularis)*, and forest (*Eucalyptus occidentalis)*.

Tucker's Rd sumplands are periform and are composed of scrub (*M.cuticularis*) or low open woodland (*M. cuticularis* u/s *Gahnia trifida*).

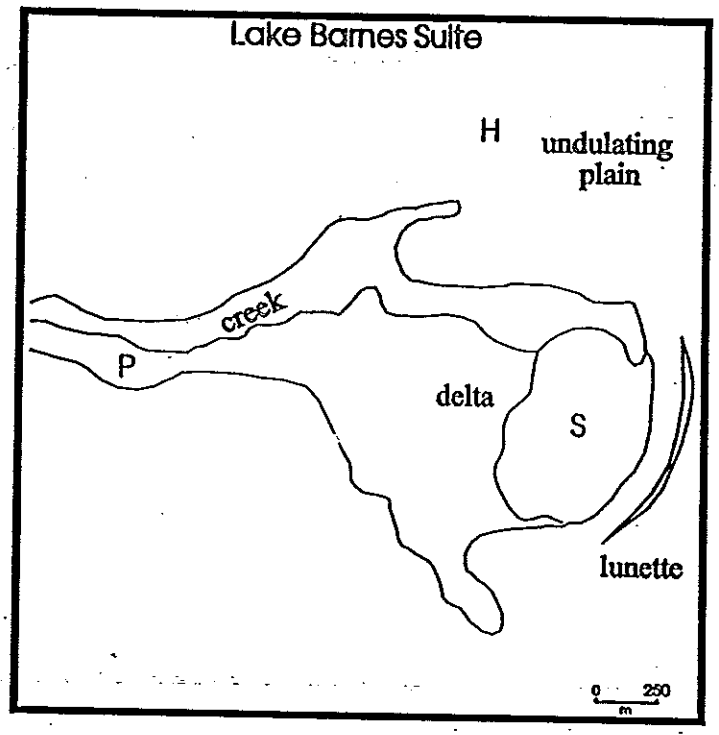
Poorarecup Lagoon is very similar to Lake Unicup. It is steep sided and has very sparse fringing vegetation.

Vegetation on the flats is maculiform and consists of similar assemblages to those described above with the addition of open low woodland (*M. cuticularis*), woodland (*M. preissiana*), open shrubland (*Hakea varia*), heath (*Viminaria juncea, Acacia saligna*), heath (*Hypocalymma angustifolium*), low heath (*M.leptoclada, M.diosmifolia, Melaleuca sp.*), sedgeland (*Restionaceae*), and herbland (*Coronopifolia, Samolus repens*). The majority of the creeks are cleared, but where they are vegetated, the assemblage is most often shrubland of *M. rhaphiophylla.*



19. - LAKE BARNES SUITE

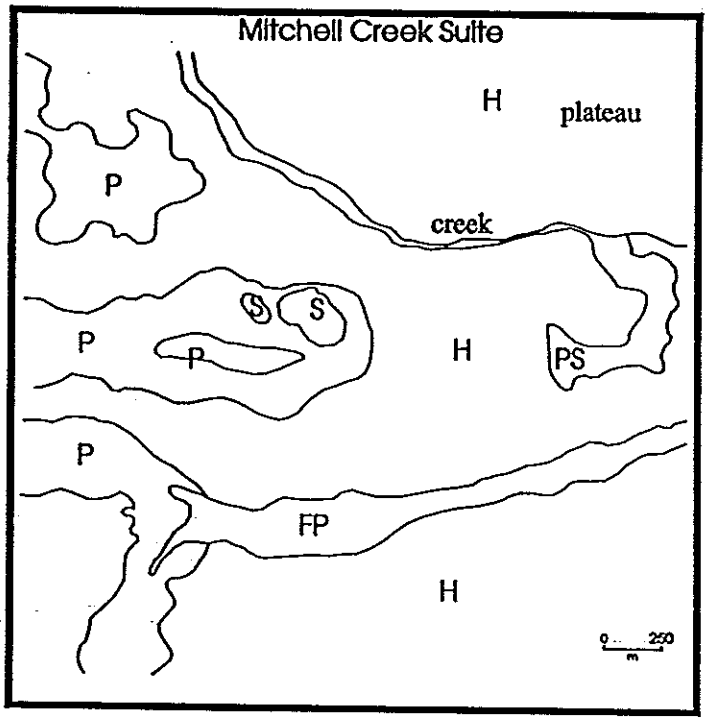
This suite contains numerous microscale and some macroscale ovoid sumplands such as Lake Barnes itself, and lakes Kokokup, Mowilyilip, and Quechinup, which are located in broad, shallow depressions related to possible Tertiary drainage systems. These depressions are adjacent to, and sometimes contiguous with, the present minor drainages (Sleeman and Kokokup Creeks, Blue Gum Cr and Marbellup Brook). The wetlands are underlain by Tertiary alluvium (gravels, quartz sand and clays), and are vegetated by forest, scrub and sedgeland (Churchwood et al 1982).



SYSTEM CONTAINING TERTIARY VALLEYS, AND UNDULATING PLAIN OVERLAIN BY PLEISTOCENE COLLUVIUM

20. - MITCHELL CREEK SUITE

This is a heterogeneous suite of microscale channels, flats, slopes and basins resulting from fluvial processes in a gently undulating terrain. The wetlands are maintained by surface runoff, groundwater rise and localised ponding of surface waters. The wetlands are variably underlain by Tertiary alluvium, Tertiary quartz sands, Tertiary laterite and Pleistocene gravels and sands of differing thicknesses. The vegetation comprises sedgelands and woodlands.

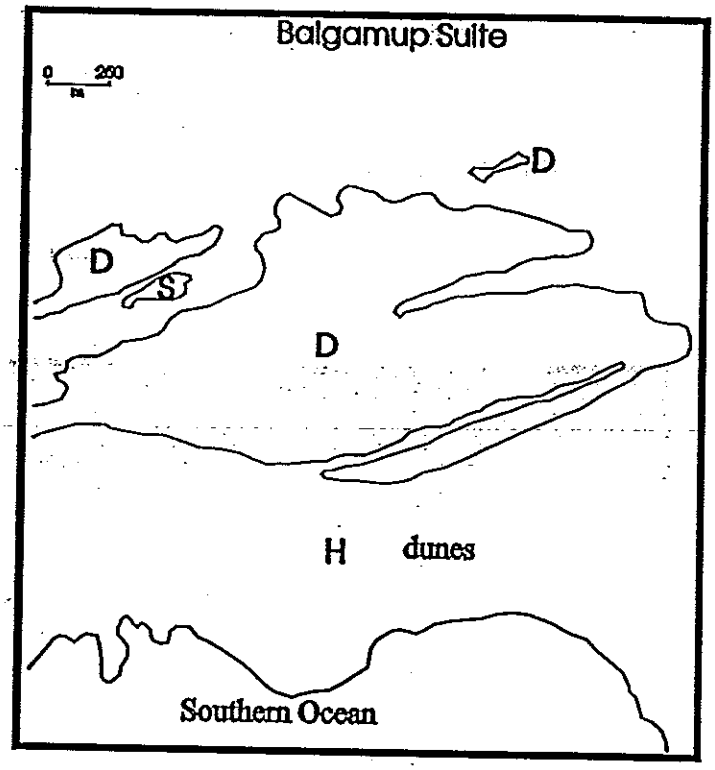


CONTACT OF PLEISTOCENE SAND DUNES AND TERTIARY FLATS

21. - BALGAMUP SUITE

This is a suite of microscale to mesoscale irregular to linear shaped sumplands and damplands formed in the bowls of parabolic dunes as they encroach inland over Tertiary pavement. The wetlands are freshwater and range from acidic to neutral (Edward et al 1994, Horwitz 1994). They are underlain by quartz sand and shelly sand, the wetter basins containing peat. The vegetation is variable and includes sedgelands (*Baumea juncea,*

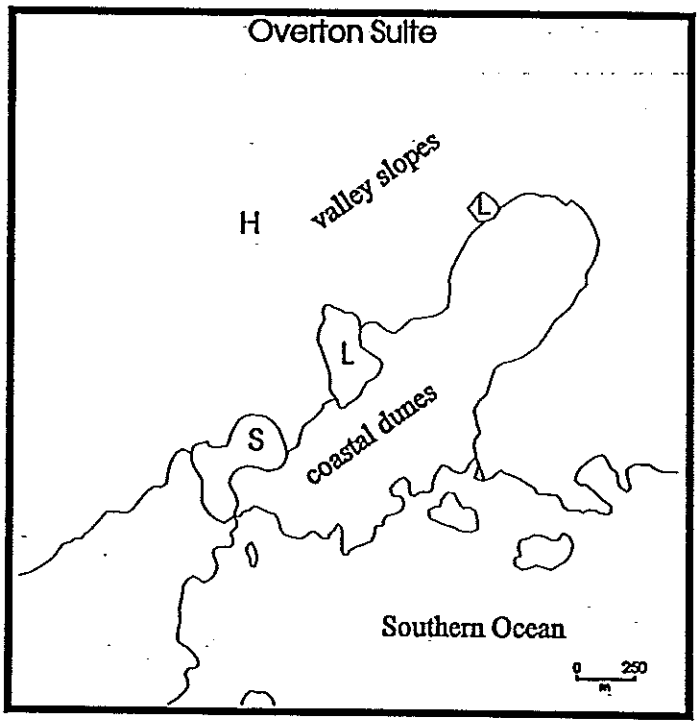
Desmocladus flexuosus, Lepidosperma sp. Leptocarpus scariosus, Leptocarpus tenax, Gahnia trifida), herblands (*Centella asiatica*), heaths and shrublands (*Agonis juniperina, A. flexuosa, Banksia littoralis*).



CONTACT BETWEEN GNEISS, PLEISTOCENE COLLUVIUM AND PLEISTOCENE DUNES

22. - OVERTON SUITE

This is a suite of microscale lakes and sumpland which lie along a contact between a sand flat and gneissic or granitic hills. The lakes are underlain by fine white quartz sand. They are fresh to subhaline. The lake margins are steep and vegetation continues from the surrounding flats and paluslopes to the lake edge. At the lake edge the vegetation structure increases in height and density and the sedge *Baumea juncea* comprises the understorey.

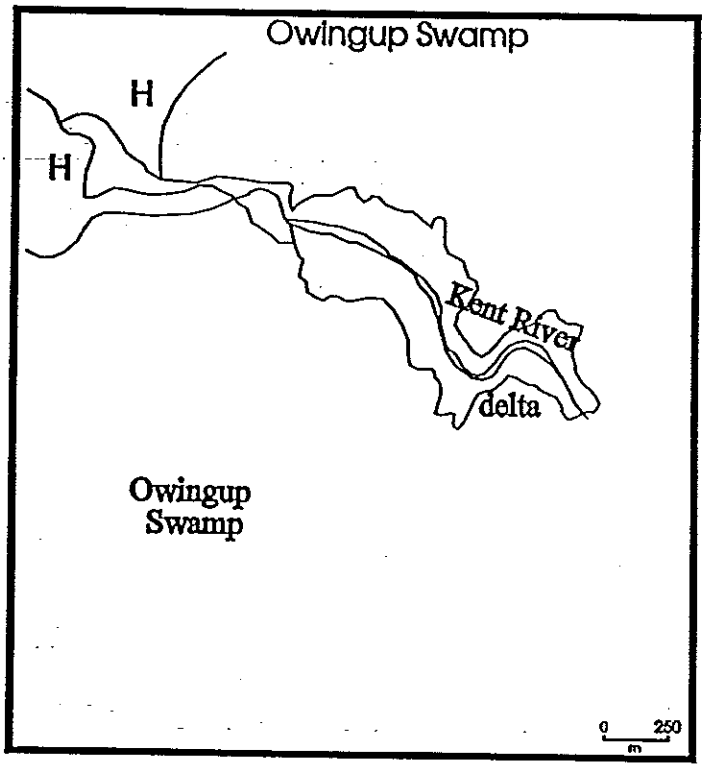


CONTACT BETWEEN PALLINUP SILTSTONE SLOPES, TERTIARY LATERITE SLOPES AND PLEISTOCENE DUNES

23. - OWINGUP SWAMP SUITE

This suite contains Owingup Swamp. The basin is macroscale and sub-rounded, surrounded by Pleistocene Coastal Dunes, Tertiary undulating terrain and Precambrian domes. It is separated from Irwin Inlet by estuarine flats, but the Kent River channel connects the two water bodies hydrologically. The wetland is no longer effected by estuarine processes.

The wetland is underlain by estuarine fine quartz sand containing shells. Salinity ranges from freshwater to subhaline. Owingup Swamp is heteroform and supports low closed forest *(Agonis juniperina),* low woodland *(M. rhaphiophylla, M. preissiana, Gahnia trifida, Lepidosperma effusum),*closed scrub *(Callistachys lanceolatum),* heath formations *(Beaufortia sparsa, Agonis linearifolia, Melaleuca leptoclada, M. rhaphiophylla, Boronia denticulata, Chaetanthus leptocarpoides, Pericalymma ellipticum and Astartea fascicularis*), and sedgelands (*Baumea articulata, B. vaginalis, B. arthrophylla, B. juncea, Leptocarpus scariosus.*)

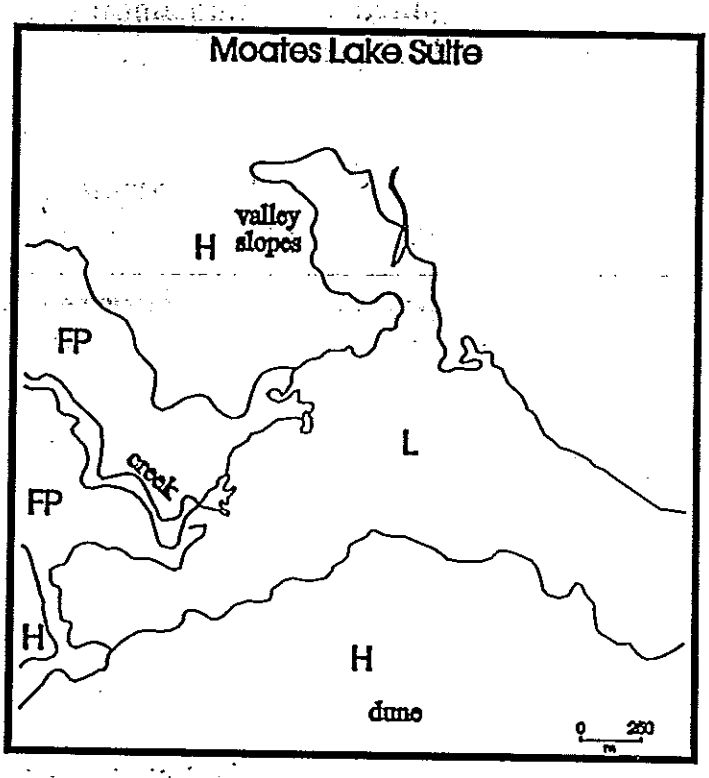


CONTACT BETWEEN PALLINUP SILTSTONE SLOPES, TERTIARY LATERITE SLOPES AND HOLOCENE DUNES

24. - MOATES LAKE SUITE

This suite includes Moates Lake, Angove Lake, and Lake Powell. The wetlands are macroscale, irregular to ovoid shaped basins, oriented east-west. They are no longer subject to estuarine processes, and are, therefore, classified as closed. They are located in valleys at the mouths of long creeks (e.g., Goodga River and Marbellup Brook) which have been blocked from flowing into the Southern Ocean by a Holocene or Pleistocene dune barrier.

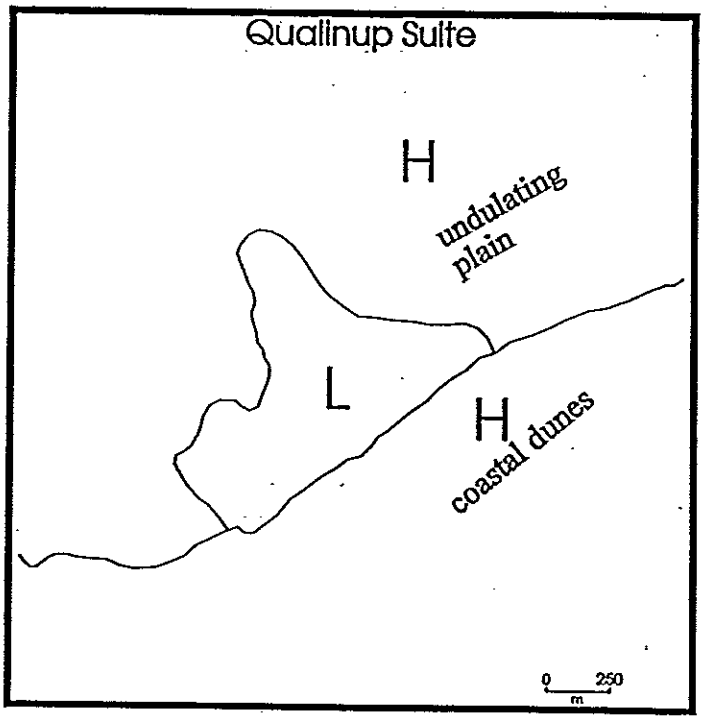
The basins are underlain by sand. The wetlands range from freshwater to subhaline. The peripheral vegetation of the lakes (Robinson 1992, ANCA 1996) includes extensive sedgelands (*Baumea articulata, B. juncea, B. preissii, Leptocarpus scariosus, L. coangustatus, Juncus pallidus, J. kraussii, J. capitatus, Isolepis prolifera* and *Schoenus brevifolius*), and closed scrub to low forest (*Agonis juniperina, A.linearifolia, Kunzea ericifolia, Astartea fascicularis, Melaleuca thymoides, M. polygaloides*).



CONTACT BETWEEN TERTIARY SAND PLAIN AND PLEISTOCENE LIMESTONE RIDGE

25. - QUALINUP SUITE

This suite includes microscale and mesoscale triangular shaped lakes and sumplands lying along the contact between Pleistocene dunes and the Tertiary plateau surface, underlain by yellow quartz sand and saprolite. Some of the wetlands have resulted from impounding of short drainage channels. Many of the wetlands appear to have altered water levels as a result of surrounding landuses, so that it is difficult to describe the natural hydrology. The basins are underlain by quartz sand, and are freshwater. The peripheral vegetation comprises forest of *Eucalyptus occidentalis*.

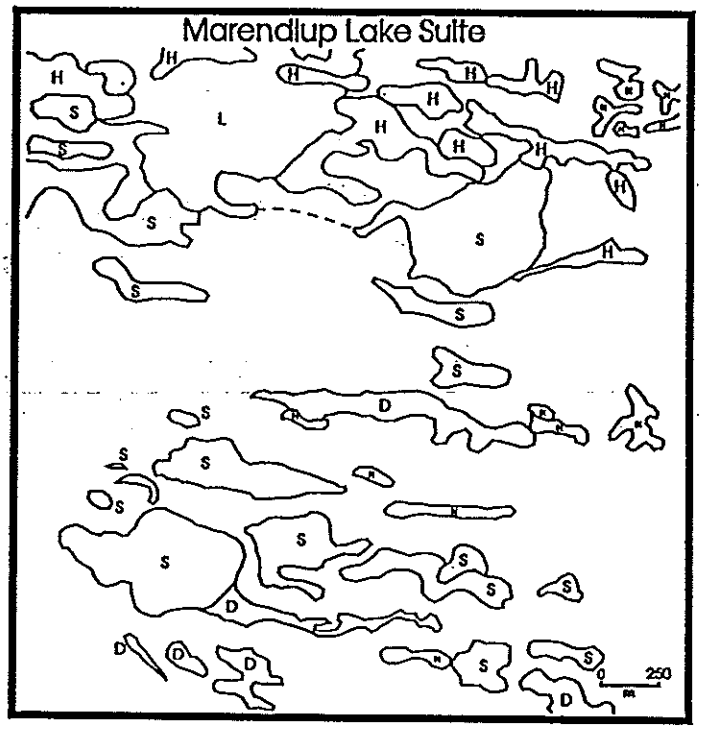


PLEISTOCENE UNDULATING FLAT

26. - MARENDIUP SUITE

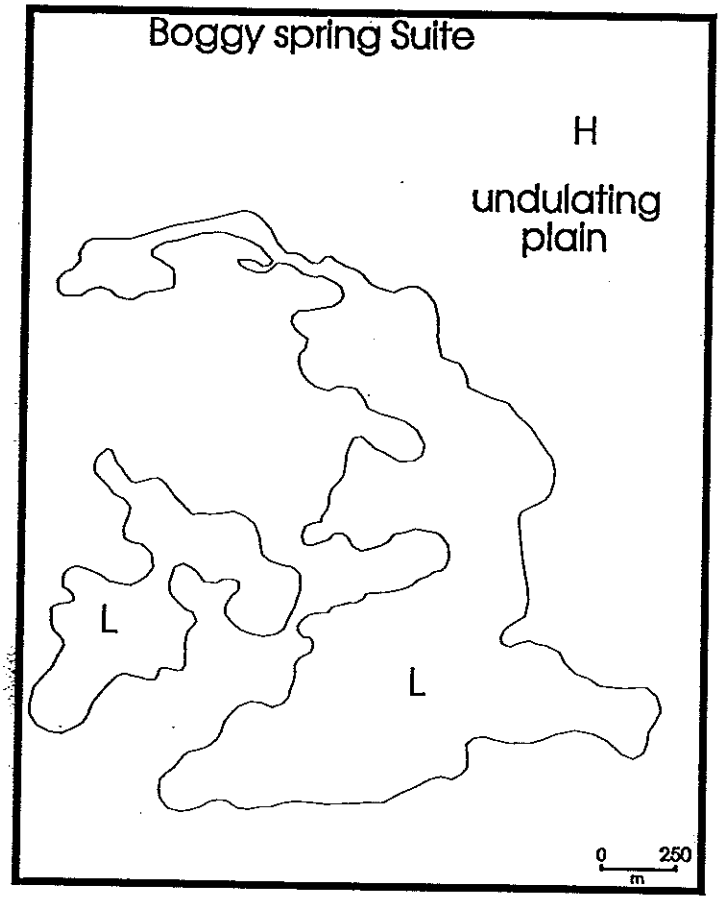
This suite contains coalescing leptoscale to macroscale irregular lakes, sumplands, and damplands. The wetlands are windows to the water table in a degraded dune terrain. They are separated by microscale linear dune ridges oriented east-west, but often bifurcated. The basins are underlain by

peat, peaty sand and quartz sand, and are freshwater. Vegetation comprises forest, shrubland and sedgelands. Examples of shrubland species are *Melaleuca cuticularis* type, and sedgeland is often composed of *Baumea articulata.*



27. - BOGGY SPRING SUITE

This suite contains two macroscale irregular lakes. The basins are underlain by clay in the midst of quartz sand terrain. The wetlands are probably freshwater to hyposaline. Vegetation cover comprises shrubland and extensive sedgeland.



CONTACT BETWEEN RIDGE OF PLEISTOCENE DUNES OVERLYING LIMESTONE AND PLEISTOCENE COLLUVIAL SLOPES

28. - LAKE WILLIAM SUITE

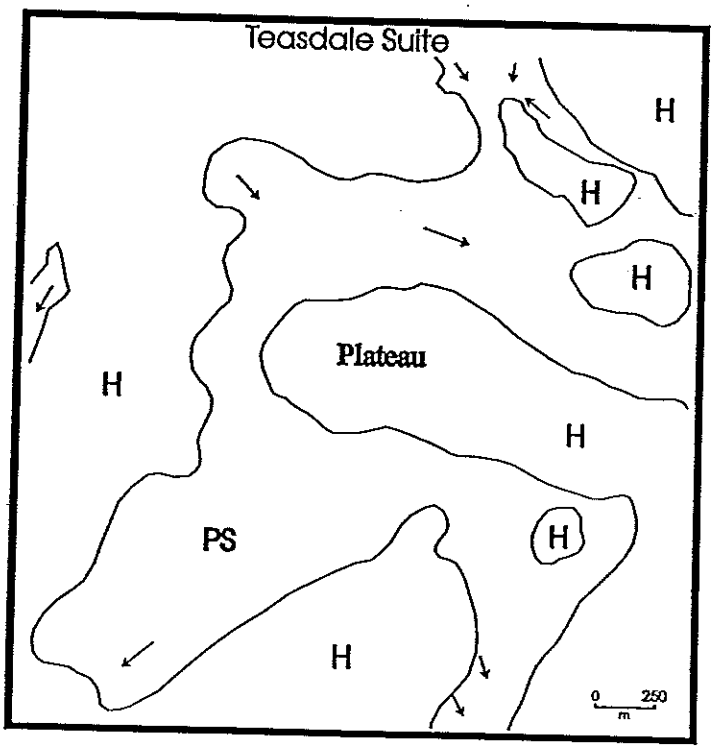
This suite includes microscale crescent to linear shaped lakes and sumplands lying along the contact between Pleistocene dunes which are underlain by limestone, and valleys underlain by Pleistocene colluvial sand. The wetlands are located in a valley tract which has been blocked by the coastal dunes. Although the wetlands are underlain by white quartz sand, it is probable that the water within the valley tract may be perched, due to

localised subsurface aquitards. Wetlands are freshwater. The peripheral vegetation comprises forest of *Agonis juniperina.*

PLEISTOCENE COLLUVIAL SLOPES AND FLATS

29. - TEASEDALE SUITE

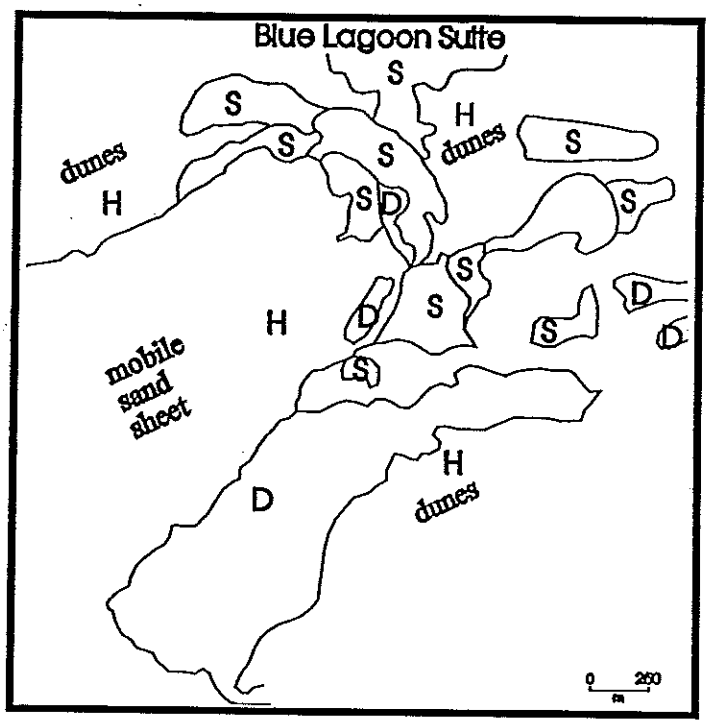
This suite contains predominantly paluslopes, some flats, and headwaters. Some of the slopes are associated with channels, but the suite is closely correlated to the distribution of fine white colluvial sand. This sand is thinly deposited over laterite or granite on the top of ridges and thickens down the valley slope until deep deposits of fine sand accumulate on the valley floors. They are freshwater. Vegetation is similar in composition to the Tertiary colluvial wetland slopes, i.e., very open low woodland (*Melaleuca preissiana, Nuytsia floribunda)* with an understorey of low heath (*Homalospermum firmum, Beaufortia sparsa, Astartea fascicularis, Evandra aristata).*



PLEISTOCENE LIMESTONE RIDGE

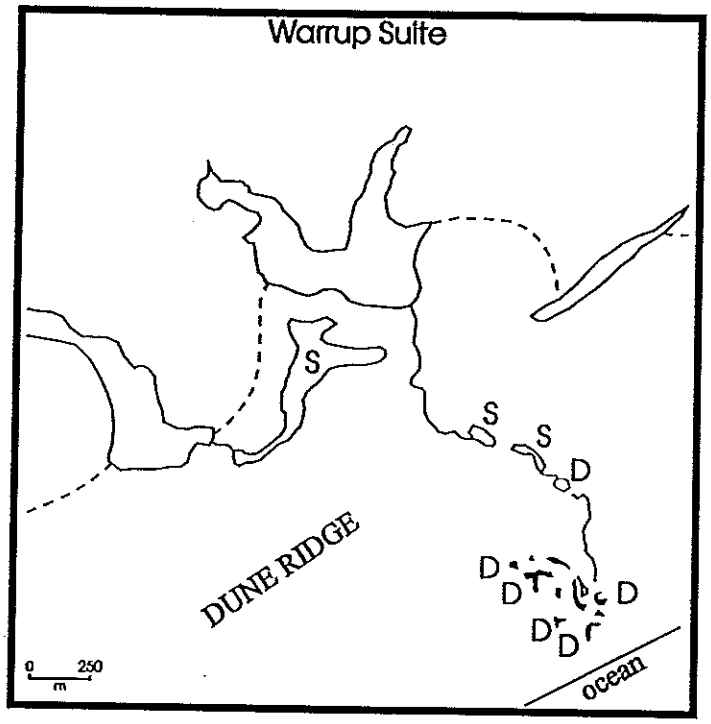
30. - BLUE LAGOON SUITE

This suite contains coalescing and segmented microscale to mesoscale irregular lakes, sumplands, damplands and slopes. The wetlands are subject to deflation and infilling by aeolian processes and represent all stages of evolution. The basins are underlain by calcareous sand and peaty sand in a limestone terrain. The wetlands are probably freshwater. Wetlands range from being open water to completely vegetated to unvegetated sand. Vegetation comprises scrub of *Melaleuca cuticularis,* shrubland of *Banksia littoralis* and *M. cuticularis,* sedgeland of *Baumea juncea* and rushland of *Juncus kraussii.*



31. - WARRUP SUITE

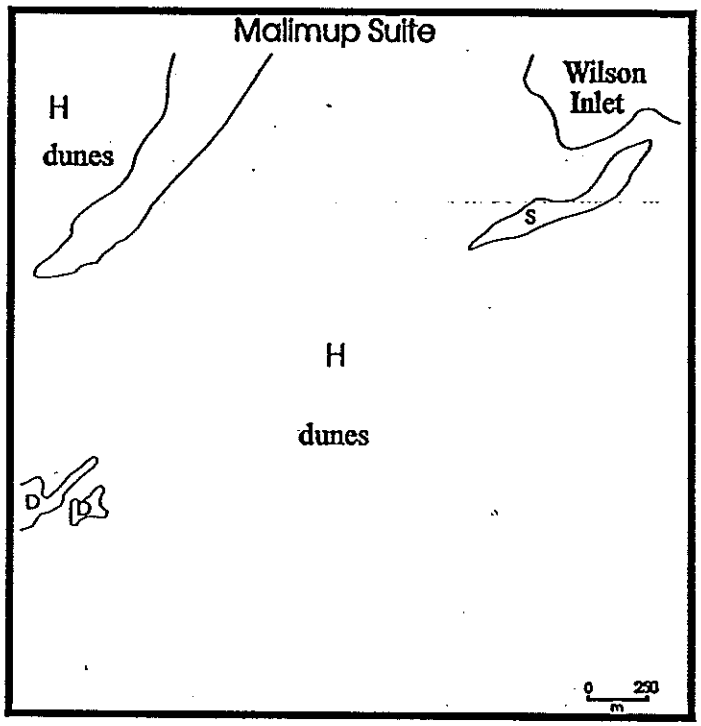
This suite includes the two un-named basins southeast of Mirrambeen Lake. The basins are microscale, and, possibly have been segmented from Mirrambeen Lake by coastal dunes. The wetlands are bordered by steep slopes cut into Pallinup Siltstone and limestone. The water is fresh to hyposaline.



PLEISTOCENE DUNES OVERLYING LIMESTONE RIDGE

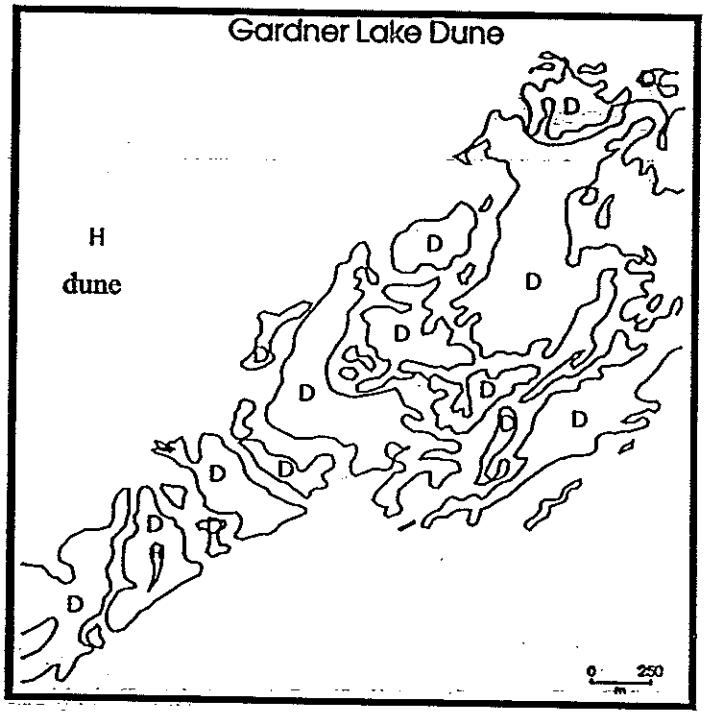
32. - MALIMUP SUITE

This is a suite within the coastal parabolic dunes. Deflation has formed irregular shaped microscale to mesoscale damplands within the bowls of the parabolic dunes. The water table maintains the wetland basin. The wetlands are underlain by sand and limestone, and the groundwater is fresh.



33. - GARDNER LAKE DUNE SUITE

This is a suite of leptoscale to microscale irregular sumplands and damplands in successive bowls of migrating parabolic dunes. The wetlands are almost in rows. They are underlain by calcareous sand and possibly limestone and are maintained by groundwater rise. The dominant vegetation comprises sedgeland with species of *Lepidosperma, Baumea, Leptocarpus,* and *Gahnia* and there are scattered trees of *Agonis juniperina* and *Banksia littoralis.*



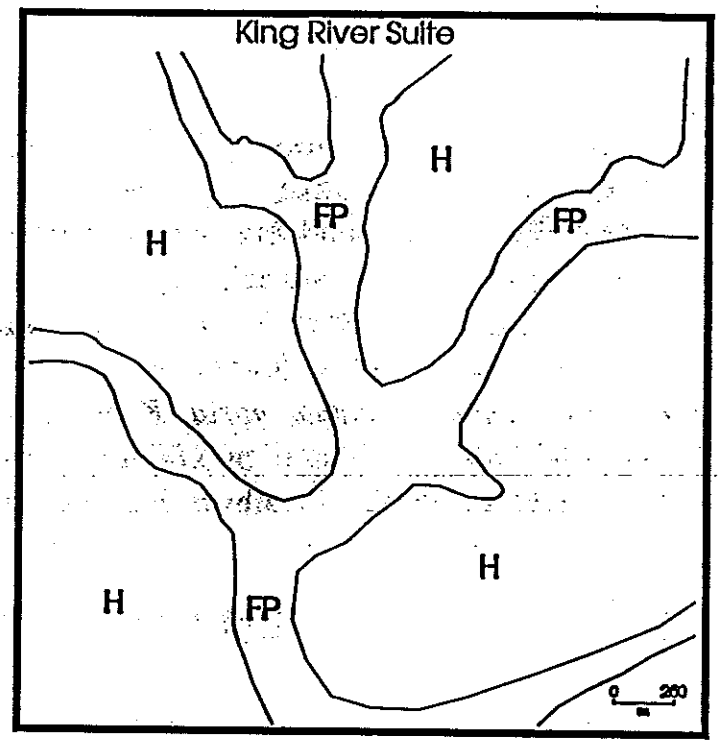
HOLOCENE

HOLOCENE ALLUVIAL CHANNELS AND ASSOCIATED FLATS

34. - KING RIVER SUITE

This suite contains floodplains and palusplains associated with recent channels. Rivers and creeks have deposited muddy sands, sands, gravels and loams as localised riverine floodplains. The channels are fringed by shrubs(*Melaleuca.rhaphiophylla*) and woodland (*Corymbia calophylla, Eucalyptus staeri, E. marginata*). The flats are vegetated by shrubland

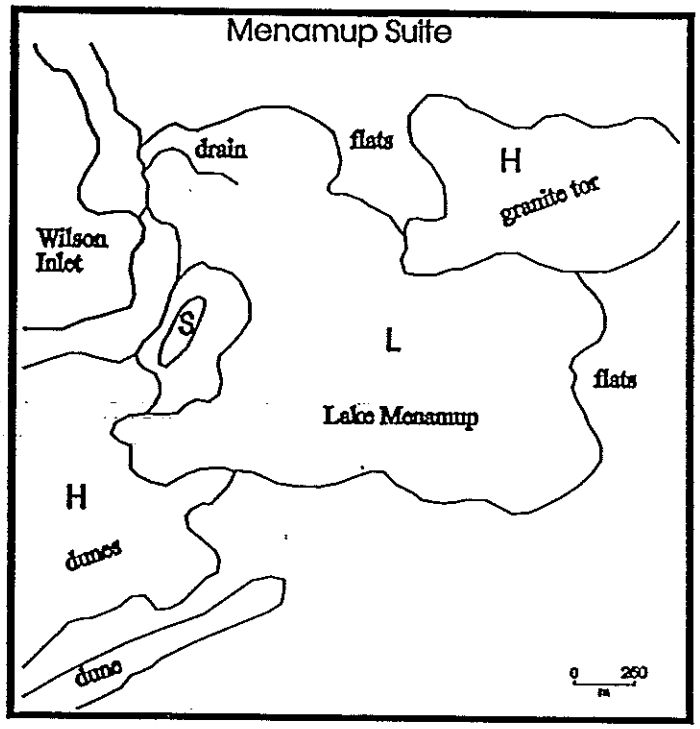
(*Agonis linearifolia, A. parviceps)* with a low heath (*Homalospermum firmum, Astartea fascicularis, Beaufortia sparsa*).



CONTACT BETWEEN PROTEROZOIC GRANITIC HILL AND HOLOCENE ESTUARINE FLATS

35. - MENAMUP SUITE

This suite contains Menamup Inlet. The basin is macroscale and rectangular. It is barred from Wilson Inlet by a barrier of low dunes. The wetland is no longer effected by estuarine processes. The wetland is underlain by estuarine fine quartz sand burrow mottled and with shells. Salinity ranges from freshwater to occasionally hyposaline. The margins to Menamup Inlet are sloping and vegetation is zoned. It comprises heath with emergent shrubs of numerous species dominated by *Melaleuca incana, Banksia quercifolia, B. coccinea, Hakea varia, K. ericifolia, Agonis ssp.,* and *Astartea fascicularis,* scrub dominated by *Melaleuca rhaphiophylla, M. cuticularis* and *M. diosmifolia,* and low heaths or herblands of *Halosarcia.*

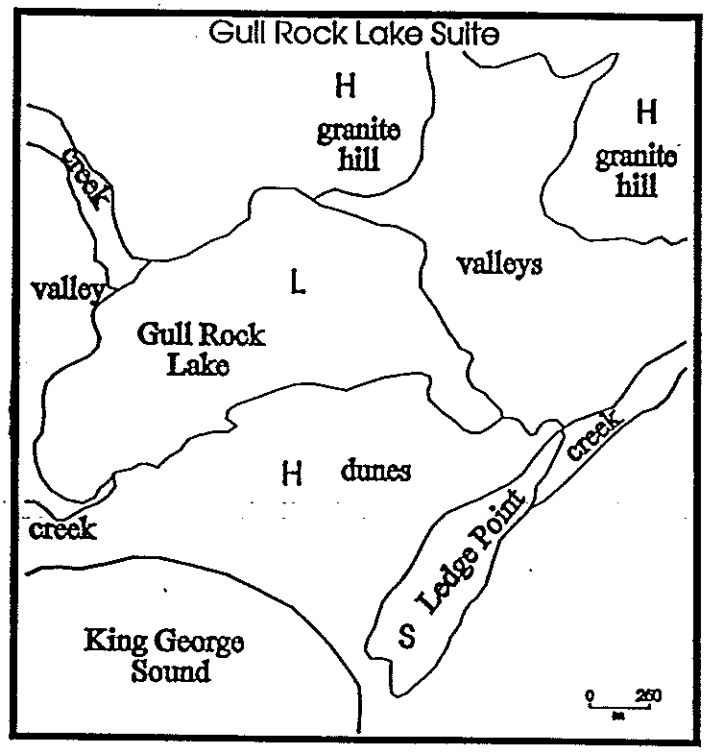


CONTACT BETWEEN PLEISTOCENE COLLUVIAL SLOPES AND HOLOCENE ESTUARINE FLATS

36. - GULL ROCK LAKE SUITE

This suite includes Gull Rock Lake and Ledge Bay sumpland. The wetlands are microscale. They exhibit variable geometry from renal to linear

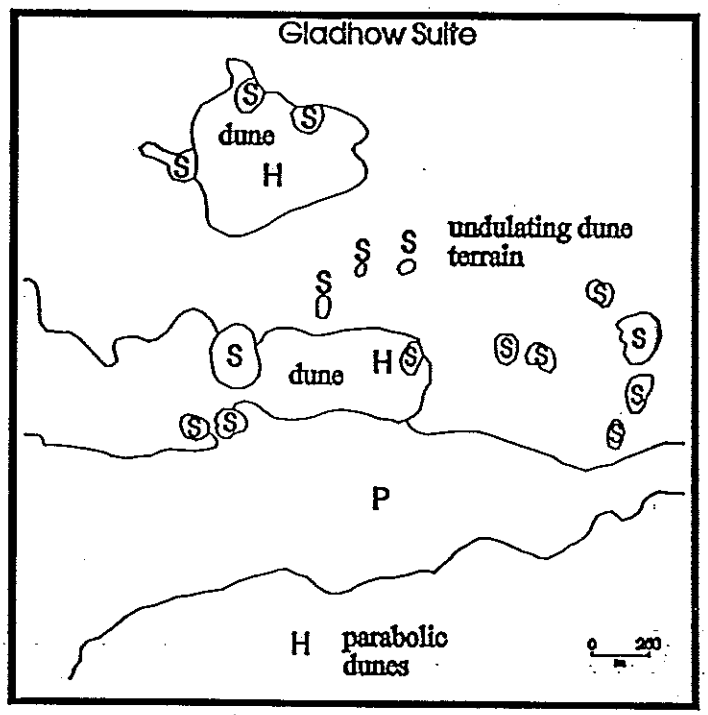
depending on their orientation to the coastline and their position within the granitic terrain. They are no longer subject to estuarine processes being barred from King George Sound by limestone, lateritic, and gneiss barriers. They are bordered by narrow fringing flats and exhibit internal tidal shoal structures formed when still estuarine. Ledge bay wetland is the best example of these structures. They are receiving basins for one or two rivers or creeks. The basins are underlain by peat over quartz sand. The wetlands are probably freshwater. The peripheral vegetation comprises low forest of *Melaleuca rhaphiophylla, Agonis juniperina and Callistachys lanceolatum* with an understorey of sedgeland of *Baumea articulata.* The shoal structures support low forest *M.rhaphiophylla* and the swales between, support herbland *Centella asiatica* and sedge *B. articulata* and *Typha orientalis.*



HOLOCENE ESTUARINE FLATS AND BASINS

37. - GLADHOW SUITE

This is a suite of basins situated on a palusplain and separated by low dune ridges. The basins are leptoscale circular sumplands and lakes. The wetland fill is 1-3 m of peat. they are recharged by precipitation and groundwater rise, and are freshwater. The vegetation is concentriform with a central zone of forest (*Melaleuca preissiana*) and an outer zone of forest (*Agonis juniperina*).

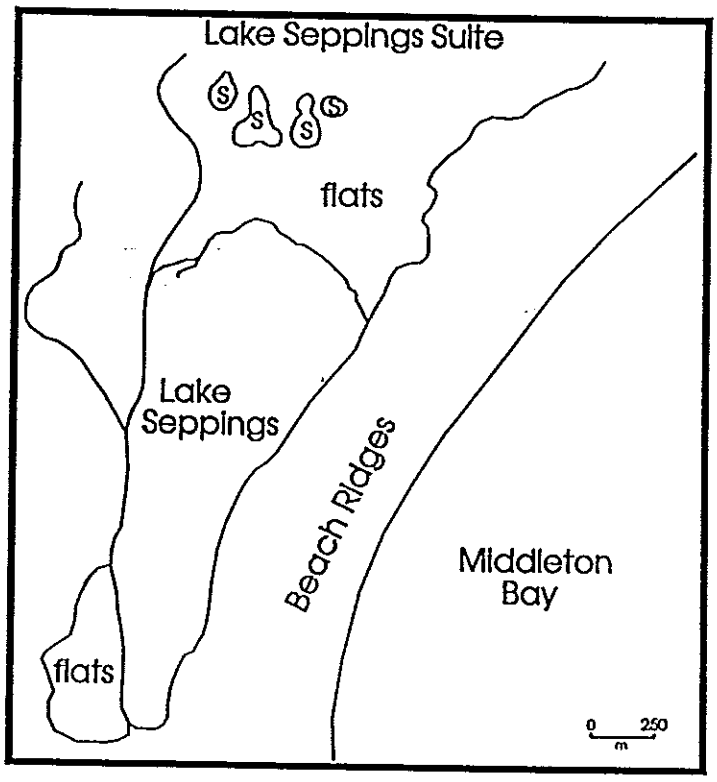


38. - TILLERUP FLAT SUITE

This suite contains floodplains and palusplains to the east of Wilson Inlet. The flats are a result of valley fill on a Precambrian and saprolitic basement, and contain grey mud with coarse quartz grit in it, muddy sands, quartz medium sands, and ferricrete nodules. Most of the flats have been cleared of vegetation. Patches of *Melaleuca cuticularis* remain.

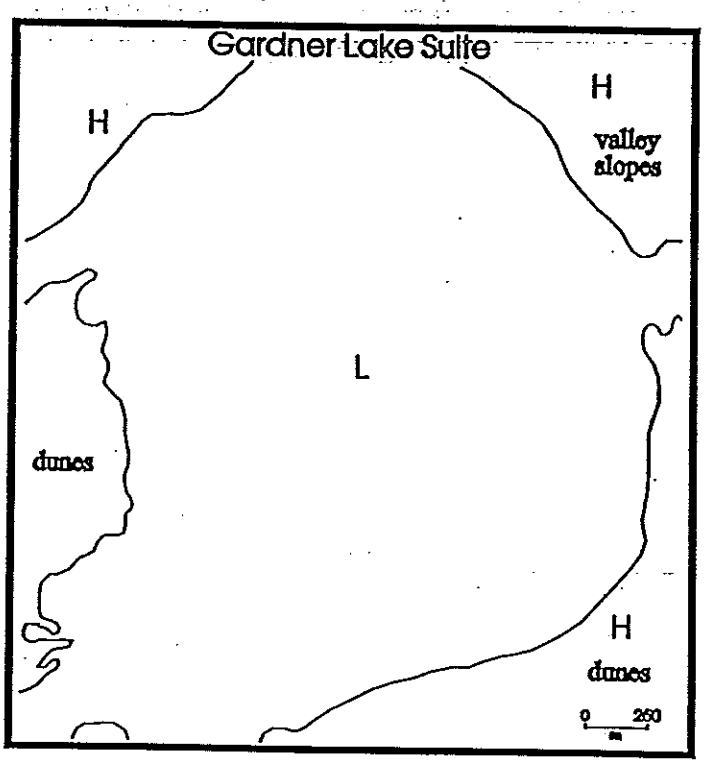
39. - LAKE SEPPINGS SUITE

Lake Seppings is the only example of this type of former estuary. The wetland is macroscale and linear. It has formed behind the barrier now known as Middleton Beach. In contrast to other types of estuaries which are constricted at one end and then blocked from the ocean by dune or bedrock barriers, this system was barred along its whole length suggesting a complex fluvial and estuarine origin. The present wetland comprises tidal flats, terrestrial basins and flats. The system is underlain by sediments from a variety of sources: in-situ weathering of bedrock to clays, colluvial deposition of fine sands, alluvial deposition of sands and muds, tidal re-working of shell beds and gravel, and in-situ peat formation. The Lake Seppings system is recharged by precipitaton and groundwater rise. It is freshwater but becomes more saline towards the northeastern end where the tidal flats are. The Lake Seppings system supports forests (*Melaleuca cuticularis)*, woodlands (*Agonis sp.* and *Melaleuca preissiana*) closed heaths dominated by *Kunzea sp., M. cuticularis, Agonis sp., or Astartea fascicularis.* The tidal flats support sedgelands (*Juncus sp.*) and herblands(*Halosarcia sp.*).



40. - GARDNER LAKE SUITE

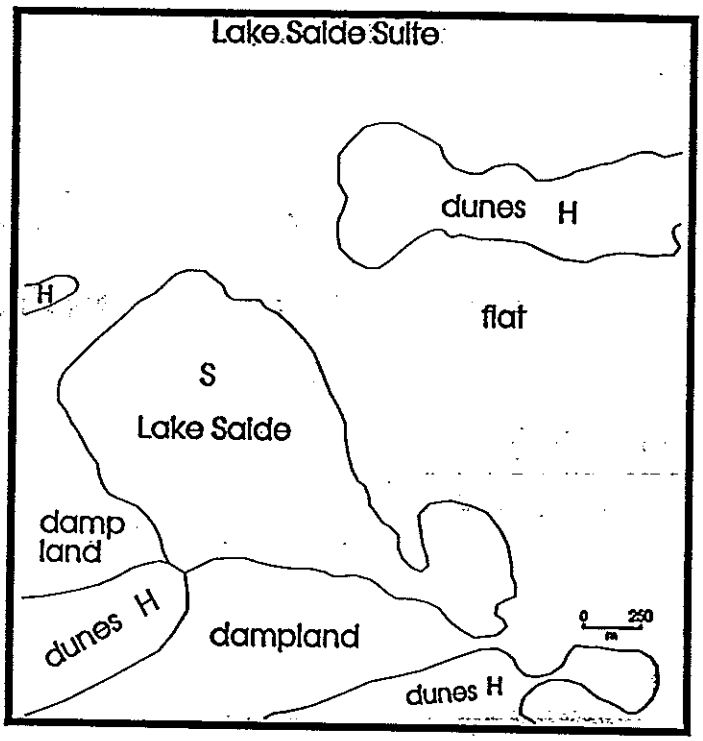
This suite includes Gardiner Lake only. The wetland is macroscale and rounded. It is no longer subject to estuarine processes, and is classified as closed. It is located in an area of alluvial flats and undulating plain (floodplain and/or palusplain), and is the receiving basin for several leptoscale creeks. The basin is underlain by sand and muddy sand. The wetlands range from freshwater to subhaline. The peripheral vegetation of Gardiner Lake includes wide sedgeland (*Baumea juncea, B. preissii, Leptocarpus scariosus, L. congustatus*), and low closed forest (*Agonis juniperina, Banksia littoralis).*



41. - LAKE SAIDE SUITE

This suite includes Lake Saide only. The wetland is a mesoscale flask shaped sumpland. It is located on estuarine flats and is underlain by peat with freshwater snails in it, overlying calcareous mud, overlying estuarine shelly mud. The wetland is freshwater to subhaline. Much of the natural vegetation has been cleared and invasion of *Typha orientalis* is extensive. Patches of natural vegetation comprise forest of *Agonis juniperina,*

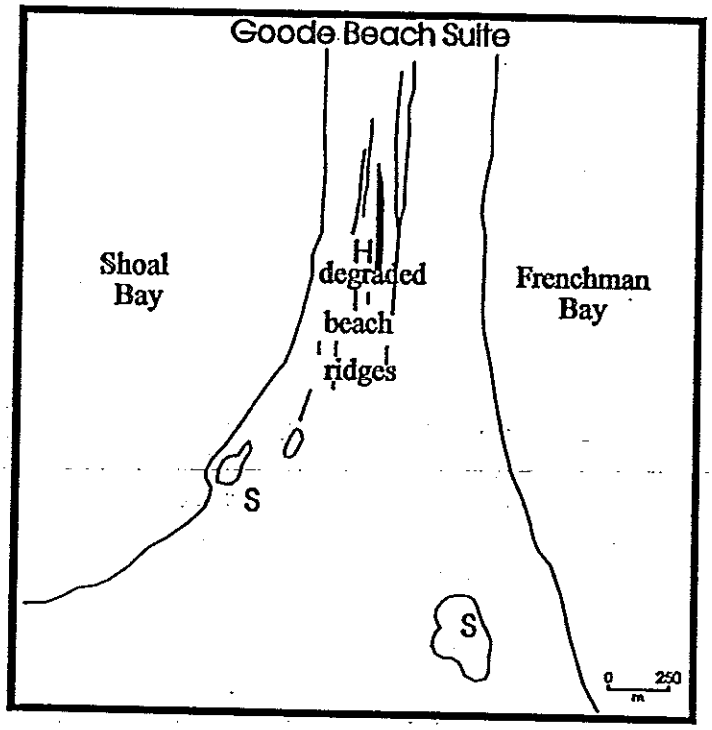
sedgelands of *Baumea juncea* or *B. articulata*; herblands of *Centella asiatica* and scrub of *Melaleuca diosmifolia*.



42. - GOODE BEACH SUITE

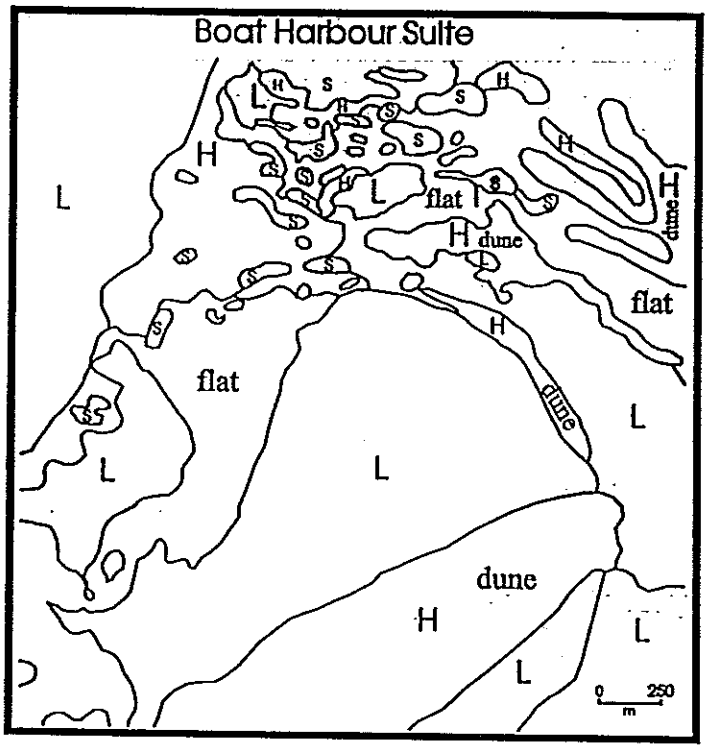
This suite includes wetlands formed on the tombolo known as Vancouver Peninsula which forms Frenchmans Bay. They are leptoscale to microscale sub-rounded sumplands within the flattened beachridge system which forms the subaerial part of the tombolo. They are underlain by either peat overlying white sand with estuarine shells overlying yellow sand or simply by the white sand. The wetlands range in age, the youngest being vegetated by sedgeland of *Baumea juncea* with patches of *Melaleuca cuticularis* and *Gahnia trifida* and the older one by sedgeland with peripheral shrubland of

many genera including *Callistachys, Agonis, Melaleuca, Hakea, Adenanthos, Lepidosperma* and *Leptocarpus.*



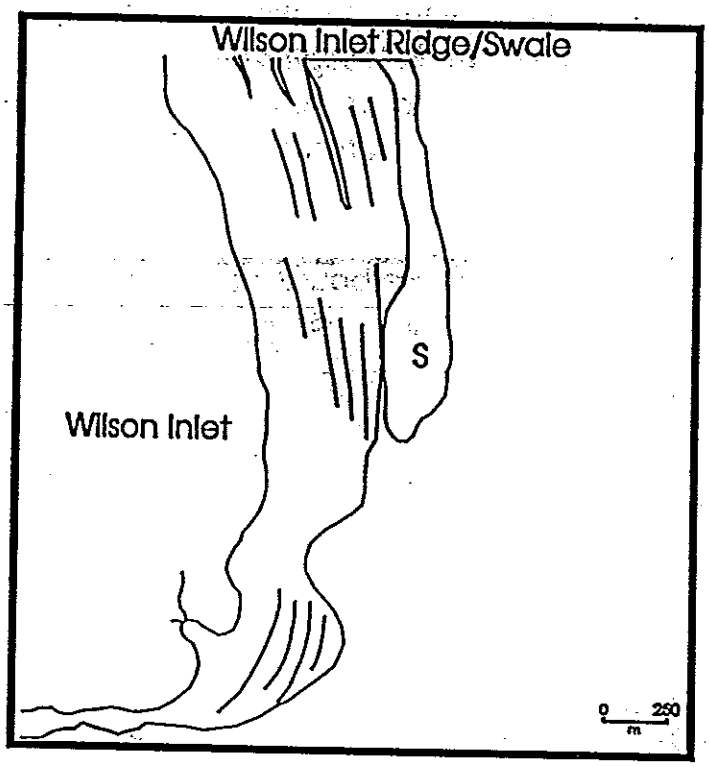
43. - BOAT HARBOUR LAKES SUITE

This suite contains eight microscale, irregular to ovoid shaped wetlands. They range from sumplands to lakes. The basins are probably the product of wetland segmentation by dunes. They are underlain by quartz sand and filled with organic muds (ANCA 1996). The salinity ranges from freshwater stasohaline to freshwater poikilohaline. The basins support forest *(Agonis juniperina),* scrub to heath formations (*Callistachys lanceolatum, Agonis linearifolia, M. rhaphiophylla, and Banksia littoralis*), and sedgelands (*Baumea articulata, B. vaginalis, B. arthrophylla, Gahnia trifida, Leptocarpus scariosus* and *Leptocarpus tenax*



44. - WILSON INLET RIDGE/SWALE SUITE

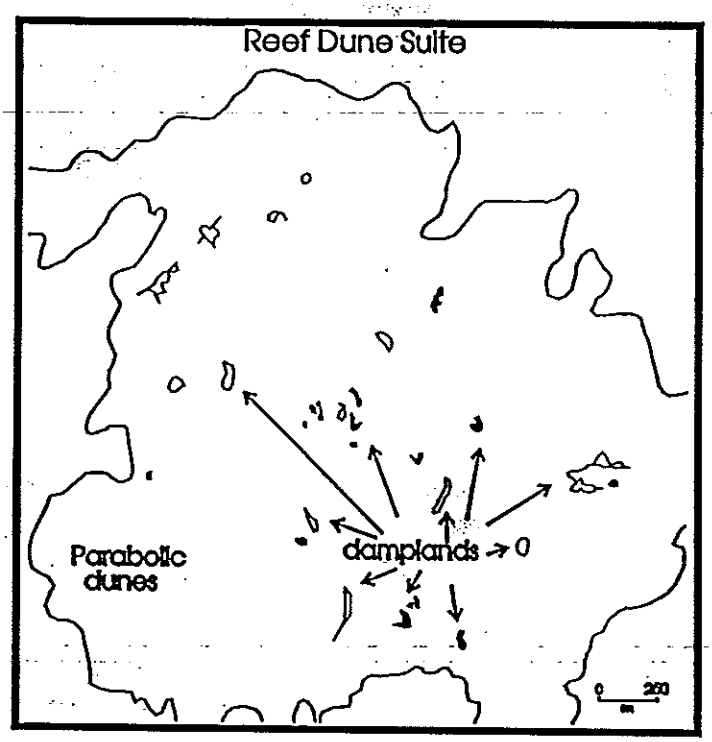
This suite contains an estuarine ridge/swale complex. Granite and ferricrete are exposed at the surface of the swales. They are vegetated by low heath or herbland comprising species of *Suaeda, Halosarcia,* sedgeland of *Juncus kraussi*, and scrub of *Melaleuca cuticularis.*



HOLOCENE CALCAREOUS SAND SWALES AND DEPRESSIONS

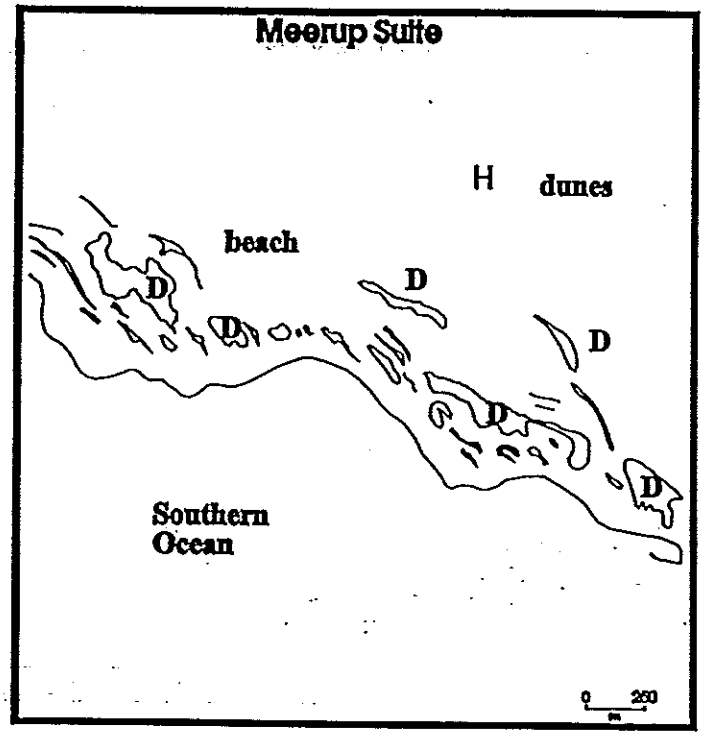
45. - REEF DUNE SUITE

This is a suite of microscale to leptoscale irregular basins in deflation hollows in the parabolic dunes. The wetlands are underlain by calcareous sand, and are maintained by groundwater rise. They are un-vegetated. Some wetlands will be ephemeral as a result of encroachment by the mobile sand, and some will become more established and be colonnised by wetland vegetation.



46. - MEERUP SUITE

This is a suite of microscale to leptoscale irregular basins in the interdune hollows behind the foredune. The wetlands are underlain by calcareous sand with a superficial peat layer, and are maintained by groundwater rise. Some are vegetated, some are not. The vegetation varies from closed scrub (*Agonis flexuosa*) to sedgelands (*Lepidosperma gladiatum*). They are an unusual feature and some are possibly ephemeral as a result of encroachment by mobile dunes.



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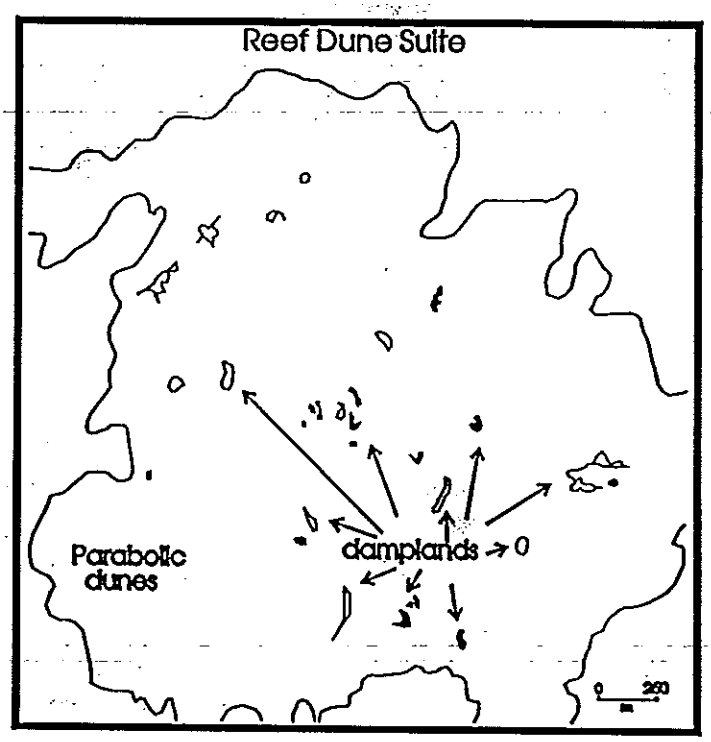

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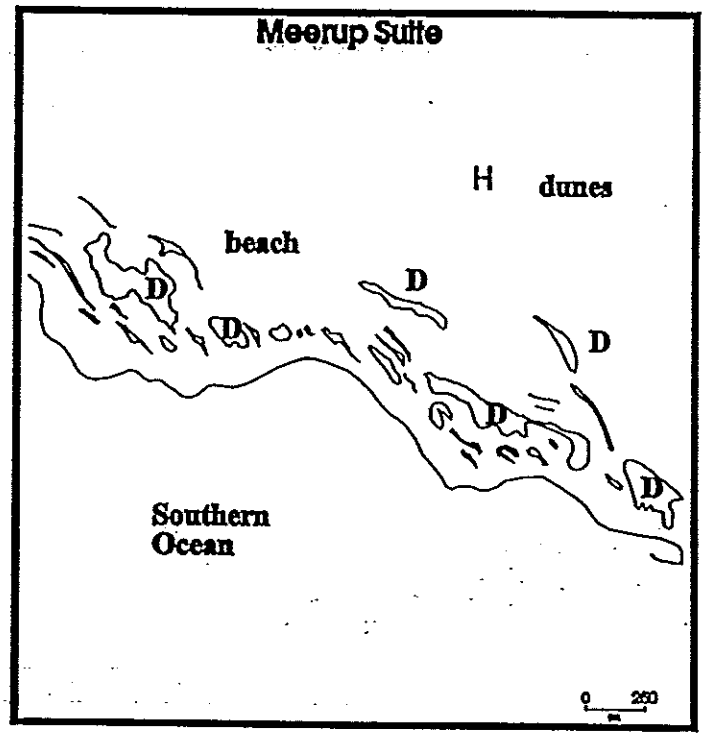

6.0 PRELIMINARY EVALUATION OF WETLANDS IN THE STUDY AREA, SOUTHERN WESTERN AUSTRALIA

Given the time constraints, the large number of wetlands, and the inaccessibility of many wetlands, what has been undertaken for this study, is a preliminary analysis to define wetland values for each Consanguineous Suite. In this analysis, the following information was used where available:

- condition of wetland
- representativeness
- scarcity of wetland type
- habitat diversity
- geomorphic/landscape values
- faunal values
- floral values
- linkage of systems

Condition of wetland includes assessment of the naturalness of the landform, stratigraphy, hydrology (such as hydroperiod, water levels, water quality, and maintenance mechanisms), and vegetation in the wetland and the buffer zone.

Representativeness relates to the range of wetland types, habitats, underlying stratigraphy, and hydrological and sedimentological processes present in each suite, and essentially, how well they are represented in the region.

Scarcity relates to the size, geographical distribution and duplication of a given wetland suite.

Habitat diversity refers to the variability present in each suite as well as the presence/absence of restricted habitat types.

Geomorphic/landscape values refer to specific features present in the wetlands, or to the setting in which the wetland occurs.

Faunal values refer to the documented use of wetlands by specific fauna, and the importance of the wetland in maintaining populations and/or diversity. Faunal functions may refer to use of the wetland either as habitat, or as a site or resource necessary for population survival.

Flora values refer to the importance of the wetland in maintaining populations and/or diversity.

Linkage of systems refers to hydrological links such as creeks flowing into or from basins, creeks on flats, palusmonts grading into paluslopes and palusplains in valley systems; and to ecological links such as a series of basins ranging from permanent open water to seasonally waterlogged vegetated damplands surrounded by upland.

Information used in assessment of the wetland suites in the study area, was derived from publications and selected field visits. Published information on fauna was drawn from the following sources:

Amphibia (frogs): - Wardell-Johnson & Roberts (1991, 1993); Jaensch (1993)

Fish: - Christensen (1982); Allen & Berra (1989); Pusey (1990); Jaensch (1992); Morgan, Gill & Potter 1996,

Invertebrate fauna: - Pusey & Edward (1990), Edward et al. (1994), Horwitz (1994)

Waterbirds: - Birds Australia Waterbird Usage of Nature Reserves Survey Data Base(1987-1997), Garnett (1992), Jaensch (1992), Watkins (1993), Lane et al (1996)

Information relating to Amphibia includes some locations cited in respective studies listed above, but overall, the surveys of Amphibia have not been long term or comprehensive, and so definitive statements of their occurrence with respect to Consanguineous Suites cannot be made. Moreover, frog population numbers seem in general to be low. Some patterns did emerge, however, and these pertained to endemism. The species *Crinea glauerti* and *Litoria adelaidensis* were fairly widespread, while the species in the *Geocrinea rosea* complex are very site specific (Wardell-Johnson & Roberts 1991). *G. lutea* is restricted to the Walpole area according to current surveys. At this stage results from surveys do not permit rigorous assessment of whether species are related or restricted to Consanguineous Suites.

Similarly, some fish distributions are widespread and some are restricted (Christensen 1982, Pusey 1990, Jaensch 1992). *Bostockia porosa* and *Edelia vittata* are widespread whereas other species such as *Galaxiella munda, G. nigrostriata, Galaxias maculatus, Lepidogalaxias salamandroides, Nannatherina balstoni* and *Tandanus bostockii* are restricted in distribution. Where it has been possible to deduce precise locations for species of fish, this information has been incorporated into the framework of the Consanguineous Suites. However, from the present data, it is still indeterminate whether the presence of fish species correlates with types of consanguineous wetland suites, or simply with water quality and periodicity. For instance, *Galaxias occidentalis* prefers neutral waters,

L. salamandroides prefers more acidic waters, *E. vittata, B. porosa, G. munda* and *G. occidentalis* tolerate some salinity (Christensen 1982).

Studies on invertebrate fauna have been centred in the coastal plain area between Donnelly River and Denmark River. Invertebrate fauna that are widely distributed in this region include micro-crustacea, e.g., Cladocera, Copepoda, and Ostracoda (Pusey & Edward 1990) and Insecta e.g., Chironomidae. Within the study area, Horwitz (1994) found some species to be either locally endemic, or south-western endemic. In the first category are oligochaetes, Diptera, isopods (Janiridae), and the decapod *Engaewa subcoerulea.* This local endemism may not necessarily correlate with a particular Consanguineous Suite, but rather with locality, or specific habitats in a given physiographic/hydrologic region. This aspect needs to be further investigated. In the second category are oligochaetes, isopods, Diptera, Odonata (*Argiolestes minimus*), and decapods (*Cherax preissii, C. crassimanus, C. qinquecarinatus, Palaemonetes australis.* In the same study by Horwitz (1994), a number of sites selected for sampling of invertebrate fauna coincide with the following Consanguineous Suites: Malimup, Boronia Rd, Owingup Swamp, Bangamup, Overton, Walpole and Pallinup suites. Data on invertebrate fauna therein are presented in the ensuing descriptions of the Consanguineous Suites.

Information on avifauna was derived from analysis of Birds Australia databases on waterbirds (1987-1997) and the findings of Raines *et al.* (unpub.), with some additional information from Watkins (1993), Jaensch (1992), Lane *et al.* (1996) and Garnett (1992). Forty five sites for which data were available are described in this report and compared to 747 other wetland sites in southern Western Australia. Observations at some sites are few, usually reflecting the lack of survey effort or a dry wetland at the time of the survey(s). Notably, little effort has been made to assess breeding at wetlands during most surveys. Many wetlands require considerably more survey work over a range of seasons to assess their values, particularly with respect to breeding.

The analysis in this report does not include any non-waterbird species; a waterbird is defined as being a species which is dependent on wetlands for its survival and includes waterfowl, shorebirds and certain species of harrier, eagle and warbler as defined by Jaensch *et al.* (1988). It should be noted, however, that wetlands that have fresh water, are well vegetated, or have peripheral vegetation, may also contribute substantially to the maintenance of many non-waterbird species.

Information on priority flora was obtained from two sources. For the area between Walpole and Denmark, the database of the Department of Conservation and Land Management, under the direction of Roger Hearn and Tony Annels was accessed. For the area between Denmark and Fitgerald Inlet, the publication by Robinson and Coates (1995) was reviewed.

Spatial distribution patterns of priority flora appeared to strongly correspond with habitat types such as margins of incised creeks, seepage zones in granite monadnocks, low dunes underlain by calcareous sands, or flats underlain by estuarine sediments which are now freshwater dominated. In this section of the report, although the presence of priority flora is noted in each Consanguineous Suite, it is emphasised that it is local rather than regional wetland processes which are effecting their occurrence at a given site.

Information on habitat diversity and geomorphic/landscape values was obtained from brief field surveys conducted during this study.

In some suites, the available information is depauperate, and should not be considered as comprehensive or indicative of the wetland suite. This type of information therefore is presented herein only as an informal indication of wetland value.

Unless specifically stated, all of the wetlands described below are relatively undisturbed, i.e., the geomorphology is undisturbed, the hydrological mechanisms maintaining the wetland are natural, the water salinity regime is unaltered (even if specific values in this regard) have been shown to have changed), the sediments are undisturbed, the vegetation is endemic and has overstorey and understorey structural components. In other words, the naturalness of the wetland, its processes and its habitats is high. Water levels may be altered for such wetlands, but this has not been shown to be anthropogenic. Recognised values for each of the suites are described in the following order:

- representativeness of wetland, processes and habitat
- importance of wetland type
- importance of geomorphic setting or geomorphic features within or adjacent to wetla
- habitat diversity
- vegetation assemblage diversity
- documented importance of wetland as a habitat for restricted flora

- documented importance of wetland to avifauna
- documented importance of wetland to amphibia
- documented importance of wetland to invertebrates
- documented importance of wetland to freshwater fish

Prior to the description of the functions, attributes and values of wetlands in each suite, there is a summary indicating the status of information used in this report, so that omissions in information may be clearly separated from paucity of attributes or functions .

Frenchman Bay Suite--slopes and creeks on granitic outcrops

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types and wetland processes within this suite. There are many smallscale slopes at this location, and together they encompass a range of habitats and vegetation associations.

Mt Bland Lake Suite--Mt Bland Lake

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data
Geomorphic/landscape values not assessed

The wetland is the single representative of wetland types and wetland processes within this suite.

Coyanarup Suite--Coyanarup Bogs

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Geomorphic/landscape values not assessed

These wetlands are the best and largest representatives of these rare wetland types, and indicative of wetland processes within this suite. They are the habitat for the herb, *Xyris* sp. nov.(DRF).

Cleerillup Suite--Cleerillup Creek

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

The wetland is the single representative of wetland types and wetland processes within this suite.

Pallinup Suite--Lake Surprise, Geriberiwelup Swamp, Kalmerndyip Lake, Bolganup Creek Lake

Avifauna-no data
Amphibia-no data
Invertebrates-limited data
Fish-no data
Rare, uncommon or restricted flora-limited data

The wetlands listed above are representative of wetland types and wetland processes within this suite.

Invertebrate fauna sampling was undertaken in Lake Surprise, one of the lakes in this suite, and this information is presented here as an indication of the possible invertebrate assemblages and diversity present in this suite. The total number of taxa recorded was 23, with Copepoda, Cladocera, Isopoda

(Janiridae), Trichoptera, Hemiptera and Coleoptera being represented. No endemic species were recorded, representing reasonable diversity.

Four priority flora species have been located in and around wetlands in this suite:

- *Tribonanthes purpurea* (DRF),
- *Stylidium lepidum, S. pseudohirsutum, Synaphea intricata* (P3).

Swan Lake Suite--Swan Lake, Mirambeen Lake, Wongerup Creek Sumpland, Hunter River Lake, Charles Bay Lake, Kelly's Creek Lake, Cheyne Road A, B,C

Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-limited data

These wetlands are representative of wetland types and wetland processes within this suite. Based on data for Cheyne Rd wetland C, these wetlands contribute to the maintenance of at least eight species of waterbird in southern Western Australia, for example Black-tailed Native Hen and Clamorous Reed-Warbler. Cheyne Rd wetland C supports the Australasian Bittern. This species is in need of protection (Garnett 1992). The Australasian Bittern is listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct".

Two priority flora species have been located in and around wetlands in this suite:

- *Restio abortivus* (DRF),
- *Lysinema lasianthum* (P2).

Fitzgerald Inlet Suite--Fitzgerald Inlet

Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

The wetland is the single representative of this wetland type and is representative of hyposaline to hypersaline estuarine processes within this

area. The system has high habitat diversity: salt pans, fluvial flats, estuarine flats, deltaic lowlands, cliffs, beach ridges, channels, relict tidal delta and the rock defined inlet basin itself (Hodgkin & Clark 1990). The low samphire and grass heaths are quite diverse with a range of species present e.g., *Atriplex cinerea, Halosarcia indica subsp. bidens, Sarcocornia quinqueflora and Suaeda australis* (ANCA 1996).

Based on limited survey effort, this inlet supports at least 16 species of waterbird, for example, the Red-necked Avocet and Red-capped Plover. It is in the top 1% of sampled wetlands for Caspian Tern, which is also listed on both the Japan Australia and China Australia Migratory Bird Agreements. It supports high numbers of Chestnut Teal, placing it in the top 1% of sampled wetlands in terms of numbers of this species. Thus it contributes significantly to the maintenance of Chestnut Teal populations which are largely restricted to the south eastern coast of Western Australia. Large numbers of Australian Shelduck use this location to moult (Lane *et al.* 1996). A comprehensive seasonal survey is required to fully determine the ornithological values of this wetland.

Four families of fish breed in the inlet: Sparidae (Black bream), Atherinidae (Hardyheads), Galaxidae (Minnows) and Gobiidae (Gobies) (Hodgkin & Clark 1990), making a total of five species. One of the galaxids, *Galaxias truttaceus* is only found between Albany and Esperence (Hodgkin & Clark 1990). There are no introduced species at present.

Fitzgerald Inlet is habitat for other species also e.g., the estuarine shrimp, *Palaemonetes australis*, molluscs including the following genera of bivalve, *Pinna, Fulvia, Spisula, Sanguinolaria*, and *Katelysia*, brine shrimps, ostracod crustacea, and the gastropod *Coxiella striatula*.

Walpole River Suite--Collier Creek, NE Walpole, Bonhall Creek, Bow River,

Avifauna-no data
Amphibia-limited data
Invertebrates-limited data
Fish-no data
Rare, uncommon or restricted flora-limited data

The wetlands listed above are representative of wetland types and wetland processes within this suite.

Paluslopes and palusmonts occur within this suite, and these types of wetlands generally are confined to the extreme south coast of Western Australia because of the combination of precipitation/ evaporation conditions. As such, they signal an important climatic difference between the Swan Coastal Plain and the Southern Coastal Plain, and hence wetlands contained within these two systems.

The Walpole area contains some of the most outstanding examples of paluslope wetlands. The combination of high rainfall and the saprolitic, gneissic to granitic terrains result in a range of paluslopes in terms of size, steepness, hydroperiod, and water volume. There are several hydrological mechanisms occurring on paluslopes: surface runoff, seepage of groundwater, and perching. These mechanisms depend to a large extent on the underlying lithologies and sediments. A range of flora therefore colonise particular areas of the slopes and often occur in specific niches e.g., *Reedia spathulata.* Wetland slopes also form part of a linked geomorphic/hydrologic system between the Precambrian uplands and the Tertiary flats, i.e., between valley slopes, channels and palusplain or floodplain.

To the northeast of Walpole township, there is an example of a palusmont. This is an even rarer wetland type in Western Australia. There are only two other locations where this type of wetland has been found, and these are both near the Walpole township (WRC Report WRT12, 1997).

The distribution of *Geocrinea lutea* one of the four allopatric species of frogs in the *Geocrinea rosea* complex, coincides with the Walpole Suite of paluslopes (Wardell-Johnson and Roberts 1991). These species inhabit vegetated slopes associated with creeks. Their distribution is restricted to the region around Walpole.

Invertebrate fauna sampling was undertaken at a location in Valley of the Giants, one of the peaty paluslopes in this suite, and this information is presented here as an indication of the possible invertebrate assemblages and diversity present in this suite. The total number of taxa recorded was 9. One species endemic to the local area was recorded (*Engaewa sp.* nov), and one species endemic to the south-west region (*Cherax preissii*) was recorded.

Twelve priority flora species have been located in and around wetlands in this suite:

- *Microtis globula* (DRF)
- *Leucopogon polystachyus, Andersonia auriculata, Amperea protensa, Mitreola minima, Schizaea rupestris* (P2).
- *Cyathochaeta stipoides, Boronia virgata, Stylidium leeuwinense, Gahnia sclerioides, Sporodanthus rivularis ms* (P3).
- *Tybastes glaucescens* (P4)

Bevan Road Suite--Bevan Rd/Roe Rd Sumplands

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

The wetlands are the only representatives of these wetland types and their processes.

Corimup Suite--Lake Corimup, White Lake, North Sister Lake, South Sister Lake, Tarnup Lake, Pfeiffer Lake, Mt. Pleasant View

Amphibia-no data
Invertebrates-no data
Fish-limited data
Rare, uncommon or restricted flora-no data

The wetlands listed above are representative of wetland types, wetland processes and wetland vegetation assemblages within this suite.

This suite, as a whole, is important for avifauna conservation, because it is significant to two species of waterbird including the Australasian Bittern which is in need of protection. Six to ten pairs of Australasian Bittern breed throughout this suite (Lane *et al.* 1996). It also supports breeding in the Little Bittern which is on the Western Australian Fauna Priority List.

North Sister Lakes-These closely associated lakes contribute to the maintenance of 16 species of waterbird, for example the Little Grassbird and White-necked Heron. At least one species (Purple Swamphen) breeds there. Two species are listed on both the Japan Australia and China Australia Migratory Bird Agreements. It also supports the Australasian Bittern which is in need of protection (Garnett 1992) and listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct".

Lake Pleasant View- This lake supports 23 species of waterbird of which six breed, for example the Little Grassbird and Swamp Harrier. One species is listed on both the Japan Australia and China Australia Migratory Bird Agreements. The lake is in the top 5% of sampled wetlands of importance in terms of numbers of Australasian Bittern which breeds there. The Australasian Bittern is in need of protection (Garnett 1992) and is listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct". It is in the top 1% of wetlands in terms of numbers of Clamorous Reed Warbler. It also supports breeding in Little Bittern which is on the Western Australian Fauna Priority List.

Lake Pleasant View was sampled for fish and no species were reported.

Manypeaks Suite--Sunday Swamp, Galli Swamps, un-named wetlands east of Kojaneerup Rd, Warburton Road, No. 1 Swamp, Mindinyup Road, Chillimup Road, Marralong, Manypeaks, Pfeiffer Road, Stirling Road, Kojaneerup Road, Landing Ground, Kulyallin, Bloxidge, Kojaneerup, Hassell Road, Mettler, Venns Road, Drawbin Road, Wanniup Road, Warburton, Corimup Road, Cheyne D., Mindijup, Murrundie, Collets Rd, Gardner Rd, North Gordon Inlet, Minvalara N., Minvalara SS, Ocumup Swamp, Pullitup Swamp, Mardetta Group

Avifauna-limited data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-limited data

The wetlands listed above are representative of wetland types, wetland processes and vegetation assemblages within this suite. In terms of both structure and floristics, wetland vegetation is variable in this suite, probably due to the variable underlying stratigraphy. The vegetation ranges from forests and shrublands to heaths and sedgelands. Therefore, a number of wetlands have been selected as regionally significant, in order to capture this diversity.

Given the floral diversity, it is not unreasonable to expect priority flora to be present. From a very short visit to several locations, two species have already been identified as Priority 2 flora. These were *Leucopogon polystachyus* from Mindijup Swamp and *Melaleuca pritzelii* from a small wetland near Pullitup Swamp.

There is limited published information about avifauna usage of these wetlands. This is summarised below, and it suggests that for the suite as a whole, waterbird usage is an important function. It is significant to waterbirds listed on International Treaties and is highly significant to several species of waterbird, one of which is in need of protection.

Mettler Lake- This lake contributes to the maintenance of at least 16 species of waterbird in southern Western Australia. It supports the Australasian Bittern, which is in need of protection (Garnett 1992). This species is listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct". It also supports the Little Bittern which is on the Western Australian Fauna Priority List.

Pabelup Suite--Pabelup Lake 1, 2, 3, Gardner Rd wetland, Yellilup Lake, Aralinga, Minvalara, Yendinnup, Lake Torrup

Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-limited data

In their setting, the wetlands in this suite are uncommon types (freshwater sumplands), with unusual wetland processes (stream and groundwater recharge) and vegetation assemblages (forest, shrubland). The wetlands listed above are representative examples of the suite. Eucalypt forests in basin wetlands, particularly those which can withstand seasonal inundation

are rare in southwestern Australia, and this vegetation adds to the regional significance of these wetlands.

There is limited published information about avifauna usage of these wetlands. This is summarised below and it suggests that for the suite as a whole, waterbird usage is an important function. The area also is significant to waterbirds listed on International Treaties and is highly significant to several species of waterbird, one of which is in need of protection.

Minvalara Swamp- This Swamp contributes to the maintenance of at least 22 species of waterbird in southern Western Australia (Lane *et al.* 1996). At least seven species (e.g. Little Pied Cormorant, Pacific heron, Eurasian Coot and Yellow-billed Spoonbill) breed there (Lane *et al.* 1996) and one species is listed on both the Japan Australia and China Australia Migratory Bird Agreements (Greenshank). A breeding colony of Rufous Night heron was identified at this site on one occasion (1986). This wetland has only been sampled twice in December and will require further seasonal sampling to fully understand its value to waterbirds.

Yellilup Lake/Swamp- This wetland supports 40 species of waterbird (Lane *et al.* 1996), placing it in the top 5% of sampled wetlands for species richness. Examples include the Musk Duck and Hoary-headed Grebe. Eight species breed at Yellilup Lake, placing it in the top 10% of sampled wetlands for variety of breeding species. Nine species are listed on the Japan Australia, and eight on the China Australia, Migratory Bird Agreements, ranking the wetland in the top 4.4% of wetlands for variety of these species. It is also in the top 10% for numbers of individual waterbirds of these species e.g.,approximately 1700 waterbirds counted in December 1987, suggesting that this wetland also could be a drought refuge. The wetland contributes to the maintenance of the Freckled Duck in southern Western Australia. This species is in need of protection (Garnett 1992) and is listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct". The wetland is also in the top 1% of wetlands for numbers of White-necked Heron. This wetland requires further sampling, particularly in the cooler months of the year to fully assess its value to waterbirds.

Yendinnup Swamp- This wetland contributes to the maintenance of at least 15 species of waterbird in southern Western Australia, for example Pink-eared Duck. At least one species (Black Swan) breeds there and two species are listed on both the Japan Australia and China Australia Migratory Bird Agreements (Greenshank and Common Sandpiper). The swamp is in

the top 10% of sampled wetlands for median numbers of individual waterbirds. This wetland has only been visited once and requires a full seasonal survey to assess its value.

Kojaneerup Suite--Pillenorup Swamp,Two Mile Lake, Kojaneerup Swamp, Quarderwardup Lake, and Un-named wetlands

Avifauna-limited data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-limited data

The wetlands listed above are representative of the range of wetland types, wetland processes and vegetation assemblages within this suite, and provide important models of sedimentological and hydrological processes associated with their setting at the edge of fringing piedmont deposits. The wetlands also are repositories for clays and sands transported from the nearby range uplands, and for fossil deposits of gypsum precipitated by the saline groundwater. Pillenorup Swamp contrasts with the other wetlands in that it is a discharge basin for freshwater. The wetlands are rimmed by shoreline ridges, the result of sand transport across the wetlands.

This suite, as a whole, contributes to the maintenance of a small number and moderate variety of waterbirds in southern Western Australia, but requires further seasonal sampling to assess its ornithological value.

Kojaneerup Swamp- This wetland contributes to the maintenance of at least 13 species of waterbird for example Pink-eared Duck and Masked Lapwing. At least one species (Pacific Black Duck) breeds there. Three species are listed on both the Japan Australia and China Australia Migratory Bird Agreements. Only three surveys have been conducted on this wetland in August, October and December. Further work including late autumn would help assess its value to waterbirds.

One priority flora species have been located on the lake margins in this suite:

- *Velleia exigua* (P2)

Inlet River Suite

Although palusplains of this type occur in the study area, most have been cleared for agriculture. An outstanding example of this suite occurs on the northern shores of Broke Inlet near Inlet River.

Boronia Road Suite--Deep River--Mt. Soho Flats, Road Flats, Middle Road Flats, Miller's Basin Road Flats, Nornalup Road Flats, Break Road Flats, Watershed Road Flats, Granite Road Flats, Blue Lake, Romance Road Flats and sumplands, Turpin Rd., Hiker Road

Avifauna-limited data
Invertebrates-no data
Fish-no data

The wetlands listed above are representative of wetland types, wetland processes and vegetation assemblages within this suite.

This suite as a whole contributes to the maintenance of a small number and variety of waterbirds in southern Western Australia, including the Dusky Moorhen which is on the Western Australian Fauna Priority List. However, the suite is insufficiently sampled to determine its full ornithological value.

Blue Lake- Also known as Blue Gum Lake, this wetland contributes to the maintenance of at least seven species of waterbird in southern Western Australia, for example Australasian Grebe and Swamp Harrier. It supports Dusky Moorhen which is on the Western Australian Fauna Priority List. The wetland has only been sampled once in December and requires substantial seasonal surveys to further determine its ornithological value.

Boronia Road floodplain- no data.
Harewood Road floodplain- no data.
Millers Basin Road floodplain- no data.

The wetlands are an important refuge and habitat for amphibia. Seven species of avifauna have been recorded from the area: *Crinea georgiana, C. glauerti, Geocrinea leai, Heleioporus inornatus, Litoria adelaidensis, Metacrinea nichollsi* and one previously unidentified and undescribed species (ANCA 1996), which was found at the Mt Soho wetlands.

the possible invertebrate assemblages and diversity present in this suite. The total number of taxa recorded was 23, with Copepoda, Cladocera, Isopoda (Janiridae), Trichoptera, Hemiptera and Coleoptera, representing reasonable diversity. No endemic species were recorded. The wetlands are also habitat for the freshwater crayfish, *Cherax crassimanus*.

Although sampling has been limited, due to inaccessibility, several freshwater fish species have been located in opportunistic field visits (Morgan et al 1996). In a small lake in this suite on Ficifolia Rd the species *Lepidogalaxias salamandroides* was identified, and on the flats adjacent to Romance Rd, two species were present, *Galaxias occidentalis* and *Galaxiella munda* (Morgan et al 1996).

Seventeen priority flora species have been located on the slopes and floodplains in this suite:

- *Verticordia fimbrilepis* (DRF)
- *Cordifex jacksonii, Tetratheca sp. Kent River(P1)*
- *Andersonia auriculata, Amperea protensa, Mitreola minima, Lysinema lasiantha, Alexgeorgea ganopoda* (P2).
- *Boronia virgata, Andersonia amabile, Gonocarpus simplex, G. pusillus, Meeboldina crassipes (formerly Leptocarpus crassipes), Synaphea intricata, Stylidium mimeticum* (P3).
- *Tybastes glaucescens, Baeckea arbuscula* (P4)

Blue lake was one of the sites within this suite visited in the field for this study. The sediment underlying this wetland is peat, showing layers of gravel sized brecciated peat, a feature of peat beds that has not been observed previously in Western Australia, and it is considered to be an important scientific feature useful for unravelling the climatic history of this region. The features of the peat bed make this wetland significant at the National level.

Suez Road Suite--Nornalup Road Flats, Roe Road/Suez Road Flats, Bevan Road Flats, Quindinillup Area, Romance Road Flats, Watershed Road Flats

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

The wetlands listed above are representative of wetland types, wetland processes and vegetation assemblages within this suite.

Quindinillup Suite--Nornalup Road, Suez Road Flats, Quindinillup Flats and sumplands, Cleerillup Road Flats, Watershed Road Flats and sumplands

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

The wetlands listed above are representative of wetland types, wetland processes and vegetation assemblages within this suite.

Although sampling has been limited, due to inaccessibility, several freshwater fish species have been located in opportunistic field visits (Morgan et al 1996). On flats adjacent to Watershed Rd, three species were present, *Galaxias occidentalis, Bostockia porosa* and *Edelia vittata* (Morgan et al 1996).

Unicup Suite--Pardelup Lagoon, Kwornicup Lake, Gills Road Group, Wamballup Swamp, Round Swamp, Martagallup Swamp, Tucker's Road, Randell Road, Tootanellup Lagoon, Perillup Road Reserve, Big Poorarecup Lagoon, Assorted wetlands along Stockyard Road, Worrongerup/Nuniup & Warnerup Swamp

Avifauna-limited data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

The wetlands listed above are representative of a diverse range of wetland types, wetland processes and vegetation assemblages within this suite. Habitat diversity is high because wetland features and characteristics are variable. Examples are listed as follows:

- wetland types include flats, channels, lakes and sumplands
- wetlands range from saline to freshwater and many are poikilohaline
- hydroperiod ranges from areas of near permanent inundation to very short periods of seasonal inundation
- water levels in the basins are highly variable
- sediments and their stratigraphic relationships are variable

This suite as a whole is very important because it contributes to the maintenance of a large number of waterbirds and is particularly important for waterbirds listed on International Treaties. On an international scale, it is very important to the Banded Stilt which is an Australian endemic shorebird.

Kwornicup Lake- This site supports at least 15 species of waterbird of which at least one breeds (Grey Teal) and two are listed on both the Japan Australia and China Australia Migratory Bird Agreements. This wetland is in the top 5% of sampled wetlands for numbers of individual waterbirds and for numbers of individuals listed on International Treaties, and in the top 1% for numbers of Banded Stilt, and Watkins (1993) classified this wetland as internationally important for this species. The wetland also contributes to the maintenance of Hooded Plover populations which are largely concentrated on the south coast of Western Australia; on a national scale, this species is considered rare and in need of protection (Garnett 1992), and

is also listed as vulnerable under the *Commonwealth Endangered Species Act 1992.*

Tootanellup Lagoon (known on Birds Australia data base as Plantagent 22442 = Tootanellup Nature Reserve). This wetland contributes to the maintenance of Spotless Crake in southern Western Australia. It has only been sampled once and requires extensive seasonal sampling to determine its ornithological value.

These wetlands are part of an extended linked wetland system which links floodplains, channels and basins - a wetland network.

Lake Barnes Suite--Lake Barnes, Lake Eyrie

Avifauna-limited data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-limited data

The wetlands listed above are representative of wetland types, wetland processes and vegetation assemblages within this suite. Lake Barnes is particularly interesting in that it features a complete linked wetland system at a small scale: slopes, leptoscale sumplands, leptoscale creek, palusplain, leptoscale delta on the western side of the wetland, and the mesoscale sumpland itself (Lake Barnes). This is an unusual system in this setting and may warrant re-classification as a separate suite with further investigation.

This suite as a whole contributes to the maintenance of a small number and variety of waterbirds in southern Western Australia, but is insufficiently sampled to determine its full ornithological value.

Eyrie Lake- This lake contributes to the maintenance of at least 14 species of waterbird, for example Black-winged Stilt and Australian Shelduck. Three of these species are listed on both the Japan Australia and China Australia Migratory Bird Agreements. At least one species (Grey Teal) breeds there.

Two priority flora species have been located in and around wetlands in this suite:

- *Conostylis misera, Laxmannia jamesii* (DRF)

Mitchell Creek Suite--Mitchell Creek floodplains and basins, Sheepwash Creek floodplains, slopes and basins, Hay River floodplains, slopes and sumplands

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data

The wetlands listed above are representative of wetland types and wetland processes within this suite. Tertiary and Pleistocene colluvial and alluvial sediments are interspersed. The channels (which have not been assessed), the wetland slopes, floodplains and basins form a linked geomorphic, sedimentological, and hydrological system within the broad, shallow gently sloping valleys.

Five priority flora species have been located in and around the creeks in this suite:

- *Laxmannia jamesii* (DRF)
- *Spyridium riparium, Andersonia sp.,*(P1)
- *Eucalyptus virginae*(P2)
- *Billardiera sp.*(P3)

Balgamup--Bellanger Barrier, Peaceful Bay, Pooryonggup, Ratcliffe Barrier

Avifauna-no data
Amphibia-no data
Invertebrates-limited data
Fish-no data
Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite. The largest wetland occurs west of Peaceful Bay, in the Walpole/Nornalup National Park.

Invertebrate fauna sampling was undertaken at Peaceful Bay, and this information is presented here as an indication of the possible invertebrate assemblages and diversity present. The total number of taxa recorded was 13. Two species endemic to the local area were recorded (species of

Janiridae and *Engaewa similis*). This suite is important for rare and restricted invertebrate species.

Overton Suite--William Bay Road Lake (Reserve 12046), Lights Beach Wetland (Lake Williams)

Avifauna-limited data
Invertebrates-limited data
Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite. Within this suite, Lake Williams itself is outstanding.

This suite as a whole contributes to the maintenance of a small number and variety of waterbirds in southern Western Australia, but is insufficiently sampled to determine its full ornithological value.

Denmark Reserve 12046 Lake (on William Bay Road)- This lake contributes to the maintenance of at least 10 species of waterbird in southern Western Australia (e.g. Hoary-headed Grebe and Eurasian Coot) and breeding in at least one species (Purple Swamphen). The wetland has been little sampled, and requires more extensive seasonal sampling to assess its ornithological value.

Lake Williams (Lights Road Wetland just north of Tower Hill). This intermittent wetland is part of the William Bay National Park and contributes to the maintenance of at least six species of waterbird, for example Pacific Black Duck and Eurasian Coot. It has been little sampled and at least one survey occurred when it would have been relatively dry. Further seasonal surveys are required to determine this wetland's value to avifauna.

The wetlands are known to support three species of amphibia: *Litoria moorei, L. adelaidensis* and *Limnodynastes dorsalis.*

Invertebrate fauna sampling was undertaken in Lake Williams, and this information is presented here as an indication of the possible invertebrate assemblages and diversity present. The total number of taxa recorded was 46, with Copepoda, Ostracoda, Amphipoda, Lepidoptera, Isopoda and

Odonata being represented. One species (*Dicrotendipes sp.*) endemic to the south-west was recorded. This suite is important for invertebrate fauna diversity.

Three freshwater fish were found in the lakes. They are: *Bostockia porosa, Edelia vittata, and Pseudogobius olorum.*

One priority flora species has been located in and around wetlands in this suite:

- *Boronia virgata* (P3)

Owingup Swamp--Owingup Swamp

Rare, uncommon or restricted flora-no data

This wetland is the single representative of the wetland suite, and hence is a single representative of the wetland type, wetland processes and vegetation assemblages within this suite. It is a megascale seasonal freshwater wetland area. On size alone it is regionally significant.

The wetland in this suite is recharged by the nutrient rich Kent River, which also flows out of the swamp thus creating a flushing effect. There are several notable features within the basin as well: a riverine delta in the north, and an occurrence of "Algae biscuits", an uncommon formation related to stromatolites, in the northeast (ANCA 1996).

A total of 53 plant species (ANCA 1996) so far has been recorded in the wetland which is extremely high diversity for wetland plants. The sedgelands and aquatic plants exemplify this diversity. There are 8 species of sedges, and 7 species of aquatic plants. Owingup Swamp also supports the largest remaining area of *Agonis juniperina* forest (Robinson 1992).

Owingup Swamp is a very important wetland because it supports high numbers of waterbirds annually (>1,000), has a high species richness, supports a large variety of species listed on International Treaties and is particularly significant for two species of waterbird, one of which is in need of protection. Owingup Swamp, in addition, supports at least 39 species of waterbirds, placing it in the top 5% of wetlands for species richness. Examples of the species occurring there include the Yellow-billed Spoonbill and Black-fronted Dotterel. Eight of the species are known to breed there e.g., Darter, Little Black Cormorant, Spotless Crake and Blue-billed Duck.

Seven species are listed on both the Japan Australia and China Australia Migratory Bird Agreements placing it in the top 4.4% of sites for variety of these species. At least five Australasian Bitterns have been at Owingup Swamp at one time. This is a very secretive species and the highest number recorded for the State was eight. Owingup Swamp is therefore an important strong hold for the Australasian Bittern. This species is in need of protection (Garnett 1992) and is listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct". The wetland is also in the top 1% of sites for numbers of Spotless Crake.

Species of Amphibia also are well represented here. Five species occur including *Crinea georgiana* which is normally not abundant (Jaensch 1993).

The wetland system is relatively rich in macro-invertebrates (45 taxa), including 14 Diptera, and is habitat for crustacea such as Koonac*(Cherax plebejus)* gilgie*(C. quinquecarinatus)*, yabbie*(C. destructor)* and shrimp*(Palaemonaetes australis)*, and for the long-necked tortoise *(Chelodina oblonga).*

Four species (*Limnesia sp., Dicrotendipes sp., Zavrelimyia sp.,* and *Cherax preissii*) endemic to the south-west were recorded. This suite is important for invertebrate populations and supports high diversity.

It has been sugested that Owingup Swamp is a major nursery for freshwater and estuarine fish, e.g., *Atherinosoma wallacei* (Jaensch 1992b, Robinson 1992). 8 fish species have been recorded. They include 3 secondary species including *Afurcagobius suppositus,* 2 species that are endemic to the far south coast of W.A., *Nannatherina balstoni* and *Galaxiella nigrostriata.*

Moates Lake Suite--Moates Lake, Angove Lake, Powell Lake

Invertebrates-no data
Rare, uncommon or restricted flora-limited data

The wetlands listed above are representative of wetland types, wetland processes and vegetation assemblages within this suite. The least disturbed of the three lakes is Moates Lake.

This wetland suite is very important because it supports a large number of waterbirds with high species richness and a great variety of breeding species. It is significant for waterbirds listed on International Treaties. It

supports large numbers of several species of waterbirds including one species in need of protection.

Angove Lake- contributes to the maintenance of at least 17 waterbird species in southern Western Australia, for example Spotless Crake. At least one of these breeds here (Musk Duck). This wetland supports the Australasian Bittern which is in need of protection (Garnett 1992) and is listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct". It also supports the Little Bittern which is on the Western Australian Fauna Priority List. Further seasonal sampling is required to assess the value of this lake to waterbirds.

Moates Lake-This lake supports 30 species of waterbird (e.g. Little Bittern and Royal Spoonbill) and is in the top 7.9% of sampled wetlands for species richness. At least five species breed there and two species are listed on both the Japan Australia and China Australia Migratory Bird Agreements. Moates Lake supports the Australasian Bittern which is in need of protection (Garnett 1992) and listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct". It also supports the Little Bittern which is on the Western Australian Fauna Priority List.

Lake Powell- Also known as Grasmere Lake, this wetland supports 55 species of waterbird. Examples include Chestnut Teal and Little Bittern. This places it in the top 5% of sampled wetlands for species richness. At least 13 species of these birds breed, placing Lake Powell in the top 5% of sampled wetlands for variety of breeding species. Ten species are listed on the Japan Australia and China Australia Migratory Bird Agreements, placing it in the top 4.4% of sampled wetlands for variety of these species. It is also in the top 5% for numbers of individual waterbirds listed on these International Treaties. Lake Powell is in the top 10% of sampled wetlands for numbers of individual waterbirds. The lake is in the top 5% of locations for numbers of Australasian Bittern. This secretive species is in need of protection (Garnett 1992) and is listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct". The lake is in the top 1% of sampled wetlands for the Spotless Crake, Black-fronted Plover and Red-necked Avocet. Watkins (1993) considers it to be internationally important for the Red-necked Avocet. It also supports the Little Bittern which is on the Western Australian Fauna Priority List.

Lake Powell is important habitat for amphibia. Five species are known to occur there, and in reasonably high numbers (Jaensch 1993).

The lakes are habitat for freshwater fish (Morgan et al 1996). Species present are:*Pseudogobius olorum, Galaxias occidentalis, Leptatherina wallacei* and *Gambusia holbrooki.* The creeks discharging into the lakes contain *Galaxias munda, Edelia vittata, Nannatherina balstoni* and *Galaxias truttaceus* in addition to the species found in the lakes. Overall, the system has high diversity and is outstanding habitat for freshwater fish in W.A.

One priority flora species has been located in and around wetlands in this suite:

- *Melaleuca diosmifolia* (P3)

Qualimup Suite--Qualimup Swamp, Toocalup Lake, Tooregullup Swamp, Cardiminup Swamp, Bitter Water Swamp

Avifauna-limited data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

The wetlands listed above are representative of wetland types, wetland processes and vegetation assemblages within this suite. However many of the wetlands in this suite exhibit altered water levels which detracts from their overall value. Based on 1993 photography, the exceptions are Bitter Water Swamp and Tooregullup Swamp.

This suite, as a whole, is probably reasonably important because it contributes to the maintenance of a small number and moderate variety of species of waterbirds. This includes the Chestnut Teal, which is largely restricted to the south east coast of Western Australia. As the suite to date has been very under-sampled, further surveys are likely to reveal other notable ornithological values.

Qualinup Lake- (also known as Qualinup Swamp), contributes to the maintenance of at least 21 species of waterbird in southern Western Australia. Examples include Chestnut Teal and Maned Duck, and the Greenshank. The latter is listed on both the Japan Australia and China Australia Migratory Bird Agreements. As this wetland has only been sampled in December a full series of seasonal surveys may reveal many other ornithological values.

Toocalup Lake - This lake contributes to the maintenance of at least 16 species of waterbird in southern Western Australia. Two of the species, the Greenshank and Wood Sandpiper are listed on both the Japan Australia and China Australia Migratory Bird Agreements. This wetland has only been visited in November and December and requires substantial seasonal sampling to determine its ornithological values.

Yenterup Lake- This lake contributes to the maintenance of at least 16 species of waterbird in southern Western Australia. Examples include Nankeen Night Heron and Grey Teal. This wetland has only been visited once in December and requires substantial seasonal sampling to determine its ornithological values.

Marendiup Suite--Lake Marendiup & surrounds, Warramurrup Swamp & surrounds

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

The wetlands listed above are representative of wetland types, wetland processes and vegetation assemblages within this suite.

Boggy Spring Suite--Boggy Spring wetlands

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite.

Lake William Suite--Lake William

Avifauna-no data
Invertebrates-no data
Rare, uncommon or restricted flora-limited data

The wetlands listed above are representative of wetland types, wetland processes and vegetation assemblages within this suite. Lake William is subject to change in its geometry as a result of sedimentary processes operating. Currently, spits are segmenting the lake basin, with the source of the sand being the surrounding dunes which have been eroded by the lake waters.

There was insufficient data to determine the value of this suite to waterbirds. Lake William contributes to the maintenance of at least one species of waterbird in southern Western Australia (Swamp Harrier). However, it has had only two visits, one in summer, and requires extensive seasonal surveys to determine its ornithological value.

Lake William is not recorded as a habitat for freshwater fish (Jaensch 1992), but does support long-necked tortoise, amphibia (*Litoria adelaidensis* and *Crinea glauerti*) and koonacs.

One priority flora species, a fern, has been located around wetlands in this suite:

- *Schizaea sp.* (P2)

Teasedale Suite--Gum Link Road, Scotsdale, Richmond Road, Quickup River, Quickup River to Hay R.

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data

The wetland listed above are representative of wetland types, wetland processes and vegetation assemblages within this suite.

Ten priority flora species have been located on the slopes in this suite:

- *Spyridium riparium(P1)*

- *Andersonia auriculata, Sollya drummondii, Schizaea rupestris, Alexgeorgea ganopoda* (P2).
- *Boronia virgata, Meeboldina crassipes (formerly Leptocarpus crassipes), M. thysanantha, Stylidium mimeticum, S. leeuwinense* (P3).

Blue Lagoon Suite--Blue Lagoon and all associated wetlands

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

These wetlands noted above are representative of wetland types, wetland processes and vegetation assemblages within this suite. As a result of dune encroachment, the wetlands exhibit stages of development, from incipient wetlands with no vegetation cover (deflation basins) to lakes with peripheral and mosaic vegetation cover; and gradation of wetland decline from lakes with large open water areas, to sumplands with islands, to damplands, to infilled depressions. The wetlands thus comprise outstanding areas for wetland scientific study of some of the types of evolutionary processes and vegetative successions therein. They also are an outstanding area for illustrating the range of wetland habitats typical of this coastal setting.

Warrup Suite--Warrup group

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data
Geomorphic/landscape values-no data

The wetlands listed above are the only two representatives of types resulting from the interaction between wetland and sedimentological processes within this setting.

Malimup Suite--Walpole/Nornalup National Park

Avifauna-no data
Amphibia-no data
Invertebrates-limited data
Fish-no data
Rare, uncommon or restricted flora-limited data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite.

The wetlands provide a contrasting habitat to their surrounds, and also, importantly, freshwater to fauna in the region.

Invertebrate fauna sampling was undertaken at Conspicuous Cliffs, and this information is presented here as an indication of the possible invertebrate assemblages and diversity present. The total number of taxa recorded was 19. Three species of oligochaetes(2 *Phreodrilidae, Insulodrilus sp.*, as well as *Cherax preissii, Dicrotendipes sp.*) endemic to the south-west were recorded, and 3 species of oligochaetes endemic to the local area were recorded. This suite is important for rare and restricted invertebrate species.

One priority flora species has been located on the slopes in this suite:
- *Gahnia sclerioides* (P3).

Gardner Lake Dune Suite--Gardner Lake Dunes

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-limited data

These wetlands listed above are the single representatives of rare and outstanding wetland types, their processes and vegetation assemblages. They are unique, in that they are an example of a series of well preserved and vegetated wetlands in the bowls of nested parabolic dunes. Not only is the dune landform type unusual, but the preservation of the resultant wetlands has not occurred elsewhere in this or any other study areas, so far

One priority flora species have been located in wetlands in this suite:

- *Diuris heberlei(P1)*

This species is restricted to this suite.

King River Suite--King River Flats, Marbellup Flats, Johnston Creek, Seven Mile Creek, Mill Brook, Copper Mines Creek

Avifauna-limited data
Amphibia-no data
Invertebrates-no data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite.

This suite, as a whole, is very important because it supports a moderate variety of waterbirds in large numbers over much of the year and is an important dry season refuge. It is also important to waterbirds listed on International Treaties, particularly the Great Knot.

King River (near the mouth)- Contributes to the maintenance of at least 26 species of waterbird in southern Western Australia, for example Eastern Curlew and Pied Oystercatcher. At least one of these species (Osprey) breeds there. Seven of these species are listed on both the Japan Australia and China Australia Migratory Bird Agreements, placing the site in the top 4.4% of sampled wetlands for variety in these species. The site is in the top 1% of sampled wetlands for numbers of Great Knot. The site is also in the top 10% of sites for the median numbers of individual waterbirds and for numbers of individual waterbirds listed on either the Japan Australia or China Australia Migratory Bird Agreements. This information is based on only one survey in March 1988 and incidental sightings in winter/early spring. Further seasonal surveys are needed to more fully evaluate its ornithological values. In particular, this wetland is likely to be a refuge for waterbirds during the dry season when many other wetlands dry up.

Mill Brook south-west (Shire of Albany). Contributes to the maintenance of the Spotless Crake in south west Western Australia, which has been found in reasonable numbers at this swamp. This wetland is very under-sampled and further surveys are likely to unveil other ornithological values.

Sampling for freshwater fish occurred at several sites along King River, Mill Brook and Marbelup Brook. Four species were documented *Galaxiella munda, Edelia vittata, Galaxias occidentalis, Bostockia porosa* (Morgan et al 199x) which is reasonable diversity.

Four priority flora species have been located on the floodplains in this suite:

- *Baeckea arbuscula(DRF)*
- *Schoenus multiglumis(P1)*
- *Boronia crassipes, Lysinema lasianthum* (P2).

Menamup Suite--Menamup Inlet

Avifauna-limited data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

This wetland is the single representative of this wetland type, its processes and vegetation assemblages. It is particularly important as a feature associated with Wilson Inlet, in that estuarine processes have segmented this basin from the main Inlet, altering its water salinity.

The Menamup Inlet, (also known as Nenamup Inlet Lake), contributes to the maintenance of at least 18 species of waterbird, for example Yellow-billed Spoonbill and Straw-necked Ibis. At least one species breeds there (Black Swan) and at least three species are listed on both the Japan Australia and China Australia Migratory Bird Agreements. This wetland has only been sampled five times. Although it has reasonable seasonal coverage, further sampling will better reflect its ornithological value.

Gull Rock Lake Suite--Gull Rock Lake, Ledge Point Wetland

Avifauna-limited data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite. Ledge Point wetland has internal linear ridge-swale development normal to the coast. This feature is relic from the stage when Ledge Point wetland was an active estuary, and these ridges and swales are an example of a tidally dominated estuarine system.

This suite, as a whole, is reasonably important because it contributes to the maintenance of a small number and moderate variety of waterbirds in southern Western Australia.

Gull Rock Lake- Gull Rock Lake contributes to the maintenance of at least 19 species of waterbird of which two are listed on both the Japan Australia, and China Australia, Migratory Bird Agreements (Great Egret and Caspian Tern). It supports the Dusky Moorhen which is on the Western Australian Fauna Priority List.

Ledge Point wetland- no data.

One priority flora species have been located in this suite:
- *Melaleuca diosmifolia* (P3).

Gladhow Suite--Gladhow

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite.

Tillerup Flat Suite

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

These wetland flats have been cleared, therefore no description of wetland values has been undertaken.

Lake Seppings Suite--Lake Seppings

Avifauna-limited data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

Lake Seppings is the single representative of an estuary which formed parallel to its coastal barrier rather than normal to it, thus making it an important representative of wetland types and processes. Fluvial and tidal processes both effect the system and have resulted in a diverse range of habitats: the lake, sumplands, beach ridges and tidal wetlands (Le Provost Semeniuk & Chalmer 198x). Sedimentological processes have also been variable and have resulted in a number of different sediment and substrate types within the system which effect habitat diversity; these include saprolite (weathered granite and gneiss), colluvial soils from erosion of valley sides, alluvial soils from river transport and deposition, sands from degraded dunes, peats, and on their seaward margin, shell beds and gravel.

The Lake Seppings Suite supports a moderate number (23 species) of waterbirds. At least three species breed there (e.g. Blue-billed Duck and Buff-banded Rail). One is listed on both the Japan Australia and China Australia Migratory Bird Agreements. The lake supports the Australasian Bittern which is in need of protection (Garnett 1992). The Australasian Bittern is listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct". It also supports breeding in the Dusky Moorhen which is on the Western Australian Fauna Priority List. Further sampling is required particularly in spring.

Gardner Lake Suite--Gardner Lake

Amphibia-no data
Invertebrates-no data
Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite.

This wetland suite is very important because it is significant in the maintenance of a large range of species including many migratory waterbirds listed on International Treaties, and is habitat for two species in need of protection. The lake supports 38 species of waterbird placing it in the top 7.9% of wetlands for species richness. Examples include Musk Duck and Blue-billed Duck. At least three species breed there. Six are listed on both the Japan Australia and China Australia Migratory Bird Agreements, placing the lake in the top 4.4% of sampled wetlands for variety of these species. It is in the top 10% of wetlands for numbers of individuals of these species. The Lake supports Australasian Bittern and Fairy Terns. These species are in need of protection (Garnett 1992). The Australasian Bittern is also listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct".

Gardner Lake is habitat for three freshwater fish species (Morgan et al 1996): *Galaxias occidentalis, Pseudogobius olorum,* and *Leptatherina wallacei.*

Lake Saide--Lake Saide

Invertebrates-no data
Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite.

Lake Saide is very important as it has a high species richness and is significant for waterbirds listed on International Treaties. This wetland supports 35 species of waterbird, for example the Little Bittern and Greenshank. It is thus in the top 7.9% of sampled wetlands in terms of species richness. Seven species breed there. Three species are listed on

both the Japan Australia and China Australia Migratory Bird Agreements, placing it in the top 4.4% of sampled wetlands for variety in these species. It also ranks in the top 10% for numbers of individual waterbirds listed on these International Treaties. The lake contributes to the maintenance of Australasian Bittern populations. The Australasian Bittern is in need of protection (Garnett 1992) and listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct".

Lake Saide is also habitat for Amphibia. Four species occur there and in reasonable numbers (Jaensch 1993).

Lake Saide is habitat for five freshwater fish species (Morgan et al 199x):*Galaxias occidentalis,Edelia Vittata, Leptatherina wallacei, Pseudogobius olorum* and *Gambusia holbrooki*. This is reasonable species richness.

Goode Beach Suite--Goode Beach wetland, Quaranup Rd

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-limited data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite

One priority flora species have been located in this suite:

- *Schoenus acuminatus* (P2).

Boat Harbour Suite--Boat Harbour Lakes

Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite. The wetlands appear to be the result of what was once a larger wetland, (comparative to Owingup Swamp) segregated by dune encroachment. As such, they are linked to Owingup Swamp in terms of natural history and wetland evolution.

Totals of 16, 18, and 43 plant species (ANCA 1996) have been recorded in the Lakes A, B, and C, respectively, which is high diversity for wetland plants. The sedges in the suite exemplify this diversity: there are 12 species of sedges (Robinson 1992).

This suite is very important because it has a high species richness, and is significant to waterbirds listed on International Treaties.

Boat Harbour Lakes A, B, C together support 34 species of waterbird, placing them in the top 7.9% of sampled wetlands for species richness. At least two species breed there (Clamorous Reed-Warbler and Purple Swamphen). Five species are listed on the Japan Australia and China Australia Migratory Bird Agreements, placing the suite in the top 4.4% of sampled wetlands for this category. They are also in the top 5% for individual numbers of these species. The Lakes are in the top 5% for numbers of Australasian Bittern. The Australasian Bittern is in need of protection (Garnett 1992) and is listed under the *Wildlife Conservation Act 1950* as "fauna which is rare or likely to become extinct".

Four species of amphibia are found here also. They are *Litoria moorei, L. adelaidensis, Crinea glauerti,* and *Limnodynastes dorsalis.* Both numbers and species diversity are reasonable. The wetlands are also important breeding habitat.

The system is relatively rich in macroinvertebrates (72 taxa), including 27 Diptera. Diatoms, ostracods and copepods are also important. It is also habitat for crustacea such as Koonac *(Cherax plebejus),* gilgie *(C. quinquecarinatus),* yabbie *(C. destructor)* and shrimp *(Palaemonaetes australis),* and for the long-necked tortoise *(Chelodina oblonga)*(ANCA 1996).

There are six fish species including *Galaxias maculatus, G. occidentalis, Edelia vittata, Bostockia porosa, Pseudogobius olorum* and a species that is endemic to the far south coast of W.A., *Nannatherina balstoni* (Jaensch 1992, ANCA 1996). This is high species richness.

One priority flora species have been located in this suite:

- *Diuris drummondii* (DRF).

Wilson Inlet ridge/swale suite

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types, wetland processes and vegetation assemblages within this suite.

Reef Dune Suite--Reef Beach, Foster Beach, Moates Lake

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

These wetlands are representative of wetland types and wetland processes within this suite. They are ephemeral wetlands at present, but some will develop into vegetated wetlands and some will be infilled by aeolian processes.

Meerup Suite--Reef Beach, Bellanger Beach

Avifauna-no data
Amphibia-no data
Invertebrates-no data
Fish-no data
Rare, uncommon or restricted flora-no data

These wetlands are representative of this wetland type. These wetland basins occur in the hollows between chaots on the beach shore, are underlain by calcareous sand, and are probably freshwater, although their hydroperiod and water levels would be affected by tidal fluctuations. Located in such a dynamic environment, they are likely to be of very recent age and undergoing rapid change, therefore they are excellent examples of wetland processes and evolution.

Wetlands which embody the values described above have been selected from each suite, and are listed in the Table below. These wetlands are classed as regionally significant within each of the wetland regions described in Section 2. Some may be outstanding at a Statewide, National or International level and these will be listed in Section 8 of the report.

Table 1: Location of suite, and types of wetlands contained within

Suite	Map Sheet	Longitude	Latitude	Wetlands within suite
Frenchman Bay Suite	Albany	117°55′	35°06′	Paluslopes on granite
Mt Bland Lake Suite	Bremer	119°29′	34°11′	Mt Bland Lake
Coyanarup Suite	Borden	118°06′	34°24′	Coyanarup Bogs
Cleerillup Suite	Denmark	117°12′	34°37′	Cleerillup Creek
Pallinup Suite	Deep River	116°54′	34°42′	Lake Surprise
	Tambellup			Geriberiwelup Swamp
	Mt. Barker	117°49′	34°35′	Kalmerndyip Lake
	Mt. Barker	117°56′	34°37′	Bolganup Creek Lake
Swan Lake Suite	Manypeaks	117°28′	34°43′	Swan Lake
	Manypeaks	117°28′	34°34′	Mirambeen Lake
	Manypeaks	117°26′	34°45′	Wangerup Creek Sump
	Bremer	119°26′	34°21′	Hunter River Lake
	Hood Point			Charles Baty Lake
	Bremer	119°29′	34°18′	Kelly's Creek Lake
	Manypeaks	118°23′	34°50′	Cheyne Road C
Fitzgerald Inlet Suite	Cocanarup	119°34′	34°04′	Fitzgerald Inlet
Walpole River Suite	Deep River	116°44′30"	34°59′	Collier Creek
	Deep River	116°46′	34°57′	NE Walpole
	Deep River	116°44′30"	34°58′	Palusmont
	Deep River	116°51′	34°58′	Bonhall Creek
	Deep River	116°57′30"	34°55′	Tributary to Bow River
Bevan Road Suite	Deep River	116°54′	34°37′	Bevan Rd/Roe Rd Sumplands
Corimup Suite	Manypeaks	118°09′	34°45-48′	Lake Corimup
	Manypeaks	118°09′	34°46′	White Lake
	Manypeaks	118°11′	34°45′30"	North Sister Lake
	Manypeaks	118°09′	34°47′	South Sister Lake
	Manypeaks	118°12′	34°46′45"	Tarnup Lake
	Manypeaks	118°12	34°47′	Pfeiffer Lake
	Manypeaks	118°11′	34°49′	Mt. Pleasant View
Manypeaks Suite	Manypeaks	118°18.5′	34°45′	Sunday Swamp
	Manypeaks	118°24′	34°34.5′	Galli Swamps
	Manypeaks	118°21	34°34.5′	Swamp
	Manypeaks	118°20	34°35′	Swamp
	Manypeaks	118°07′	34°44′	Warburton Road
	Manypeaks	118°12′	34°44.5′	No. 1 Swamp
	Manypeaks	118°04′	34°47′	Mindinyup Road
	Manypeaks	118°13′	34°32′	Chillimup Road ~ 1
	Manypeaks	118°24′	34°35′	Chillimup Road
	Manypeaks	118°21′	34°34.5′	Chillimup Road
	Manypeaks	118°26.5′	34°34.5′	Chillimup Road ~4
	Manypeaks	118°28′	34°34.5′	Chillimup Road ~ 5
	Cheyne	118°32′	34°33′	Marralong
	Manypeaks	118°04′	34°34.5′	
	Manypeaks	118°06.5′	34°36.5′	
	Manypeaks	118°11′	34°36′	Pfeiffer Road
	Manypeaks	118°13′	34°34′	Stirling Road

	Manypeaks	118°26.5′	34°34.5′	Chillimup Road
	Manypeaks	118°28′	34°34.5′	Chillimup Road
	Cheyne	118°32′	34°33′	Marralong
	Manypeaks	118°04′	34°34.5′	
	Manypeaks	118°06.5′	34°36.5′	
	Manypeaks	118°11′	34°36′	Pfeiffer Road
	Manypeaks	118°13′	34°34′	Stirling Road
	Manypeaks	118°13-14′	34°35′	Stirling Road
	Manypeaks	118°17′	34°35′	Kojaneerup Road
	Manypeaks	118°19.5′	34°35′	Landing Ground
	Manypeaks	118°23′	34°36.5′	Kulyallin
	Manypeaks	118°08′	34°38′	Bloxidge
	Manypeaks	118°19	34°37′	Kojaneerup
	Manypeaks	118°21′	34°38.5′	Hassell Road
	Cheyne	118°37′	34°35′	Mettler
	Cheyne	118°32′	34°39′	Venns Road
	Manypeaks	118°19′	34°42′	Drawbin Road
	Manypeaks	118°14-15′	34°41.5′	
	Manypeaks	118°30′	34°43′	Wanniup Road
	Manypeaks	118°07′	34°44′	Warburton
	Manypeaks	118°13′	34°45′	Pfeiffer Road No. 1 Swamp
	Manypeaks	118°6-12′	34°46-48′	Corimup Road
	Manypeaks	118°17.5′	34°49′	Cheyne D.
	Manypeaks	118°04′	34°47′	Mindijup
	Bremer	119°12′	34°13′	Murrundie
	Bremer	119°25′	34°11′	Collets Rd
	Bremer	119°22′	34°14′	Gardner Rd
	Bremer	119°28′	34°16′	North Gordon Inlet
	Bremer	119°08′	34°19′	Minvalara N.
	Bremer	119°24′	34°19′	Un-named wetland
	Bremer	119°25′	34°19′	Pullitup Swamp
	Bremer	119°08′	34°21′	Minvalara SS
Manypeaks Suite	Bremer	119°06′	34°22′	Yendinnup Swamp
	Bremer	119°14-16′	34°22′	Mardetta Group
Pabelup Suite	Bremer	119°24′	34°06′	Pabelup Lake 1
	Bremer	119°25′	34°07′	Pabelup Lake 2
	Bremer	119°25′	34°08′	Pabelup Lake 3
	Bremer	119°22′	34°13′	Gairdner Rd wetland
	Bremer	119°01′	34°19′	Yellilup Lake
	Bremer	119°03′	34°18′	Aralinga
	Bremer	119°09′	34°20′	Minvalara
	Bremer	119°06′	34°22′	Yendinnup
	Bremer	119°12′	34°23′	Lake Torrup
Kojaneerup Suite	Borden	118°16′	34°30′	Two Mile Lake
		118°21′	34°26′	Kojaneerup Swamp
		118°20′	34°27′	Quarderwardup Lake
		118°22′	34°25′	Un-named wetland
		118°29′	34°21′	Un-named wetland
		118°29′	34°22′	Un-named wetland
Boronia Road Suite	Deep River	16°57′	34°49′	Mt. Soho Flats
	Deep River	116°51′ & 55′	34°53′	Flats
	Deep River	116°56′	34°53′	Middle Road Flats

	Deep River	116°53′	34°34′	Turpin Road Flats
78	Deep River	116°50′	34°35′	Hiker Road Flats
	Denmark	117°02′	34°46′	Miller's Basin Road Flats
	Denmark	117°02′	34°50′	Nornalup Road Flats
	Denmark	117°11′	34°51′	Break Road Flats
	Denmark	117°09′	34°44′	Watershed Road Flats
	Denmark	117°14′	34°46′	Granite Road Flats
	Denmark	117°16′	34°46′	Blue Lake
	Denmark	117°05′	34°50′	Romance Road Flats and sumplands
Suez Road Suite	Deep River	116°59′	34°45′	Nornalup Road Flats
	Denmark	117°01′	34°44′	Roe Road/Suez Road Flats
	Denmark	117°07′	34°41′	Bevan Road Flats
	Denmark	117°10′	34°42′	Quindinillup Area
	Denmark	117°04′-06′	34°47′	Romance Road Flats
	Denmark	117°11′	34°49′	Watershed Road Flats
Quindinillup Suite	Deep River	116°59′	34°40′	Nornalup Road
	Denmark	117°03′	34°42′	Suez Road Flats
	Denmark	117°09′	34°42′	Quindinillup Flats and sumplands
	Denmark	117°11′	34°36′	Cleerillup Road Flats
	Denmark	117°09′	34°47′	Watershed Road Flats and sumplands
Unicup Suite	Denmark	117°22′	34°36′	Pardelup Lagoon
	Denmark	117°25′	34°33′	Kwornicup Lake
	Denmark	117°26′-27′	34°34′	Gills Road Group
	Denmark	117°27′	34°31′	Wamballup Swamp
	Tambellup	117°32′	34°24′	Round Swamp
	Tambellup	117°31′	34°28′	Martagallup Swamp
	Frankland	117°16′	34°34′	Tucker's Road
	Frankland	117°11′-12′	34°34′	Randell Road
	Frankland	117°09′	34°29′	Tootanellup Lagoon
	Frankland	117°07′	34°29′	Perillup Road Reserve
	Frankland	117°13′	34°24′	Big Poorarecup Lagoon
	Frankland	117°21′	34°23′	Assorted wetlands along Stockyard Road
	Frankland	117°24′	34°24′	Worrongerup/Nuniup & Warnerup Swamp
Lake Barnes Suite	Mt. Barker	117°39′	34°44′	Lake Barnes
	Mt. Barker	117°38′	34°47′	Lake Eyrie
Mitchell Creek Suite	Denmark	117°22′	34°50′	Mitchell Creek
	Mt. Barker	117°31′	34°48′	Sheepwash Creek
	Mt. Barker	117°28′	34°50′	Hay River
Balgamup	Deep River	116°44′	34°59′	Bellanger Barrier
	Rame Head	116°54′	35°02′	Peaceful Bay
	Rame Head	116°56′	35°02′	Peaceful Bay
	Rame Head	116°52′	35°02′	Peaceful Bay
	Denmark	117°19′	35°01′	Pooryonggup
	Denmark	117°23′	35°01′	Ratcliffe Barrier
Overton Suite	Denmark	117°13.5′	35°00′	William Bay Road Lake
172	Denmark	117°16′	35°01′	Lights Beach Wetlands including Lake Williams

Missing Gnowangerup Suite & Quaranup suite

	Bremer	119°20′	34°25′	Cardiminup Swamp
	Bremer	119°19′	34°26′	Bitter Water Swamp
	Bremer	119°29′	34°19′	Tooregullup Swamp
Marendiup Suite	Bremer	119°11′	34°25′	Lake Marendiup & surrounds
	Bremer	119°10′	34°25′	Warramurrup Swamp & surrounds
Boggy Spring Suite	Bremer	119°14′	34°25′	Boggy Spring wetlands
Lake William Suite	Mt. Barker	117°36′	35°05′	Lake William
Teasedale Suite	Denmark	117°01′	34°54′	Gum Link Road
	Denmark	117°14′	34°55′	Scotsdale
	Denmark	117°15′	34°53′	Richmond Road
	Denmark	117°24′	34°52′	Quickup River
	Denmark	117°26′	34°56′	Quickup River to Hay R.
Blue Lagoon Suite	Bremer	119°13′	34°27′	Blue Lagoon and associated wetlands
Warrup Suite	Manypeaks	118°29′	34°44′	Warrup group
Malimup Suite	Rame Head	116°51′	35°02′	Walpole/Nornalup NP
Gardner Lake Dune Suite	Manypeaks	118°07′	34°59′	Gardner Lake Dunes
King River Suite	Mt. Barker	117°51′	34°54′	King River Flats ✓
	Mt. Barker	117°44′	34°58′	Marbellup Flats ✓
	Mt. Barker	117°58′	34°56′	Johnston Creek ✓
	Mt. Barker	117°47′	35°00′	Seven Mile Creek ✓
	Mt. Barker	117°51′	34°53′	Mill Brook ✓
	Hood Point	119°36′	34°02′	Copper Mines Creek
Menamup Suite	Parry Inlet	117°29′	35°01′	Menamup Inlet
Gull Rock Lake Suite	Mt. Barker	118°00′	35°00′	Gull Rock Lake
	Breaksea	118°00′	35°01′	Ledge Point Wetland
Tillerup Flat Suite	DenmarkMt. Barker			no wetlands identified
Gladhow Suite	Mt. Barker	117°50′	35°01′	Gladhow ✓
Lake Seppings Suite	Mt. Barker	117°55′	35°01′	Lake Seppings ✓
Gardner Lake Suite	Manypeaks	118°09′	34°58′	Gardner Lake
Lake Saide	Parry Inlet	117°28′	35°02′	Lake Saide
Goode Beach Suite	Albany	117°56′	35°05′	Goode Beach wetland
	Albany	117°56′	35°05′	Quaranup Rd
	Albany	117°56′	35°05′	Quaranup Rd
Boat Harbour Suite	Denmark	117°05′	35°01′	Boat Harbour Lakes
Wilson Inlet ridge/swale suite D31	Denmark	117°29′	34°29′ 59	Wilson Inlet
Reef Dune Suite	Bremer	119°06′	34°22′	Reef Beach
	Bremer	119°12′	34°27′	Foster Beach
	Manypeaks	118°51′	34°58′	Moates Lake
Meerup Suite	Bremer	119°06′	34°28′	Reef Beach
	Rame Head	116°46′	35°01′	Bellanger Beach

152 205 155

144 + 58

7.0 WETLANDS AT RISK

7.1 Management categories

Most of the wetlands listed in Table I as being regionally significant, could be assigned to the Conservation management category (Hill et al 1996). In most areas, these wetlands are already in reserves or are presently buffered by areas of natural vegetation. Owingup Swamp is one exception to this, and urgently requires protection of its outstanding wetland values. Other exceptions are those wetlands which are presently classed as Resource Enhancement. Their specific management requirements range from re-vegetation and water quality control, to administrative decision and policy making, to consciousness raising through education of the public and government agencies as to their importance. The relevant wetlands with recommended management procedures are tabled below:

Table II

Wetland	Management Requirement
Owingup Swamp	Recognition of outstanding conservation values Definition of wetland boundary Recognition of linked wetland systems with Boat Harbour Lakes and Kent River Re-vegetation of cleared wetland area Buffer zone to northern boundary
Corimup Suite	Recognition of conservation values Definition of wetland boundaries Recognition of linked wetland system Buffer zone around system
Lake Barnes & Lake Eyrie	Recognition of conservation values Definition of wetland boundaries Recognition of linked wetland system Re-vegetation Water quality improvement
William Bay Rd Reserve 12046	Water quality improvement
Qualinup Swamp	Recognition of conservation values Water quality improvement
Marbellup Cr & King River	Recognition of conservation values Re-vegetation of floodplain
Goodga River & Angove River	Recognition of conservation values Re-vegetation of channel & floodplain

	Inclusion into conservation reserve
Powell Lake	Decision as to whether this wetland is a conservation reserve or a sewage and/or water retention and drainage basin Appropriate management for functions and values of the lake
Lake Seppings	Recognition of conservation values Definition of wetland system boundary Recognition of linked wetland system Cessation of encroachment into wetland area
Lake Saide	Recognition of conservation values Delineation of conservation zone within wetland Re-vegetation of part of wetland Retro-fitting of drains to protect conservation zone

7.2 Risks to wetland values

There are many anthropogenic effects which can alter, modify or degrade wetland systems. They have been the focus of numerous management strategies and are reasonably well documented and understood. They range in scale from regional effects such as groundwater extraction to local effects such as creek siltation or the dumping of rubbish.

However, in spite of a broadscale recognition of the types of deleterious effects, that take place in wetlands, both by the community and by professionals, there remains very little understanding of the chain of effects which may occur, or of time scales of these impacts. There is even less understanding of how these impacts may be stopped or reversed. It is therefore crucial that outstanding wetlands such as those identified in this report, should be managed in such a way that the **entire** system and the processes which maintain it are protected. This will require much more detailed investigation of the regional context, the site and perhaps comparable sites, than can be attempted in this report. This kind of protection requires commitment of time, and resources, and is ideal for co-operative projects between scientists, managers and the community.

Even during this short study, it was possible to recognise some practises which continue to occur and which continue to create management problems. These are broadly described below and related, where relevant, to specific wetlands or wetland suites.

Lack of recognition of the wetland itself: There are some wetland types which managers and the community are unable to recognise. These wetlands, therefore, are at worst, at risk of being cleared, and at best, at risk of inappropriate land management. Failure to recognise wetlands has resulted in loss of wetland and habitat diversity, and demands for re-patriation, re-habilitation or compensation, rather than in wise use of the wetland in the overall scheme of rural or urban land use. In this region, the wetlands at risk are:

- palusplains
- paluslopes, and
- wetlands in mobile parabolic dunes or mobile sand sheets.

The suites containing these wetlands in this region are:

1. Tillerup Flat Suite
2. Walpole Suite
3. Teasedale Suite
4. Frenchman Bay Suite
5. Balgamup Suite
6. Malimup Suite
7. Gardner River Dune Suite
8. Reef Dune Suite
9. Meerup Suite

Lack of recognition of wetland boundary: This is a major and ongoing problem for community, managers, engineers and some professionals. Not only does the problem occur on private property, but also on public open space, conservation reserves and planning reserves. Three examples of wetland encroachment on planning reserves are the road through the southern part of the wetland on Chillinup Rd (118°4'E, 34°32'S), the sewage plant at Lake Seppings, and the railway and roads through Marbelup Brook floodplain. An example of wetland encroachment into a reserve is Owingup Swamp, and examples of encroachment of wetlands on private property are in the Gladhow Suite and Lake Saide. Some of these examples are historic, but some, such as Lake Seppings, are recent.

Lack of recognition of linked wetland systems and wetland catchment: This is the cause of numerous deleterious wetland impacts, particularly water level changes, changes to water salinity, the enrichment of water by

nutrients and the associated plethora of problems, the increase in siltation in some wetlands, aquatic weed invasion, loss of biodiversity of aquatic fauna, loss of habitat diversity, and more. Common examples are found in conservation reserves where the wetland basin (usually a lake) is in the reserve, but the channels flowing into it are outside. Moates Lake, Goodga River, Black Cat Creek, and Angove Lake, Angove River are two examples. Wetland Suites in this region which contain linked wetland systems are:

1. Mt Bland Lake Suite
2. Swan Lake Suite
3. Pabelup Suite
4. Boronia Rd Suite
5. Suez Rd Suite
6. Quindinillup Suite
7. Unicup Suite
8. Lake Barnes Suite
9. Mitchell Creek Suite
10. Blue lagoon Suite
11. Lake William Suite
12. King River Suite
13. Gull Rock Lake Suite
14. Lake Seppings Suite
15. Owingup Swamp Suite

WL

Wetlands in areas of groundwater rise: Wetlands effected by groundwater rise are in essence a specific example of linked wetland systems, in that all the wetlands are hydrologically linked to each other through the lateral and vertical movement of regional groundwater. Groundwater, rising to intersect the surface, also compounds this linkage by establishing surface water flow paths between the wetlands. An example is the Unicup Suite, which now comprises wetland basins surrounded by wide shallow floodplains, developed as a result of surface inundation (by groundwater) of low lying areas. The groundwater has been rising regionally (Ferdowsian 1997), for some period and is predicted to continue at a similar rate. Low lying areas considered to be at risk, have been mapped. Risks associated with regional groundwater rise are 1) death of vegetation due to prolonged waterlogging, and 2) death of vegetation due to dissolution and precipitation of salts.

In this situation, and particularly for the example of the Unicup Suite, it is important to know what the underlying sediments and stratigraphic

relationships are in order to determine the extent of the linkage between each wetland and the groundwater. In this type of terrain, the sediments are variable and in some cases, wetlands may not be linked to a regional groundwater system. Rather, there may a number of alternative mechanisms operating. For instance, there may be a local surface aquifer that maintains the wetland by ponding precipitationr; there may be lateral flow along a subsurface aquifer which discharges into a local area; there may be colluvial material which is nearer the surface than the regional groundwater, and which is thick enough to contain sufficient groundwater to maintain a dampland; or there may be local depressions in the landform surface which over time have developed soils which retard drainage sufficiently to support seasonal waterlogging. In areas of groundwater rise, it must first be established that the wetland requiring management is indeed maintained by this process. If this is the case, and water levels are rising, then, the extent of the area over which this mechanism is operating must be defined for each wetland, and the surface area will require re-vegetation.

Wetland suites which could potentially be affected by groundwater rise are:

1. Gladhow Suite ✓
2. Marendiup Suite ✓
3. Boggy Spring Suite ✓
4. Qualinup Suite ✓
5. Manypeaks Suite ✓
6. Unicup Suite ✓
7. Pabelup Suite ✓
8. Corimup Suite ✓
9. Lake Barnes Suite ✓

Inadequate and inappropriate buffer zones: Buffer zones around wetlands are often the most efficient and sometimes the only way of protecting a wetland and its processes. Therefore, it is highly desirable that the wetland buffer be appropriately placed and be of sufficient width. In many examples of wetlands in the study area, buffer areas are designed to match cadastral boundaries, such as property boundaries, fences or roads, with adverse results (such as partly destoyed wetlands), or continuing degradation. Buffer zones must take into account linked wetland systems. For example, a wetland flat or basin discharge area for water from wet slopes is often buffered in such a way that excludes the slopes which are having direct sedimentological and hydrological input into the system. Examples of sites which require buffer zones which take account of the

geomorphology, are those in dune terrain, undulating plains, and undulating plateau. The relevant wetland suites that are affected by, or could be affected by inadequate buffers are:

1. Unicup Suite
2. Manypeaks Suite
3. Pabelup Suite
4. Corimup Suite
5. Boggy Spring Suite
6. Marendiup Suite
7. Walpole Suite
8. Boat Harbour Suite
9. Gladhow Suite
10. Coyanarup Suite
11. Pallinup Suite
12. Bevan Rd Suite
13. Quindinillup Suite
14. Lake Barnes Suite
15. Moates Lake Suite
16. Blue Lagoon Suite
17. Bangamup Suite
18. Malimup Suite

8.0 OUTSTANDING WETLANDS

Although the data base on wetland values in this report is incomplete and selective, it is possible to identify some of the wetlands which have recognisable outstanding values. However, it is probably premature to define the level of significance to which they belong. In many instances, a single wetland function, process or feature may be the rationale for assigning high value to a particular wetland. Examples are Blue Lake (stratigraphy), Gull Rock Lake (geomorphology), Mt. Bland Lake (geomorphology). In other instances, there are many attributes contributing to high wetland value e.g., Owingup Swamp (size, avifauna use, presence of algal-sedimentary structures, presence of fluvial delta, vegetation diversity) and Blue Lagoon Suite (wetland type, setting, evolution, wetland processes and gradation, habitat diversity).

A list of outstanding wetlnad in this study area, with their nominated features is provided below:

- Frenchman Bay-type, processes
- Mt Bland Lake Suite-geomorphology
- Coyanarup Suite-wetland type, flora
- Fitzgerald Inlet-geomorphology, fish, aquatic habitat
- Corimup Suite-wetland type, size, natural history, landscape, refuge
- Pabelup Suite-wetland type, habitat, linked system, water source
- Boronia Rd Suite-amphibia, Blue Lake stratigraphy, lack of disturbance
- Unicup Suite-wetland types, processes, habitat diversity
- Blue Lagoon Suite-wetland type, setting, evolution, wetland processes and gradation, habitat diversity
- Swan Lake Suite -wetland type, habitat, evolutionary processes
- Gardiner Lake Dune Suite-wetland type, processes, habitat,
- Gull Rock Lake Suite-geomorphology
- Goode Beach Suite-setting, processes
- Owingup Swamp Suite-size, avifauna, habitats, vegetation diversity, organo-sedimentary features, fluvial delta, linked system
- Boat Harbour Lakes Suite-avifauna, fish, habitats, vegetation diversity, linked system

It is highly recommended that areas in which several outstanding wetlands occur, be added to the national conservation estate. This proposal would be beneficial in that it would be the best way of protecting values of individual wetlands, it would provide natural corridors for faunal movement, and it would facilitate management and minimise fire risk to property. Six areas are suggested herein.

Area to contain wetlands in the Corimup Suite

Area to contain Angove River, Angove Lake, Black cat creek, Goodga River and Moates Lake, Gardner lake, Gardner Lake Dunes suite, and the wetlands of Reef Dune Suite in the parabolic dune.

Area of impounded wetlands (lakes, sumplands, and creeks) behind the coastal dune barrier at Hassell Beach

Area containing the wetlands around Blue Lagoon and the parabolic dunes which are necessary for wetland evolution in this suite.

Area containing the Goode Beach Suite and the Frenchman Bay Suite, i.e., from Frenchman Bay Rd to Possession Point, incorporating the islands, tombolo, beach ridges, wetlands and granite tors.

Area around Walpole incorporating palusmonts such as the Chugg palusmont, Boronia Ridge palusmont, paluslopes such as northeast Walpole and Collier River, estuarine flats, and the delta of Frankland River.

9.0 REFERENCES

Allen G R & Berra T M (1989) Life history aspects of the West Australian Salamanderfish, *Lepidogalaxias salamandroides* Mees. Rec West Aust Mus 14 (3):253-267

Australian Nature Conservation Agency (1996) A Directory of Important Wetlands in Australia. Second edition. ANCA, Canberra

Biggs E R, Leech R E J, and Wilde S A (1980) Geology Mineral Resources and hydrogeology of the Darling System, Western Australia In: Atlas of Natural Resources Darling System Western Australia. Dept. Conservation & Environ. Univ. W. A. Press, 3-20

Bureau of Meteorology (1975) Climatic Averages, Western Australia. Aust. Gov. Publ. Serv., Canberra

Christensen P (1982) The distribution of Lepidogalaxias salamandroides and other small freshwater fishes in the lower south-west of Western Australia. J Roy Soc WA 65 (4):99-106

Churchward H M, & McArthur W M (1980) Landforms and Soils of the Darling System, Western Australia. In: Atlas of Natural Resources Darling System Western Australia. Dept. Conservation & Environ. Univ. W. A. Press, 25-33

Churchward H M, McArthur W M, Sewell P L and Bartle G A (1988) Landforms and Soils of the south coast and hinterland, Western Australia. Northcliffe to Manypeaks. Divisional Report 88/1 CSIRO Division of Water Resources.

Edward D H D, Gazey P, & Davies P M (1994) Invertebrate community structure related to physico-chemical parameters of permanent lakes of south coast of Western Australia. J Roy Soc WA 77:51-63

Ferdowsian R and Ryder A T (1997) Salinity and Hydrology of the Wamballup Swamp Catchment. Resource management technical report 160 Agriculture W. A. Albany

Ferdowsian R and Ryder A T (1997) Salinity and Hydrology of the Mills Lake Catchment. Resource management technical report 166 Agriculture W. A. Albany

Garnett, S. (1992). Threatened and extinct birds of Australia. Royal Australasian Ornithologists Union Report Number 82. Pp. 212. Royal Australasian Ornithologists Union, Melbourne.

Gentilli J (1972) Australian Climate Patterns. Nelson Academic Press Melbourne

Hearn R, McFarlane T and Annels A (in press) Declared Rare and Poorly Known Flora in the Southern Forest Region. Report to Conservation and Land Management Perth

Hodgkin P and Clark R (1988) Estuaries and Coastal Lagoons of South Western Australia. Wilson Inlet, Irwin Inlet Parry Inlet - Estuaries of the Denmark Shire. Environmental Protection Authority Perth, W. A.

Hodgkin P and Clark R (1990) Estuaries and Coastal Lagoons of South Western Australia. Estuaries of the Shire of Ravensthorpe and the Fitzgerald River National Park. Environmental Protection Authority Perth, W. A.

Hodgkin P and Clark R (1990) Estuaries and Coastal Lagoons of South Western Australia. Estuaries of the Shire of Albany. Environmental Protection Authority Perth, W. A.

Horwitz P (1994) Patterns of endemism in the freshwater fauna of the far southern peatlands and shrublands of Southwestern Australia. Report to Australian Heritage Commission and the Heritage Council of Western Australia.

Jaensch R P (1992) Waterbirds in wetlands on the south coast of Western Australia Summer 1991-2. Unpublished report to Dept. Conservation and Land Management, Woodvale.

Jaensch R P (1992) Fishes in wetlands on the south coast of Western Australia. Unpublished report to Dept. Conservation and Land Management, Woodvale.

Jaensch R P (1993) A survey of frogs in wetlands on the south coast of Western Australia. Unpublished report to Dept. Conservation and Land Management,

Jaensch, R. P., Vervest, R.M. and Hewish, M.J. (1988). Waterbirds in nature reserves of south-western Australia 1981-1985: Reserve accounts. Royal Australasian Ornithologists Union Report Number 30. Pp. 290. Royal Australasian Ornithologists Union, Melbourne.

Jennings J N and Mabbut J A (1977) Physiographic outlines and regions. In: Jeans D N (Ed) Australia - a geography. Sydney Univ. Press p38-52

Lane, J., Jaensch, R. and Lynch, R. (1996). Western Australia, pp. 762-943 in R. Blackley, Usback, S. and Langford, K. (eds). A Directory of Important Wetlands in Australia, Second Edition. Pp. 968. Australian Nature Conservation Agency, Canberra.

Le Provost, Semeniuk and Chalmer (198?) Lake Seppings Unpublished report to Shire of Albany

Morgan D L, Gill H S, and Potter I C (1996) The distribution of Freshwater Fish in the south western corner of Australia. Report to Water & Rivers Commission, Perth W. A.

Muhling P C and Brakel A T (1985) Mount Barker - Albany, Western Australia. 1:250,000 Geological Series - explanatory notes. Geological Survey of W. A.

Northcote K H, Bettenay E, Churchward H M and McArthur W M (1967) Atlas of Australian Soils, Sheet 5. Pert-Albany-Esperence Area, with explanatory data. CSIRO Australia. Melbourne Univ. Press

Playford P E, Cockbain A E and Low G H (1976) Geology of the Perth Basin, Western Australia. Geol. Survey W Aust Bull. 124

Raines, J. A., Yung, F.H. and Burbidge, A.H. (unpub.). Wetlands of outstanding ornithological importance for the Register of the National Estate in south-west Western Australia: Report to the Australian Heritage Commission. Royal Australasian Ornithologists Union, Melbourne (1995).

Robinson C J (1992) Survey and Inventory of the flora of wetlands of the south coast of Western Australia. Unpublished report to Dept Conservation and Land Management, Woodvale, W.A.

Robinson C J and Coates D J (1995) Declared Rare and Poorly Known Flora in the Albany District. Report to Conservation and Land Management Perth

Semeniuk C A (1988) Consanguineous wetlands and their distribution in the Darling System, Southwestern Australia. Jour. Roy. Soc W.A. 70(3) 69-87

Semeniuk C A, Semeniuk V, Cresswell I D and Marchant N G (1990) Wetlands of the Darling System, Southwestern Australia: a descriptive classification using vegetation pattern and form. Jour. Roy. Soc W.A. 72(4) 109-121

Semeniuk V (1985) The age structure of a Holocene barrier dune system and its implication for sealevel history reconstructions in southwestern Australia. Marine Geology, 67: 197-212

South Coast Regional Assessment Panel and South Coast Regional Initiative Planning Team (1995-96) South Coast Regional Land and Water Care Strategy. The Albany Hinterland Sub-Region.

South Coast Regional Assessment Panel and South Coast Regional Initiative Planning Team (1995-96) South Coast Regional Land and Water Care Strategy. The Kent Frankland Sub-Region.

South Coast Regional Assessment Panel and South Coast Regional Initiative Planning Team (1995-96) South Coast Regional Land and Water Care Strategy. The Fitzgerald Biosphere.

Thom R and Chin R J (1984) Bremer Bay, Western Australia. 1:250,000 Geological Series - explanatory notes. Geological Survey of W. A.

Thomson C, Hall G and Friend G (Ed.) (1993) Mountains of Mystery. A Natural History of the Stirling Range. Dept. Conservation and Land Management

V & C semeniuk Research Group (1997) Mapping and Classification of Wetlands from Augusta to Walpole in the South West of Western Australia. Report to Water and Rivers Commission. Water Resource Technical Series Report No. WRT 12

Wardell-Johnson G & Roberts J D (1991) The survival status of the *Geocrinea rosea* (Anura: Myobatrachidae) complex in riparian corridors: biogeographical implications. In: Saunders D A & Hobbs R J (eds), Nature Conservation 2: The role of corridors. Beatty & Sons, Chipping Norton, p.167-175

Wardell-Johnson G & Roberts J D (1993) Biogeographic barriers in a subdued landscape: the distribution of the *Geocrinea rosea* (Anura: Myobatrachidae) complex in south- western Australia. J. Biogeography 20:95-108

Watkins, D. (1993). A national plan for shorebird conservation in Australia. R.A.O.U. Report Series, No. 90. Royal Australasian Ornithologists Union, Melbourne.

Wilde S A & Walker I W (1984) Pemberton-Irwin Inlet Western Australia. 1:250,000 Geological Series-Explanatory Notes. Geological Survey of W. A.